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DEVELOPING AN OPTIMAL MODEL FOR LOCATING SANITARY LANDFILLS BY ANP METHOD. CASE STUDY: ILAM CITY

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Abstract

Locating sanitary landfills is one of the most significant environmental issues in the residential area. The aim of this study is to find the optimal location for the landfill in Ilam city in Iran. The current landfill is located near the river that supply water to the Ilam Dam. Inadequate landfill causes contamination of groundwater resources. Based on the field survey using GIS software and experts opinion, 4 regions were proposed for the landfill. Criteria as environment, hydrology, access roads and population centers were taken into consideration. Sub-criteria such as groundwater depth, the distance from springs, wells, and aqueducts, vegetation cover, surface water resources, animal species habitats, distance from protected areas, prevailing wind direction and distance from main roads were considered. The criteria were weighted by a questionnaire among experts. Ranking of the criteria, the coefficient of each criterion and pair-wise comparison matrix tables were determined with acceptable consistency by Analysis Network Process (ANP) method using Super Decision version 2.8. Results showed that region 1 with a weight of 0.419 and inconsistency rate of 0.05, according to the studied criteria and subcriteria was the most suitable option. The weighting order was obtained for the options 1,2,3,4 in order: 0.419, 0.274, 0.160 and 0.147. Therefore, in terms of the importance and appropriateness of the landfilling location options, they can be ranked as: 1>option 2> option 3> option 4. The results of this study concluded that environmental criteria for landfill location is essential. Landfills can generate harmful effects on their surroundings and influence the quality of public health.

Key words: environmental criterion, Ilam, inconsistency, landfill, optimal location

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1. Introduction

One of the most significant concerns of urban management is the optimal location of landfills. The main purpose of comprehensive waste management is to organize urban waste in a way that meets public health and environmental considerations and the possibility of reusing and recycling the waste (Rathore et al., 2016; Wang et al., 2009). Locating a landfill properly can minimize the adverse environmental effects of waste and is considered a significant waste management strategies especially in countries with a poorly developed or less integrated waste management system (Isalou et al., 2014; Omrani et al., 2012; Ramtel et al., 2021). Measuring the quantity and quality of leachate from waste, the amount of gases and vapors released from waste, geographical conditions and regional climate can be relevant for the selection of appropriate methods of landfilling (Shariatmadari et al., 2006). India waste management project emphasizes investment in waste conversion and energy potential from landfill with methane extraction (Sunil Kumar et al., 2017). Recent developments in the process of urbanization, and consequently the physical growth and development of cities, have caused some issues in the urban space that

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have exposed not only its inhabitants, but also the entire environment to its adverse effects (Ferronato and Torretta, 2019). For example, air pollution during various stages of the solid waste disposal includes the production of biogas, which contains methane and carbon dioxide, produced by the natural decomposition of waste (Makarenko and Budak, 2017). Consequently soil, water, and air degradation have negative impacts for public health (Njoku et al., 2019). Such implications increase with the inappropriate solid waste disposal (Addo et al., 2015).

Studying different waste management methods (collection, minimization, control and purification) in the landfills of urban waste in Iran shows that only 8% of urban waste is recycled, composted and reused, while 92% of the waste is buried; that in this management method of solid waste, about 25% of burring is basic and sanitary, and the rest is unhealthy buried and dumped (Takdastan et al., 2009). The study drew on a novel, integrated method for the selection of municipal solid waste (MSW) landfills in the Iranian metropolis, Shiraz; the study relied on the GIS and multi-criteria decision-making methods. The weight of each criterion was determined and assigned to the corresponding layer in ArcGIS 10.5. By combining these layers through a fuzzy logic, the sites satisfying the disposal conditions were identified (Eghtesadifard et al., 2020). Two different zoning procedures, LEPT and AHP, have been utilized in order to perform landfill siting for Ravansar County-west of Iran. The criteria were the distance from faults and gas pipelines, mines, rivers, roads, lakes, residential areas, slope, springs, water wells, and soil thickness. Results showed that 5.2% of the study area is highly suitable for landfill placement (Ghobadi et al., 2017). For determining the appropriate location for waste landfilling of Hidaj city in Zanjan province, the Analytic Hierarchy Process (AHP) and ArcGIS 10.3 software were used. The results showed that the selected area likely has high potential for landfilling of municipal solid wastes of Hidaj for the next 20-year period (Khosravi et al., 2019).

The research has been conducted on the location of landfills in Mahallat city using Analysis Hierarchical Process (AHP) (Madadi et al., 2013), in Heir district of Ardabil province using Analysis Network Process (ANP) model (Shahab and Mahdavi, 2014) and the researchers have reached at selecting landfills in acceptable areas.

The current landfill of Ilam city (Harderaz) is located on the ridge of the most significant watershed of Ilam province, which has affected all the downstream areas by creating runoff. Although some measures have been done to prevent the movement of surface runoff towards Ilam dam, there is still this risk that if any of the garbage trucks ignores, the dam which supplies drinking water to the people of Ilam and the surrounding villages will be exposed to a serious threat. Research shows that environmental assessments have not been performed for the current landfill in Ilam. The current landfill is located near the rivers that supply water to the Ilam Dam. Ilam Dam supplies water to Ilam city and nearby cities. There is a threat that burying large volumes of waste in inappropriate places can cause a lot of damage to groundwater resources. Inadequate landfill causes contamination of groundwater resources.

The purpose of this study was the finding the optimal location for the landfill in Ilam city in Iran. Based on field survey and using GIS software, expert opinion and weighting of criteria and sub-criteria, 4 regions were proposed for landfill. A questionnaire and a survey among experts were used. Three main criteria, environment, hydrology, access roads were taken into consideration. The present study was performed by ANP method using Super decision version 2.8. Network Analysis Process (ANP) is structured techniques for analyzing complex decision. The Super decision is decision support software that implements the ANP.

According the studies, the development of a landfill location model in Ilam city by simulation through weighting and software results has not been done so far. Innovation of research in determining the location using the pair matrix based on opinions of experts, ANP model and software results this method may cause less damage to the environment.

2. Material and methods

2.1. Study area

Ilam province is in the West of Iran, bordered on the Iraq country. It is located in the North latitude from 32° 02´ 51´´ to 34° 02´ 28´´ and the eastern longitude from 45° 41´ 04´´to 48° 05´ 26´´. The region's climate based on Domarton method is Mediterranean with an average annual rainfall of 588.7 mm distributed unevenly in temporal and spatial scales. The average annual temperature at Ilam station is 16.9°C. In terms of the geological structure, this area is located on the northwestern part of the Zagros Fold belt. This structural zone is located in southwest Iran and its width is estimated to be 150 to 250 km. (Rostami et al., 2020).

According to the last census in 2016, the population of Ilam province, equivalent to 580,158 people has been settled in 20 districts, 21 cities, and 40 villages and 753 settlements. 60.69% live in urban areas, 38.61% in rural areas, and less than 0.7% as quasi-nomadic. An examination of the population density and distribution shows that the province has about 1.2 percent, or 0.77 of the total population of the country. This population is about 35 people per square kilometer compared to the province's area and the average proportion of density of the whole country. Ilam city with a population of 235,144 people, equivalent to 40.5% of the province's population, and as the most populous city is the capital of the province. Currently, in Ilam city, the garbage waste is collected from the doors of houses daily, which causes a favorable status in terms of urban cleaning. Then, the garbage is transferred in light vehicles to the landfill in the southwestern part of Ilam in about 8 km interval overlooking the rivers supplying water to the Ilam dam and 3 km from the airport and the villages of Cheshmeh Kaboud and Sartaf, and is dumped and buried unhealthy without segregation (Fig. 1).

2.2. Research methodology

The purpose of the study is to identify the most suitable areas for the landfill in Ilam because current landfill is located near the rivers that supply water to the Ilam Dam. Water resources are one of the most vulnerable parts of ecosystems and any variation in climate parameters, such as temperature and precipitation that cause changes in hydrological processes; i.e., snowfall, drought, floods, and groundwater levels (Ahmadi et al., 2020). The present study was performed by ANP method using Super decision version 2.8.

In this research to measure the weights of the components and rank the criteria used Network Analysis Process (ANP). The Super decision software was used based on the ANP. Based on field survey, zoning using GIS software and expert opinion, 4 regions were proposed for landfill. A questionnaire was designed with three main criteria of environmental, hydrology and access routes and population centers. In respect of hydrology of the region, sub-criteria such as groundwater depth, the distance of the intended location from springs, wells and aqueducts, in respect of environmental criterion, items such as vegetation, surface water resources and animal species habitats, and in respect of access routes and population centers criterion, items such as distance from the protected areas, direction of prevailing wind and distance from the main roads, 9 sub-criteria were considered. The questionnaire was given to a number of proficient and experienced experts. The analysis of the expert comments was performed by using the Analysis Network Process (ANP) Model (Faraji Sabokbar et al., 2010).

The first step in the ANP method is to create a model and develop a problem. The purpose of decision-making is the development of an optimal model for locating a landfill in Ilam city, and decision criteria and possible options (District 1, District 2, District 3 and District 4) were identified in Fig. 2. After formulating the studied problem, the pair-wise comparison tables compiled based on the graphical representation were prepared and completed from top to down.

According to the network relations of the research problem, in this model, first, 3 criteria, environmental characteristics, hydrology, access routes and population centers were compared pair-wise. In the second level of the research, due to the inter-relationships among the criteria for weighting, all the research criteria were compared with each other. Sometimes, the criteria themselves have to be analyzed in more detail, in which case, another level (including sub-criteria) is added to the analysis. In this study, 9 sub-criteria were compared together regarding the related criteria.

Finally, ANP group workmates were deemed to consider and correlate both competing options at the fifth level of the network analysis pair-wise and sub-criterion at the fourth level. After doing this by the decision-making group, and in order to achieve the relative (local) weight of each of the competing options, the group's views should be converted to a single view, and based on this, and using geometrical average, the combined Super matrix of the ANP group was calculated.

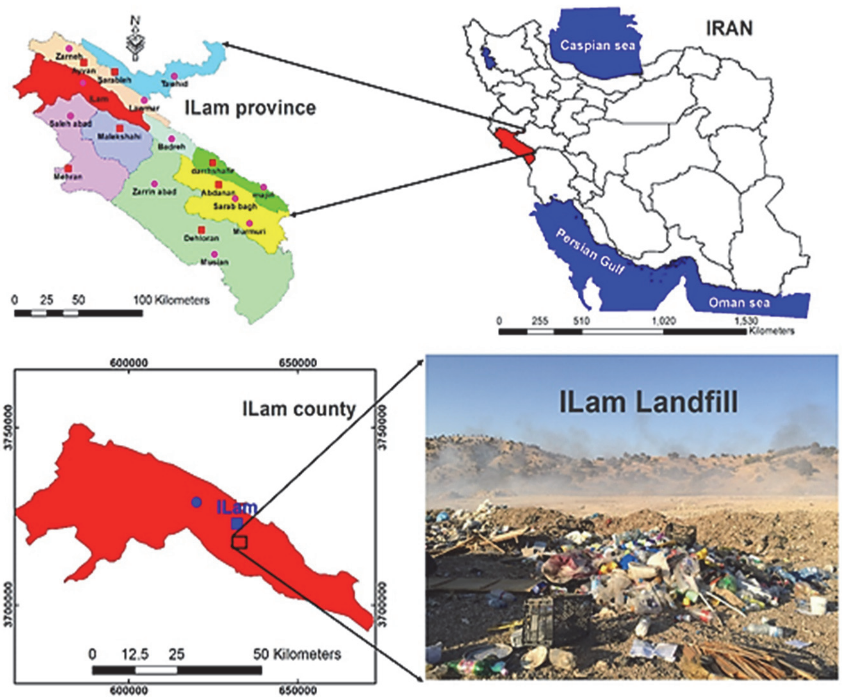


Fig. 1. The location of current landfill of Ilam city

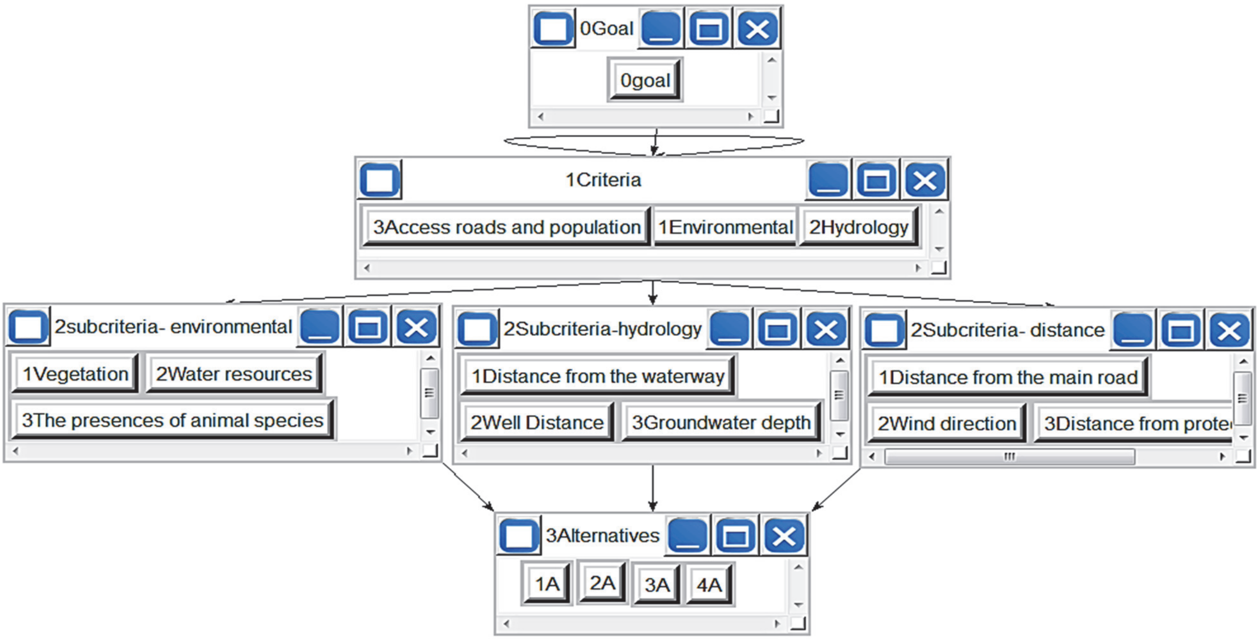


Fig. 2. Designing model: purpose, criteria, sub-criteria, and decision making options

The ANP process included steps as follows:

1: Constructing model and structuring problem.

The undergone issue should be stated clearly and disintegrated into a rational system like a network. The framework can be decided on the basis of decision maker opinion through brainstorming or other appropriate methods (Khan and Samadder, 2015).

2: Comparative Pair-wise matrices and precedency vectors.

The ANP decision elements at each component are compared to pair-wise with regard to their control criteria, and the components themselves are also correlated to pair-wise with regard to their goal access. Decision makers are expected to show feedback to a series of pair-wise comparisons in which two elements or components at a time will be correlated with regard to some specific criterion. The relative significance values are indicated based on scale of 1 to 9, where “1” represents equal importance between the two elements and “9” shows utmost importance of one element, in contrast to the other column component in the matrix. Meade and Sarkis (1999) suggested a selection of the consistency index (CI) and consistency ratio (CR) to confirm the constancy of the comparison matrix. CI and RI can be calculated using Eqs. (1, 2).

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

where λmax is the largest priority of the pairwise comparison matrix and N is the number of classes. If CR≤0.1, then the estimate is proved; however, a new comparison matrix is solicited until CR≤0.1.

3: Supermatrix formation;

The supermatrix concept is like to the Markov chain process. To perform better results in this system, the local priority vectors are entered into the columns of a matrix, known as a supermatrix (Meade and Sarkis, 1999).

4: Adopting the best alternatives;

If the supermatrix formed in Step 3 includes the whole network, the priority weights of alternatives can be appeared in the column of alternatives in the normalized supermatrix. Put it another way, if a supermatrix is only involved interrelated components, additional calculations must be taken into account to obtain the overall priorities of the alternatives. The alternative with the largest overall priority should be the one adopted (Meade and Sarkis, 1998; Saaty, 2001).

3. Results and discussion

3.1. Determining the pair-wise comparison matrix

In order to determine the relative weights of the main criteria, the priority of each criterion relative is determined. In Analysis Network, the weight and significance of each criterion of the study problem should be determined relative, too. For this purpose, the main criteria of the topic were compared with each other pair-wise and after normalization of the compared pair-wise matrix, the coefficient of each was declared. The mean of the criteria and sub-criteria scores from the experts' view is illustrated in Table 1.

Based on the results of the pair-wise comparison, the significance coefficient of research criteria from the experts' view, weighting and ranking of these indicators relative to each other are shown in

Table 2; in which, the environmental criterion is first in the ranking, and then, hydrology and access roads and population centers are of special significance. The inconsistency rate of the opinions of the decision-making group equals 0.05, which according to the condition CR< 0.1, indicates an inconsistency in the opinions of the ANP group and, in turn, the reliability of the obtained priorities.

3.2. Determining the pair-wise comparison matrix of the sub-criteria relative to the criteria

Based on determining the significance coefficient of each criterion relative, the weight and significance of each sub-criterion of the studied problem should be determined relative to the main criteria. For this purpose, the sub-criteria of each main criterion of the topic were compared with each other as pair-wise. The relative significance of the sub-criteria, vegetation with water resources and the presence of animal species were given as scores 1 to 9, which is shown in Table 3.

In Table 4, based on the pair-wise comparison results of the significance coefficients of the environmental sub-criteria, weight, and ranking of these indicators were determined relative to each other. Also, in Table 4 the inconsistency rate of the decision-making group that equals 0.05 are shown, which according to the condition CR < 0.1, indicates consistency in the views of ANP group and hence the reliability of the obtained priorities. In the pair-wise comparison matrix of relative significance of the hydrological sub-criteria relative to each other, the distance from the waterway compared to the distance from wells, springs and aqueducts, and the depth of groundwater and comparison of wells, springs and aqueducts with groundwater depth were given scores from 1 to 9, shown in Table 5. Based on the results of the pair-wise comparison, the significance coefficient of the hydrological index criteria relative to each other, weight and ranking of these indicators, the well, spring and aqueduct distance with a higher weight compared to the other criteria of groundwater depth and waterway distance was in the first rank. The results are shown in Table 6. According to Table 6, the inconsistency rate of the decision-making group equals 0.02, which according to meet the condition CR<0.1, indicates consistency of the views of the ANP group, and as a result, reliability of the obtained priorities.

The pair-wise comparison matrices of relative significance of the sub-criteria of access routes and population centers relative to each other were compared pair-wise and scores from 1 to 9 were given, and the results of this pair-wise comparison and relative significance of the sub-criteria have been shown in Table 7.

Based on the results of the pair-wise comparison, the relative significance coefficient of the subcriteria of access road and population centers index relative to each other, weight and ranking of these indices based on the weight of the index and their ranks from 1 to 3 is shown in Table 8. There, it is shown the prioritization of sub-criteria relative to the criterion of access roads and population centers; the inconsistency rate of the views of the decision-making group is 0.05 that meets the requirement, CR<0.1, and represents consistency in the views of ANP group and, as a result, reliability of the obtained priorities.

3.3. Investigating the inter-relationships between the criteria

In the environmental factor, comparisons of hydrology with access routes and population centers were given scores from 1 to 9, and after calculating the inconsistency rate, the results have been shown in Table 9.

Table 1. Pair-wise comparison matrix of relative significance of the main criteria

	Environmental	*Hydrology*	*Access roads and population centers*
Environmental	-	5,2,1/7,2,5,1,2,6,3,4,7,1/3	4,4,1/3,2,5,3,4,2,2,3,4,5
Hydrology	-	-	6,1/2,1/5,6,1,2,1/3,1,1,3,1/3,3
Access roads and population centers	-	-	Inconsistency=0.05

Table 2. Weight and rank of the main criteria

Criteria	*Weight*	*Rank*
Environmental	0.527	1
Hydrology	0.33	2
Access roads and population centers	0.139	3
Inconsistency=0.05		

Table 3. Pair-wise comparison matrix of environmental sub-criteria

Indicators	*Vegetation*	*Water resources*	*The presence of animal species*
Vegetation	-	5,2,7,3,3,2,5,1,2,3,1,1/4	3,1/5,1/2,5,2,6,3,5,2,1,1/2,3
Water resources	-	-	2,1,1,1/7,1/9,1/4,1/6,1,5/1,1,1,1
The presence of animal species	-	-	Inconsistency=0.05

Table 4. Weight and ranking of the environmental indicators

Indicator	*Weight*	*Rank*
Vegetation	0.493	1
The presence of animal species	0.310	2
Water resources	0.195	3
Inconsistency	0.05	

Table 5. Pair-wise comparison matrix of relative significance of the hydrological sub-criteria relative to each other

Indicators	*Distance from the waterway*	*Well, spring and aqueduct distance*	*Groundwater depth*
Distance from the waterway	-	1/3,1,1,1,1, 1/5, 1/3,1/6, 1/6,1,1/3	2,1,1/6,1,2,1/5,1,1/4,1/4, 1/6,1/3, 1/5
Well, spring and aqueduct distance	-	-	3,5,2,2,3,4,8,3,1/3,1,6,5
Groundwater depth	-	-	Inconsistency=0.02

Table 6. Weight and ranking of sub-criteria of hydrology

Indicators	*Weight*	*Rank*
Well, spring and aqueduct distance	0.625	1
Groundwater depth	0.238	2
Distance from the waterway	0.136	3
Inconsistency	0.02	

Table 7. The pair-wise comparison matrix of relative significance of the sub-criteria access routes and population centers relative to each other

Indicators	*Distance from the main road*	*Wind direction*	*Distance from protected areas*
Distance from the main road	-	1/7,2,1/3,1,1/4,1/5, 3/1,1/7,2,1/5,1/2	3,6,1,1/5,1,1,2,1,1,2, 1/3,1
Wind direction	-	-	5,1,1/5,1/2,1/2, 1/2,1,1,2,2,4,1
Distance from protected areas	-	-	Inconsistency=0.02

Table 8. Weight and ranking of sub-criteria of access road and population centers index

Indicators	*Weight*	*Rank*
Wind direction	0.593	1
Distance from protected areas	0.249	2
Distance from the main road	0.157	3
Inconsistency	0.02	

Based on the results of pair-wise comparison, the significance coefficient of the research criteria relative to the environmental factor, weight and, ranking of the indices of hydrology and access routes and population centers were determined. The results are shown in Table 10.

3.4. Pair-wise comparison of the criteria relative to hydrology criterion

Two criteria of environmental and access routes and population centers were compared and a score from 1 to 9 was given; the results of which are shown in Table 11. The results of significance coefficient of the two criteria of environmental and access routes and population centers in relative to hydrology criterion, in light of weight and ranking, the indices of environmental and access routes and population centers placed in first and second order respectively; the results have been shown in Table 12.

In the compared pair-wise of the criteria relative to the factor of available roads and population centers, pair-wise matrix of the relative significance of research criteria relative to the factor of access roads and population centers from the experts' points of view is shown in Table 13. Weight and ranking of research criteria relative to access routes and population centers criterion obtained for environmental factors 0.667 and 1, for hydrology 0.333 and 2.

Table 9. Pair-wise comparison matrix to the environmental factor

Indicators	*Hydrology*	*Access roads and population centers*
Hydrology	-	4,4,1/2,2,5,3,4,2,2,3,5
Access roads and population centers	-	Inconsistency=0.00

Table 10. Weight and ranking of research criteria relative to environmental criterion

Indicators	*Weight*	*Rank*
Hydrology	0.750	1
Access routes and population centers	0.250	2
Inconsistency	0.00	

Table 11. Pair-wise comparison matrix of the relative significance of the research criteria relative to the environmental factor

Indicators	*Environmental Factors*	*Access roads and population centers*
Environmental Factors	-	1,5,7,2,1,1,4,3,2,4,5
Access roads and population centers	-	Inconsistency=0.05

Table 12. Weight and ranking of research criteria relative to hydrology criterion

Indicators	*Weight*	*Rank*
Environmental Factors	0.750	1
Access routes and population centers	0.250	2
Inconsistency	0.00	

Table 13. Pair-wise comparison matrix of the relative significance of the research criteria relative to the access roads and population centers criterion

Indicators	*Environmental Factors*	*Hydrology*
Environmental Factors	-	1,4,4,2,1,1,1,3,2,4,1
Hydrology	-	-

3.5. Pair-wise comparison of options relative to each sub-criterion

After determining the significance coefficient of the criteria and sub-criteria, the significance coefficient of the options relative to each sub-criterion was determined. At this phase, if a criterion does not have any sub-criteria, it will be judged with itself directly. In this problem, all criteria have sub-criteria, so the significance coefficient of the options has been determined relative to the sub-criteria (Table 15). The results of the highest and lowest impacts of the sub-criteria on the selection of landfill in Ilam city according to the decision-making group have been shown in Table 15. Also the situation of option in Fig. 3 (A, B, C, D) and weight and ranking of the most suitable option for the landfill in Ilam. Weight and ranking of the most suitable option for landfill in Ilam is presented in Table 16.

3.6. Impact of subcriteria on the landfill in Ilam city

Based on Fig. 4, the impact of the sub-criteria on different options, among the four selected options, the first one provides the vital conditions for the new location of the landfill, followed by the second option, then the third and fourth options have the next priority. According to Fig. 4, in option 1 which is shown in blue colour, all of the sub-criteria studied have the greatest weight and importance.

The weight of the criteria reflects their significance in determining the purpose, and weight of each sub-criterion relative to the relevant criterion indicates the share of that sub-criterion in the main criterion. The weight of each option relative to the sub-criteria indicates the share of that option in the relevant sub-criterion, so the final weight of each option was calculated by summing the products of the weight of each criterion by the weight of its sub-criteria multiplying the weight of the option by that sub-criterion.

So, based on the working method and calculating the final weight, the results show that considering all the criteria and the sub-criteria examined in this study, the most suitable location for a landfill in Ilam city, is option 1, and then options 2, 3, and 4.

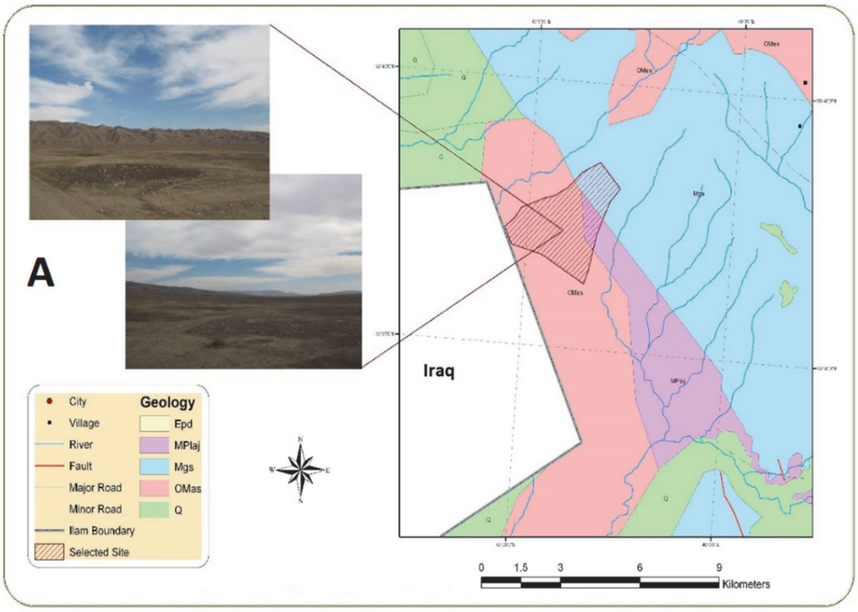
Option 1: the main connecting route to this site is Ilam-Mehran road, the closest route to Ilam city with an area of 8.8 square kilometers. From this road, an asphalt road branches at the intersection of the Sarney area towards the intended area. The altitude of the site is 425 meters. The materials of the area are calcareous coarse-grained sediments, along with silty clay, which is converted to fine-grained sediments and gypsum formations toward the northeast. The slope of the area is suitable for constructing a landfill. The main part of the site is composed of limes of Asmari formation and also the anhydride member of this formation called Kalhor. The age of this formation is related to Cenozoic. The eastern part of the site is an alternation of anhydride and red to gray marls, which also have calcareous intermediates. The age of these units is also related to Cenozoic. This option, as a landfill of Ilam city, has the least damage in various aspects, including environmental, social and economic, vegetation, surface water resources, and the presence of animal species.

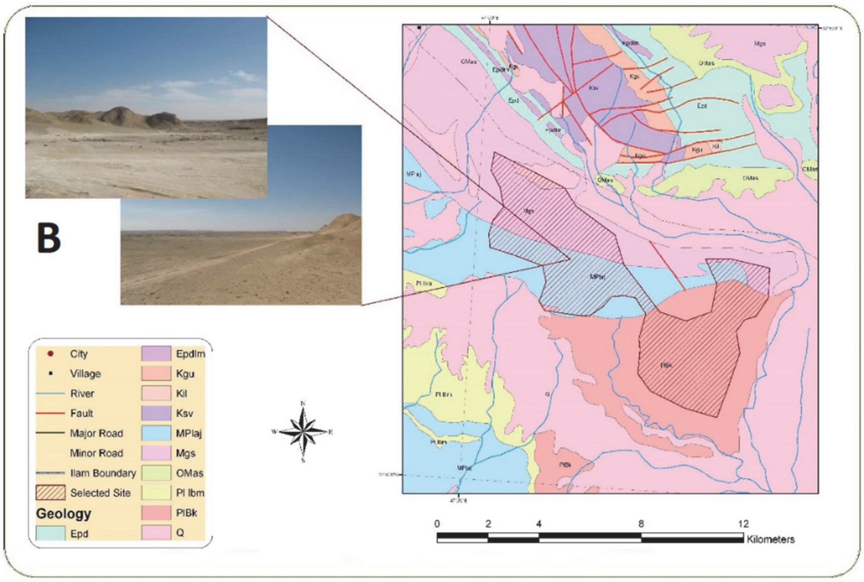
Table 15. Option weight relative to each sub-criterion

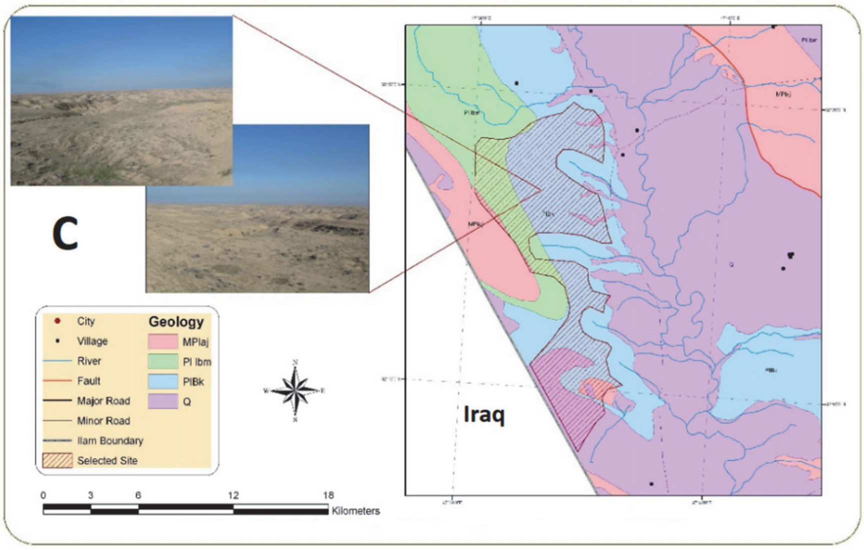
sub-criterion	*Options*				*Inconsistency*
	Option 1	**Option 2**	**Option 3**	**Option 4**	
Vegetation	0.422	0.265	0.174	0.137	0.03
The presence of animal species	0.368	0.301	0.130	0.200	0.09
Water resources	0.443	0.240	0.173	0.141	0.07
Well, spring and aqueduct distance	0.395	0.278	0.163	0.163	0.02
Groundwater depth	0.395	0.239	0.197	0.168	0.02
Distance from the waterway	0.510	0.247	0.110	0.131	0.08
Distance from protected areas	0.464	0.239	0.138	0.157	0.04
Wind direction	0.464	0.239	0.157	0.138	0.08
Distance from the main road	0.464	0.239	0.138	0.157	0.02

Table 16. Weight and ranking of landfill options

Rank	*Weight*	*Option*
1	0.419	1
2	0.274	2
3	0.160	3
4	0.147	4
Inconsistency		0.05







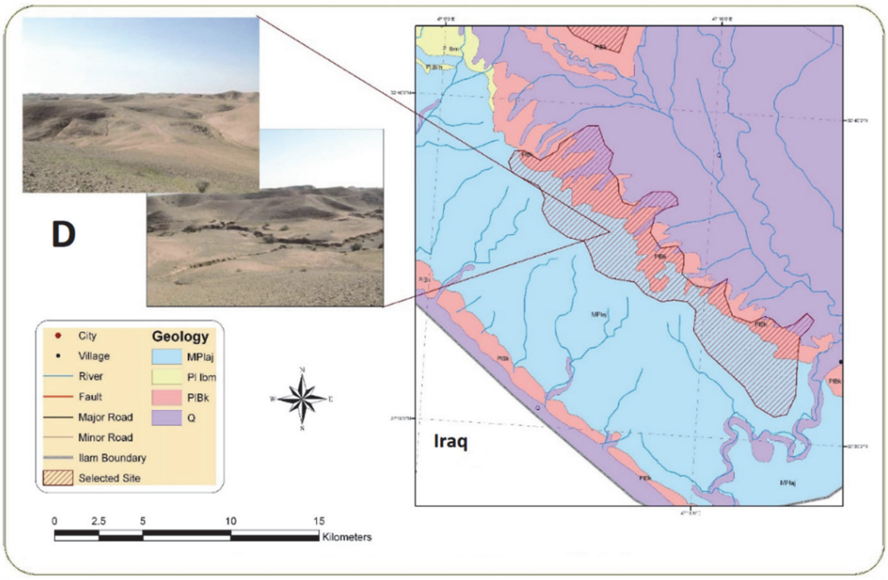


Fig. 3. Location of various landfill options (1-A, 2-B, 3-C, and 4-D)

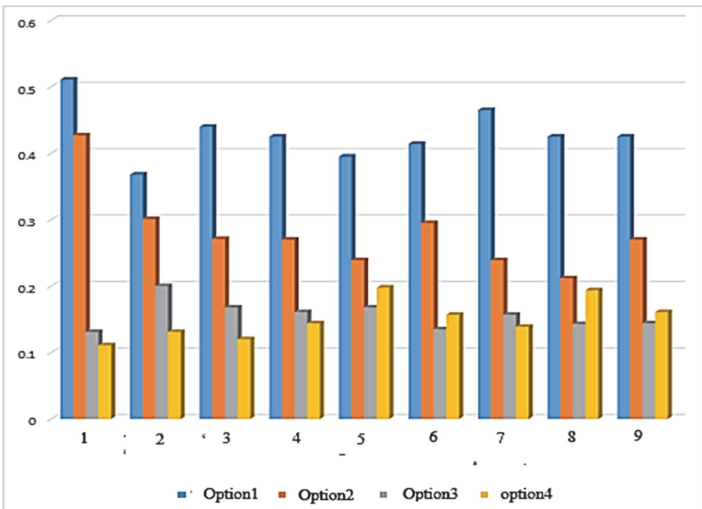


Fig. 4. Effect of sub-criteria based on research Vegetation (1), The presence of animal species (2), Water resources (3), Distance wells, springs (4), Groundwater depth (5), Distance from the waterway (6), Distance from protected areas (7), Wind direction (8), Distance from the main road (9)

Option 2: the main connecting route to this site is Dehloran-Mehran road with an area of about 37.1 square kilometers. The altitude of the area is 296 meters. The materials of the area are silty clay, and layers of plaster and marl are seen in the area. Vegetation in the area is low. There are no wells, springs, and aqueducts in the area. The main problem of this site is being far from Ilam city.

Option 3: the main connecting road to this site is Dehloran-Andimeshk road, from which an asphalt road branches to the area. The material of the area is silty and the area is in the form of a hill. The only problem with this option is that it is far from Ilam city. The water depth is 30 meters under the ground surface. Vegetation in the area is low. The area of this site is about 83.3 square kilometers. This option is more expensive than the other two options in terms of the access road.

Option 4: the main connecting route to this site is Dehloran-Mehran road with an altitude of 195 meters. The area lacks agriculture. It has low vegetation and its water depth is about 80 meters. The materials of the area are silt and clay along with sand with an area of 71.3 square kilometers. The area is in the form of a Mahuri hill and has many small waterways. This option is recommended as the last option for a landfill for Ilam city and other neighboring towns due to its remoteness and lack of access to a suitable road.

According to the criteria and sub-criteria of the waste disposal research, Ilam city is in accordance with the proposed options, especially option 1 that is in a completely suitable area. Due to the growing trend and future development of the city, and population growth, it is required to move and transfer the current landfill of Ilam city to place of option 1. The results of this study are similar to the research conducted in Hedge Zanjan for better location of landfills in terms of weighting criteria such as depth and quality of groundwater, access to roads, protected areas and vegetation cover at the site (Khosravi et al., 2019). In a study to determine the location of landfills in Mahneshan city in Iran, it was concluded that pairwise comparison and determination of the weight of each of the environmental criteria is effective in determining landfills (Jafari and Jafari, 2017). In this respect, the results of this study are similar to the present study. In the present study, by weighting the criteria and ANP method, a more environmentally suitable site was found for locating the landfill.

The solid waste disposal management is still a socio-environmental problem in Azuay in Ecuador. A multi-criteria decision analysis, integrated with a geographical information system and AHP methodology, was conducted. A percent of 76.17 of the territory is not suitable for landfill implementation (Cobos Moral et al., 2020). The results of this study are consistent with the present study in order to change the location of landfills. Moradi's research used relatively similar sub-criteria to the present study, such as access roads and population centers, vegetation, distance from protected areas and groundwater depth (Moradi et al., 2018). The results of their research showed that the geographical structure of the region can impose severe restrictions on many uses, especially sensitive uses such as landfills, which is consistent with the results of this study.

4. Conclusion

In order to ensure compliance with environmental criteria and achieve the purposes of sustainable development and prevent environmental pollution, it seems necessary to locate landfills for the sanitary burying of the waste.

Landfills can potentially have adverse and harmful effects on their surrounding and influence on public health and the environment. Sustainable development has an efficient logic that discusses five dimensions (economy, environment, society, culture, and politics) in relation to each other, that is, these dimensions must be considered in order to achieve sustainable development in local and national planning. Therefore, according to the results of this study, if the landfill of urban waste be selected without observing environmental parameters, human and environmental health will be endangered and improper selection of landfill will have consequences that hinder urban sustainable development.

The current improper disposal place in Ilam city have a great impact on the health of the environment and human society. The most important achievements of the current research is the definitive decision to use the options with the priority of option 1. Due to the high percentage of organic matters in the composition and volume of the household wastes in Ilam city, it is recommended to build a compost plant along with the necessary training to segregate and separate waste from the origin is one of the basic measures for environmental protection and sustainable development.

For future research, it is suggested that more environmental criteria be considered in determining landfill and modeling with newer methods and software.

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