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# Optimal Solid Waste Landfilling Site Selection in Qeydar Using AHP And TOPSIS Models

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## Abstract

**Background:** Increased waste production is one of the main consequences of current urbanization and also the most important factor affecting the environment. Sanitary landfilling is the main waste disposal method in many countries, including Iran. The use of satellite and GIS data for municipal waste landfilling site selection is one of the new and fast landfilling site selection methods.

**Methods:** The data in this study were collected from relevant organizations and institutions and analyzed and standardized using ArcGIS10.3 software. Afterward, the criteria were weighted using expert opinions and the analytic hierarchy process (AHP) and a binary comparison matrix was formed in Expert Choice software to overlap the layers. Finally, the selected alternatives were ranked using the TOPSIS method.

**Results:** After ranking the selected alternatives using the TOPSIS method, the best site was selected in the south east of the specified region. The results indicated that the current landfill is located in a suitable place, but it cannot meet solid waste landfilling needs for at least the next 15 years.

**Conclusion:** Given the problems of the current landfill in Qeydar (the capital of Khodabandeh County, Zanjan Province, Iran) and the growing population of this city, selecting a new landfill in the city is essential.

**Keywords:** Solid waste landfilling site selection, Analytic hierarchy process (AHP), TOPSIS, Qeydar, Iran

## Background

Excessive population growth, urban development, the emergence of new technologies and changes in consumption patterns, on the one hand, and restrictions on the use of natural resources, on the other hand, have led to complex problems in human quality of life and caused various social, economic, and environmental consequences. With the expansion of cities and consequently the increase in urban activity and consumption, large amounts of waste are produced in urban communities. Waste disposal has always been a serious problem for mankind for many years. Perhaps the simplest and most practical way was to dump waste in low-lying areas outside urban areas and then incinerate it to prevent pollution. Waste disposal problems in these areas have led to the replacement of sanitary landfills with open dumpsters in some countries of the world (1). Although landfilling is the last resort in municipal solid waste management, it is a common municipal solid waste management technique in developing countries (2). Municipal solid waste management is one of the requirements of any city, which can cause many problems for the city if not taken into account seriously (3). In Iran, the lack of proper management and explicit regulations for the collection, disposal, and recycling of more than 40,000 tons of waste per day has caused these wastes to be buried in the ground or scattered around cities (4). Finding a suitable landfill is one of the most important stages of studies in parallel with landfill design (5). Solid waste landfilling site selection is a relatively complex and costly issue that requires consideration of multiple factors and spatial analysis (6).

Solid waste landfilling site selection is dependent on many factors such as topography and geology of the site, hydrology of the area, climatic conditions, required land area, soil cover, groundwater level, location and urban development, characteristics of landfill waste, adjacent land use, surface water distance from the landfill, land price, and landfill life. Thus, extensive studies are required for municipal solid waste landfill planning, design, and site selection with a focus on effective factors. The selection of multiple factors and consequently the multiplicity of layers of information leads decision-makers to subconsciously use a system that, in addition to high accuracy, has high speed and ease of operation (7). Recently, the Geographic Information System (GIS) has been recognized as a suitable tool for use in landfill selection studies. Researchers are currently using GIS capabilities to locate landfills, as the GIS software can analyze large volumes of information layers (8) and provide a suitable decision-making platform. GIS is a computer system for managing and analyzing spatial data. It is able to collect, store, analyze and display geographic data (9). In addition to GIS, the analytic hierarchy process (AHP) is one of the most widely used decision-making tools. AHP is a flexible, robust, and simple method (10). The Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS) was used in this study to prioritize the alternatives. TOPSIS is used as a member of the MCDM family or a multi-criteria decision-making method. The TOPSIS model was first used by Yang (11). It is used for preferences ranking based on similarity to the ideal solution. In this model, planning is defined based on the Euclidean distance between cases to the ideal case and the best solution is the one that has the shortest distance with the ideal solution and the farthest distance with the non-ideal solution (12).

In recent years, many studies have addressed solid waste landfilling site selection. In a study to select a municipal landfill by network analysis process, Banar et al. used the ANP and AHP methods to locate landfills in Eskisehir, Turkey. They concluded that both methods produced the same result and the current landfill site of the city was the most suitable waste disposal place (13). In another study, Effat and Mohamad used remote sensing data for mapping potential waste disposal sites for cities in sub-Sinai using multi-spatial evaluation. They classified the related criteria into three environmental, economic, and social factors. They selected a solid waste landfilling site for each city by taking into account each of the environmental, economic, and social issues (14). Chabuk et al. selected a landfill site for Al-Musayiab Qadhaa in central Iraq. In this study, 15 variables were considered for site selection for municipal solid waste landfilling, and the best sites were selected using the analytic hierarchy process (AHP) (15). Mirzaei et al. conducted a study to select landfill sites using AHP and TOPSIS in Golpayegan, Iran. Using AHP, three waste disposal sites were introduced. Besides, the best site was selected using TOPSIS (16). Chabok et al. conducted a study to find out the best solid waste landfills in southern cities of Khuzestan province including Khorramshahr, Abadan, Shadegan, and Mahshahr using fuzzy logic and by focusing on environmental, economic, and social indicators. The results showed that most parts of the study area, especially the central parts of the area were unusable or severely restricted for landfilling municipal solid waste. Moreover, Shadegan faced more restrictions due to agricultural lands, Shadegan wetland, and the wildlife-protected area. In contrast, Khorramshahr and Mahshahr counties had fewer environmental restrictions for municipal solid waste disposal and landfilling (17). Emadodin et al. addressed solid waste landfilling site selection in Gorgan using AHP and ANN models. They determined suitable landfilling sites in the northwest, northeast, the middle line of the city, and some southern areas of Gorgan (18).

Given the importance of site selection for solid waste landfills in Qeydar, this study was conducted after field visits to introduce a suitable landfilling site for the city with an approach to preserving the environment, reducing soil and water pollution, and saving natural resources.

## Methods

Qeydar is a town in Khodabandeh County located in Zanjan province, about 88 km southeast of Zanjan city. The city of Qeydar is located at 48°35'W and 36°7'N and 2050 meters above sea level. The location of the city is shown in Figure 1.

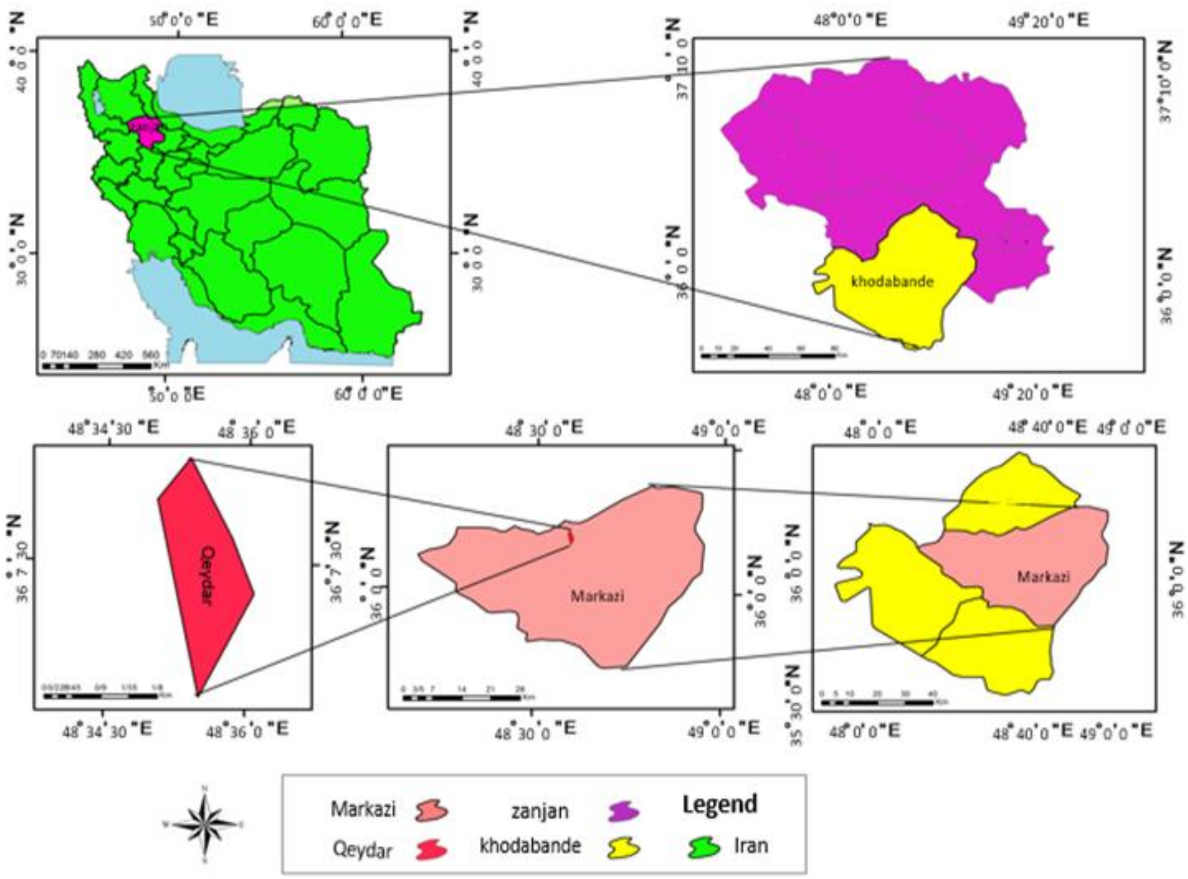



**Figure 1. The location of Zanjan Province, Khodabandeh County, and the city of Qeydar**

For site selection in the GIS system, criteria and constraints were prepared as map layers and processed and analyzed. The desired area was selected with a distance of 5 km to the center of Qeydar based on parameters such as geological, pedological, land use, and access indexes. Distance from industrial centers and mines, slope, the slope direction, hydrological and hydrogeological factors, and distance from residential areas, each played an important role in landfill site selection. To prepare standard maps, the layers were converted to raster images and reclassified. Then, following the expert opinions, the data in Table 1 were entered into Expert Choice software in order of importance. The data were then analyzed using Arc GIS 10.3, Excel, Expert Choice 11 software. The selected alternatives were weighted using the AHP method and ranked using TOPSIS. Furthermore, to calculate the area of land required for landfill, the waste production up to the year 2036 and the area required for landfill were estimated.

In assessing the environmental potential for sanitary landfilling, not all of the used criteria have the same weight, and some of the criteria act as a key factor, i.e. their absence or low quality, even if other parameters are present, will cause the study area be assessed as unsuitable for landfilling. Thus, to rank the importance of landfill decision criteria, factors are weighted (11). The analytic hierarchy process (AHP) is the best way to weigh the criteria. AHP was first introduced by Saaty as a common method for solving problems and multi-criteria quantitative analysis. In fact, it is a quantitatively flexible method for selecting criteria based on their performance and according to one or more criteria (19). In general, the goal of AHP-aided decision-making is to determine the weight of the criteria. Turing the subject or the problem under consideration into a hierarchical structure is the most important part of the hierarchy process (20) until the hierarchical structure is formed and finally the relative weight of each criterion is calculated. Table 1 shows binary comparisons of the alternatives (21).

**Table 1. A comparison of 9 Saaty's quantities for binary comparison of the options**

| Points | Definition |
|---|---|
| 1 | Equally preferred |
| 3 | Moderately preferred |
| 5 | Strongly preferred |
| 7 | Very strongly preferred |
| 9 | Extremely preferred |
| 2, 4, 6, 8 | Intermediate preferences |

The final weight of each alternative is calculated in relation to the target using a chain multiplication of weights from the alternative to the target. The AHP model can be implemented in Expert Choice software. The target in Expert choice is considered as the main branch of hierarchical analysis and criteria are considered and introduced as the sub-branches of the target (22). In the present study, the weight of each option was calculated using the data in Table 1 with Expert Choice software by binary comparisons of the sub-criteria based on the value of the inconsistency ratio. Then, to standardize the weights, the standard outputs for the model were prepared, and finally, the criteria and alternatives were ranked based on the objectives of the study.

Since the AHP method alone is not efficient for selecting the best landfilling site, it is necessary to use the TOPSIS method for the final site selection. TOPSIS is a multi-criteria decision-making method for ranking alternatives by simulating them to the ideal solution (23). The advantage of this model over other models is that it uses quantitative and qualitative criteria at the same time. Besides, its output can express the order of prioritization of alternatives quantitatively and can eliminate inconsistencies among the indicators (24). TOPSIS is performed through the following steps:

1. Forming the data matrix with *n* indexes and *m* alternatives
2. Standardizing the data and forming the standard matrix
3. Determining the weight of each index
4. Determining the distance of alternative *i* from the ideal alternative where positive ideals include geology, soil type, road distance, land use, slope, distance from industrial and mining facilities, and slope direction
5. Determining the minimum alternative i where negative ideals include the distance from wells, rivers, cities, and villages
6. Determining the interval criteria for the ideal alternative ($Ai^+$) and minimum alternative ($Ai^-$)
7. Determining the $Ci^-$ value
8. Ranking the alternatives based on the $Ci^+$ value that varies from 0 to 1. An alternative has the highest rank when $Ci^+$ is 1 and the lowest rank when $Ci^+$ is 0 (16).

Factors such as waste production rate, population growth, and density of compacted materials at the landfill are needed to calculate the land area required for landfilling. Thus, the rate of population growth and annual waste production, as well as the landfill height and shape should be examined (24). Given that waste production increases in parallel with population growth, Eq. (1) was used to estimate the population of the city of Qeydar until 2036 and to calculate the population growth rate:

$$P_t = P_0(1 + r)^t \quad (1)$$

Where $P_t$ is the population in the target year t, $P_0$ is the population in the current year, *r* is the population growth rate in percent, and *t* is the project period or the number of years the project is to be operating.

The area of land required for the landfilling site until 2036 was calculated using the following equation:

$$V = R/D\,(1 - P/100) + CV \quad (2)$$

Where *V* is the land area required per year (hectares), *R* is the per capita production, *CV* is the volume of required soil cover, *P* is the reduction in waste volume due to compaction, and *D* is the average waste density (24).

## Results

The first and most important step in this study was the preparation of data in ArcGIS software and the formation of a hierarchical structure in Expert Choice software as shown in Figure 2.

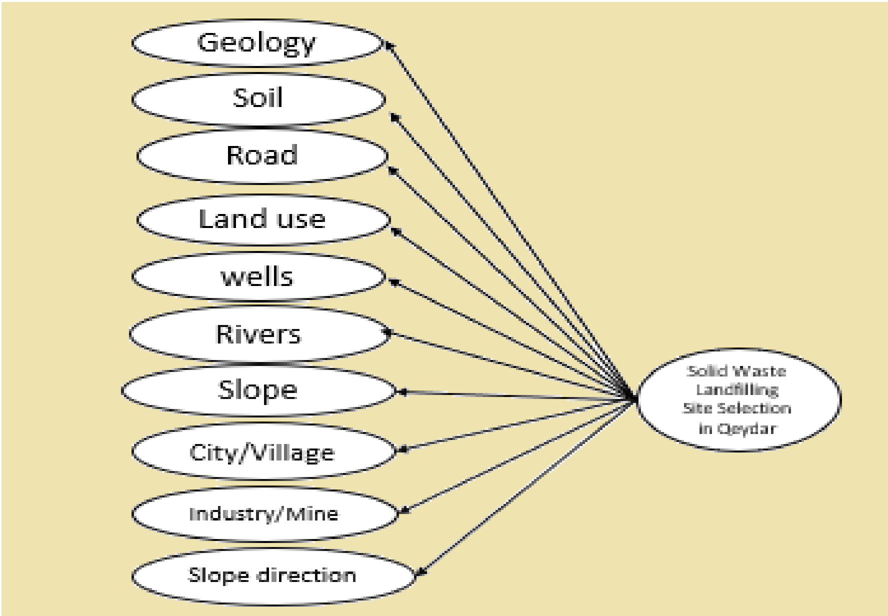



**Figure 2. The hierarchical structure**

The layers were classified and the landfill site maps were plotted using the data in Table 2. These data were prepared based on expert opinions and the standard quantities presented in Table 1. Then, the map of each criterion was plotted (Figures 3(a) to 3(i)) using the weights and scores presented in Table 2.

**Table 2. Classification and evaluation of information layers**

| Point | Extremely preferred (9) | Very strongly preferred (7) | Strongly preferred (5) | Moderately preferred (3) | Equally preferred (1) |
|---|---|---|---|---|---|
| Geological features | - | Ek | Ktzl | Omql | Qft1 |
| Soil type | - | VT/E | IVT,IVST+IVT | IVST,IVS | IIIT,IIIS,IIST |
| Distance from the roads | 120-200 | 200-500 | 500-1000 | >1000 | <120 |
| Distance from wells | >1000 | - | 500-1000 | 300-500 | <300 |
| Distance from rivers (m) | >1100 | 900-1100 | 700-900 | 500-700 | <500 |
| Slope (%) | 0-5 | 5-10 | - | 10-15 | >15 |
| Distance from cities and villages (km) | 4-5 | 3-4 | 2-3 | - | >5 & <2 |
| Distance from industrial centers and mines (m) | >2500 | 2000-2500 | 1500-2000 | 1000-1500 | <1000 |
| Slope direction | South and southeastern, Leveled | Eastern | Southwestern | Western Northeastern | Northern Northwestern |
| Land use | Barren and unused lands | Semi-dense pastures | Rainfed and irrigated farming lands, dense pastures | Irrigated farming lands | Gardens, residential complexes, industrial towns, mines, cities, villages, farming lands |

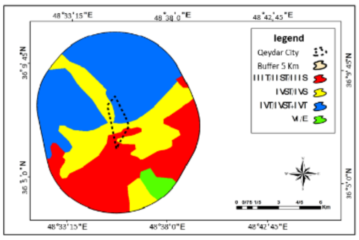
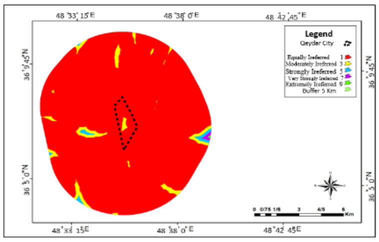
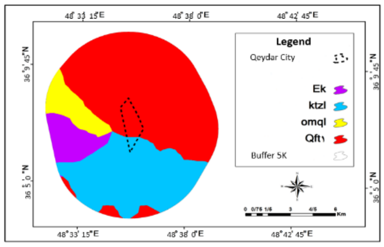


**Figure 3(a). Pedological classification and valuation**



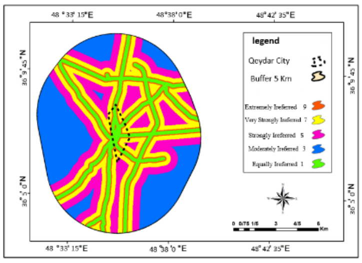
Distance from rivers

**Figure 3(b). Distance from rivers**



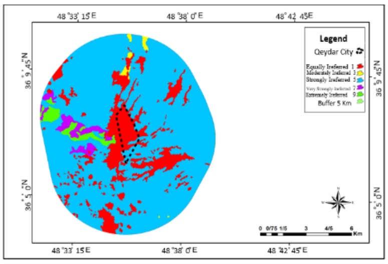
Geological classification and valuation

**Figure 3(c). Geological classification and valuation**



Distance from roads

**Figure 3(d). Distance from roads**



Distance from farming lands

**Figure 3(e). Distance from farming lands**

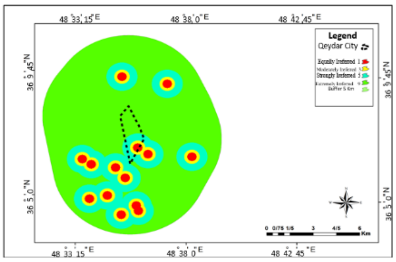
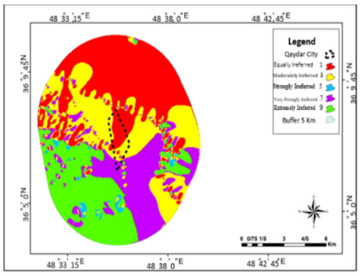
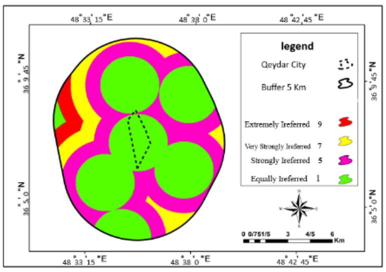


**Figure 3(f). Distance from wells**



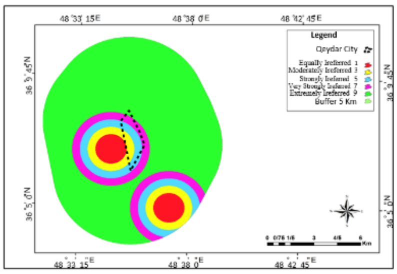
slope analysis

**Figure 3(g). Slope analysis**



Classification and valuation distance from city and villages

**Figure 3(h). Distance from cities and villages**



Distance from industrial centers and mines

**Figure 3(i). Distance from industrial centers and mines**

The weight of each sub-criteria was estimated through binary comparisons in Expert Choice software by taking into account the inconsistency ratio. By entering the priority criteria in the Expert Choice software based on the calculations, the inconsistency ratio was set equal to 0.05. Since the calculated value was less than the standard value (0.1), the inconsistency was acceptable. Following the expert opinions, the criteria were evaluated in Expert Choice software as shown in Table 3.

**Table 3. The matrix formed in the Expert Choice software**

| | Geological features | Soil | Roads | Land use | Wells | Rivers | Slope | Cities/villages | Industries/ mines | Slope direction |
|---|---|---|---|---|---|---|---|---|---|---|
| Geological features | | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 |
| Soil | | | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 |
| Roads | | | | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| Land use | | | | | 2 | 3 | 4 | 5 | 5 | 6 |
| Wells | | | | | | 2 | 3 | 4 | 5 | 5 |
| Rivers | | | | | | | 2 | 3 | 4 | 5 |
| Slope | | | | | | | | 2 | 3 | 4 |
| Cities/villages | | | | | | | | | 2 | 3 |
| Industries/mines | | | | | | | | | | 2 |
| Slope direction | | | | | | | | | | |
| Inconsistency rate:0.05 | | | | | | | | | | |

To calculate the weights of the criteria, the values in each column of the comparison matrix were added and the value for each matrix element was divided by the total value of the column. Then, the average of the elements in each row of the standardized matrix was calculated. To this end, the sum of standardized scores for each row was divided by the number of criteria. These average values are estimates of the relative weights of the benchmarks compared as shown in Figure 4.

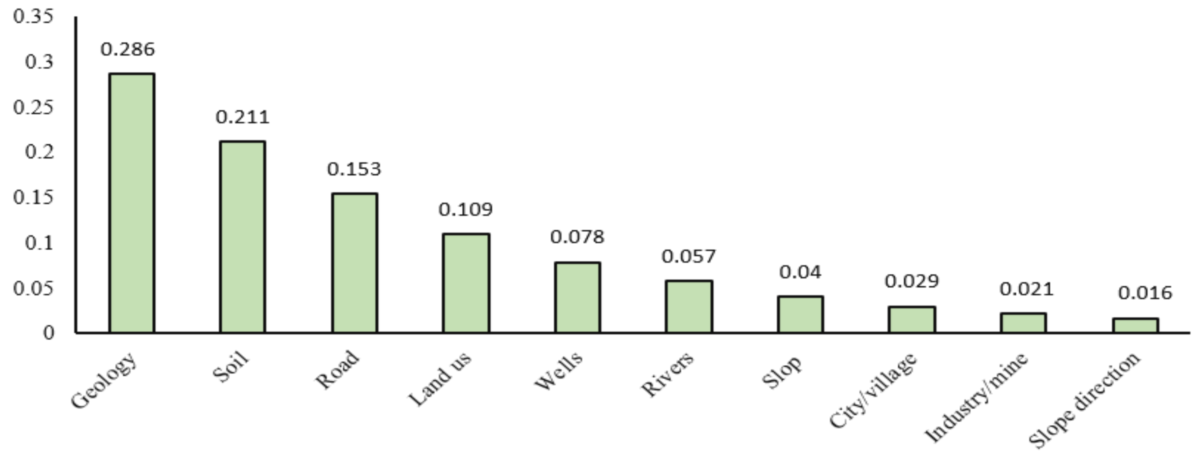



**Figure 4. The relative weight of criteria**

It should be noted that by superimposing the maps in ArcGIS software and using the AHP method, the weight values of the criteria were multiplied by 100 as shown in Table 4.

Finally, after weighing the layers, the GIS software was used to overlay the maps as displayed in Figure 5.

**Table 4. The weight vector of the criteria**

| Information layers | Geological features | Soil type | Roads | Land use | Wells | Rivers | Slope | Cities/ villages | Industries/ mines | Slope direction |
|---|---|---|---|---|---|---|---|---|---|---|
| Value | 29 | 21 | 15 | 11 | 8 | 6 | 4 | 3 | 2 | 1 |

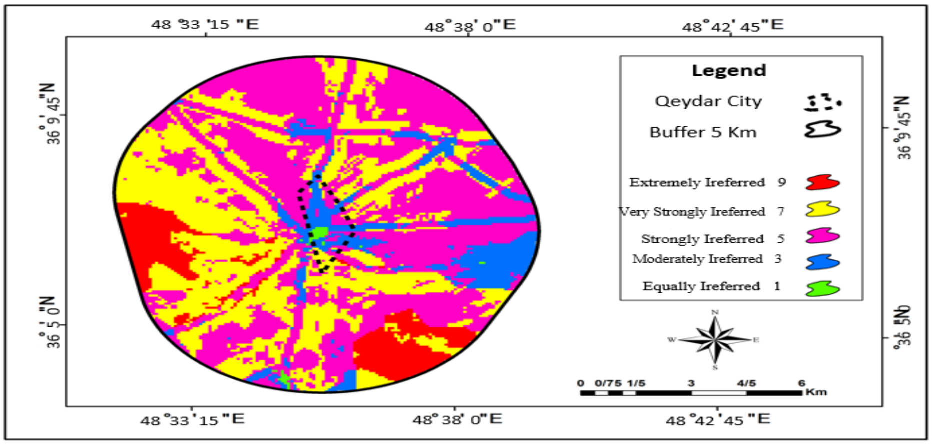



**Figure 5. The map obtained by superimposing the information layers using the AHP method**

After applying the changes, the final map obtained from the AHP method was displayed in Figure 6. As can be seen, the first zone was located in the southeast and the second zone was located in the west of the study area.

TOPSIS was performed in Excel software The weights calculated by the AHP method were used to perform the calculations as shown in Table 5.

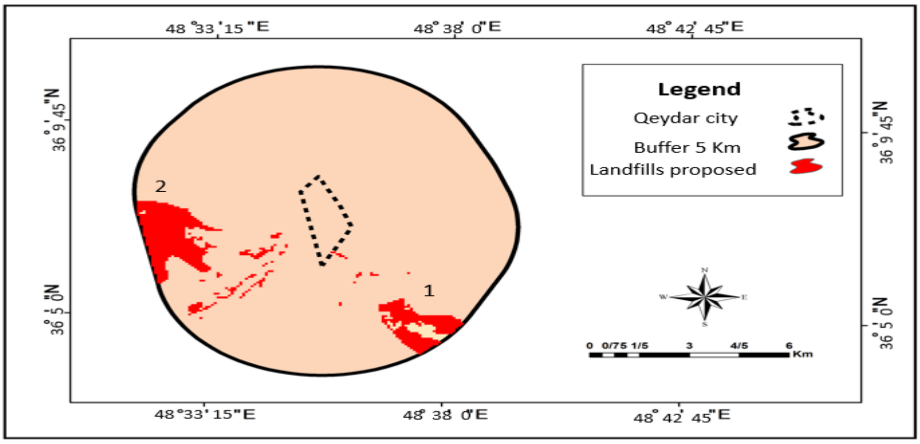



**Figure 6. The landfills proposed by the AHP method**

**Table 5. The calculations performed with TOPSIS**

| Stages | Locations | Geological features | Soil type | Roads | Land use | Wells | Rivers | Slope | Cities/ villages | Industries/ mines | Slope direction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Weighting | Southeastern | 5 | 7 | 9 | 5 | 9 | 1 | 9 | 5 | 5 | 7 |
| | West | 7 | 5 | 3 | 5 | 7 | 1 | 7 | 9 | 9 | 9 |
| Normalization | Southeastern | 0.58 | 0.81 | 0.95 | 0.71 | 0.79 | 0.71 | 0.79 | 0.49 | 0.49 | 0.61 |
| | West | 0.81 | 0.58 | 0.32 | 0.71 | 0.61 | 0.71 | 0.61 | 0.87 | 0.87 | 0.79 |
| Weighted matrix | Southeastern | 0.166 | 0.172 | 0.145 | 0.074 | 0.062 | 0.040 | 0.03 | 0.01 | 0.01 | 0.01 |
| | West | 0.233 | 0.123 | 0.048 | 0.074 | 0.048 | 0.040 | 0.02 | 0.03 | 0.02 | 0.01 |
| Ideal $A^+$ and | $A^+$ | 0.233 | 0.172 | 0.145 | 0.074 | 0.062 | 0.040 | 0.03 | 0.03 | 0.02 | 0.01 |
| ideal $A^-$ | $A^-$ | 0.166 | 0.123 | 0.048 | 0.074 | 0.048 | 0.040 | 0.02 | 0.01 | 0.01 | 0.01 |
| Distance from the positive ideal | Southeastern | 0.04 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.07 |
| | West | 0.0 | 0.002 | 0.009 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 |
| Distance from the negative ideal | Southeastern | 0.00 | 0.002 | 0.009 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 |
| | West | 0.004 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.069 |

After performing the calculations, the zones were ranked using TOPSIS as shown in Table 6.

**Table 6. The alternatives ranked by TOPSIS**

| Locations | $cl_i$ | Ranks |
|---|---|---|
| Zone 1 | 0.621 | 1 |
| Zone 2 | 0.389 | 2 |

Given the influence of various factors on the usefulness of an area to be introduced as a landfill site, a method that can incorporate all parameters in the decision and also expert opinions should be used (25). After superimposing the maps and using the methods, two zones were identified (the first zone located in the southeast and the second zone in the west of Qeydar). After prioritizing the alternatives using TOPSIS, the first zone with the value $cl_i$ was selected as the best zone.

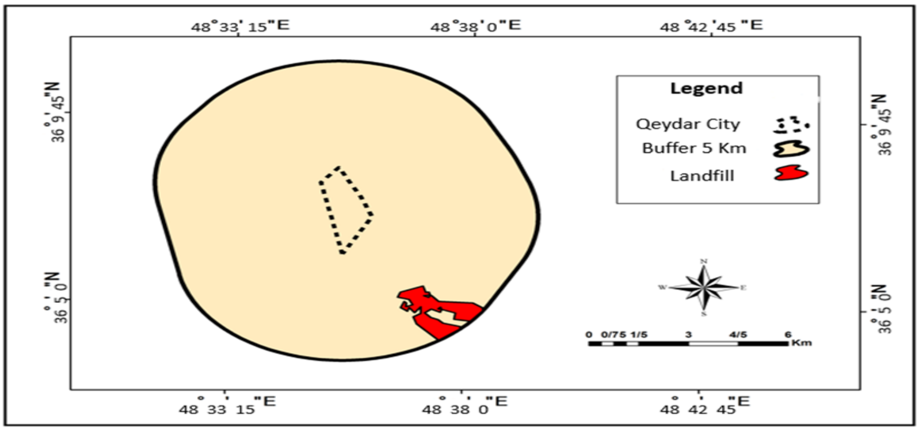



**Figure 7. The site proposed for solid waste landfilling**

Furthermore, using Eq. (1), it is estimated that in 2036 the population of Qeydar will reach 46304 persons. Thus, the total amount of waste generated during 15 years was calculated to be 451256.6 tons. To calculate the land area required for landfilling, Eq. (2) was used, in which the percentage of reduction in waste volume through compaction was considered equal to 40% (16). Based on these data, the soil coverage until 2036 is estimated at 6446522.3 cubic meters. The area required for landfilling until 2036 was calculated to be 1444021 square meters using Eq. (6), if a depth of 5 meters is intended for landfill applications. Due to the population growth and increased waste production and the need for a landfill with an area of 1444021 for the next 15 years, the proposed site must meet waste landfilling needs.

## Discussion

Optimal solid waste landfill site selection is the most important step to create and develop a plan for the future of cities based on environmental, geomorphological, geological, hydrological, climatic, and urban economy assessments (26). Using GIS, AHP, TOPSIS, effective criteria for solid waste landfill site selection in Qeydar were identified and analyzed in this study. AHP assessments showed that the geological features with a weight of 0.289 had the highest weight and relative importance and the slope direction weighing 0.016 had the lowest weight. Various criteria are involved in landfill design considerations, some of which were analyzed in this study. In solid waste landfilling site selection, geological evaluations are of high significance. The most important factors to be noted are the type of bedrock, thickness, the material and their origin, and soil folding patterns (27). The geological units in the study area include Karaj Formation (EK), Tizkoohi Formation (Ktzl), Qom Formation (OMql), terrace reserves, and old highland alluvial fans (Qft1), which were classified based on the permeability characteristics of the formations. The data showed that the Karaj Formation has a high score while the terrace reserves and old highland alluvial fans have a low score. Similarly, Pourkhosravani et al. (28) highlighted the importance of geological criteria in solid waste landfilling site selection. Another issue that should be considered in choosing a landfill is land use. Land uses in one area should not interfere with other activities. Furthermore, in landfill site selection, care should be taken that the site does not have valuable uses such as quality agricultural lands, forests, and wetlands (22). Accordingly, barren and unused lands were scored high, whole gardens, human settlements, industrial and mining areas, cities and villages, and irrigated farming lands received the lowest score. Aghdasizad et al. (24) also showed that barren and unfertile areas are the best places for municipal waste landfills. The city of Qeydar, as the main producer of grains in Zanjan Province, has good agricultural lands and extensive gardens and farms. Thus, barren and infertile areas are considered good options for landfill site selection, and cultivated areas, gardens, and urban areas were considered the most unsuitable options.

In the present study, land classification was performed based on the data from soil science studies. Soil science is a set of measures taken to identify the soils of an area, which include describing the properties of soils, classifying them according to a standard system, determining the boundaries of soils on a map, and describing how they are distributed. Therefore, the lands in the study area were classified into different qualitative groups, each representing a certain level of land quality. This classification shows the specific capabilities of soil, texture, salinity, and alkalinity. Accordingly, Aghsaei and Souri (29) confirmed the importance of soil permeability criteria in solid waste landfilling site selection.

The most suitable place for landfilling is a place where there is no connection between waste and groundwater and does not disturb the surrounding residents and development programs in place in the region (30). One of the important parameters that should be considered in landfill site selection studies is the presence of surface water in that area. There are a large number of main and secondary rivers in the study area, hence, the study area does not meet the requirements for landfilling purposes, and some arrangements should be made for the drainage of the selected landfill. The highest score was calculated for areas above 1100 meters and the lowest score for less than 500 meters. These findings were in line with the results reported by Mirabadi and Abdi on the importance of distance from hydrological sources (21). In locating suitable substrates for urban and industrial constructions, high groundwater depth can have adverse consequences on wastewater disposal and building strength. The average depth of water surface in the study area is 30 meters. The minimum distance between the landfill site and water wells should be 300 meters and the most optimal distance is 1000 meters.

The slope is one of the main restricting criteria in solid waste landfilling site selection (31). Areas with a slope between 0 to 5% were the best areas and areas with a slope above 15% were considered as unsuitable areas in the present study. Similarly, Jamshidi Zanjani and Rezaei (32) and Emadodin et al. (18) showed that the slope factor is one of the main criteria in solid waste landfilling site selection. Landfills always have adverse effects on their environment. Thus, landfills in urban and rural residential areas pose a threat to the health of citizens (33). For this reason, in the present study, the sites within a distance of 4 to 5 km from residential areas were considered the most suitable places for landfilling, and the areas within a distance of more than 5 km and a distance of less than 2 km were considered the most unsuitable places for landfilling. Aghdasizad et al. also emphasized the importance of distance from economic activities by highlighting the sub-criterion of distance from residential areas (24).

After determining the optimal distances for the landfill site and superimposing the maps, two zones were introduced as the best options using the TOPSIS method. As a result, the first zone with a score of 0.621 was selected as the best landfill site candidate and the second zone with a score of 0.389 was selected as the second-best candidate. Accordingly, the first zone with an area of 2583127.8 square meters can be used as the best landfill site for at least the next 20 years in Qeydar.

Due to the unavailability of updated GIS data, the existing (older) data were analyzed in the present study. However, to solve this problem, field visits and satellite images of Google Earth were used. It is recommended that up-to-date data, if available, be used in similar evaluations in the future.

## Conclusion

An analysis of the final map plotted using AHP and TOPSIS methods and field surveys of the current landfill site showed that the current landfill site of Qeydar meets the requirements for sanitary landfilling purposes. However, given the population growth rate and increased waste production, the current site can meet landfilling needs only until 2020 and does not have the landfilling capacity until 2036. Thus, to select a suitable solid waste landfill site, the authorities are required to use current sanitary landfill technical and engineering methods instead of traditional methods. They also need to focus on implementing recyclable waste separation programs to take effective steps for protecting the environment.

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## Conflict of interest

The authors declared no conflict of interest in this study.

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