Journal of Scientific Research and Development 2 (5): 129-134, 2015
Available online at www.jsrad.org
ISSN 1115-7569

Application of AHP and GIS for landfill site selection (A case study: city of Susa)

Amir Foroughian, Hossein Eslami *

Department of Water Engineering, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran

Abstract: One of the environmental problems is finding a suitable place for municipal waste. Given the number of parameters influencing the choice of landfill, find a suitable place through traditional and field method is very difficult and in some cases impossible. In the present study using GIS and AHP indicator, disposed to landfill sites in the city of Susa is identified. In this research, 4 important criteria which have principal effect on landfill site selection are identified including technical and operational, ecological, biological, socio-economic and physical criteria and 15 layers were used. The final score of the parameters were calculated by the method of pair wise comparisons. After the incorporation of 15 layers of information in AHP and analysis of fuzzy method using Arc GIS software, the final maps were prepared for municipal landfill. Based on the results western part of the city of Susa was offered to municipal landfill.

Key words: Landfill; AHP; Arc GIS; Pair wise comparison

1. Introduction

Along with industrial development and production of various industrial societies, man is faced with massive amounts of waste that in terms of materials and elements and risk to human health and the environment is very important. Given the dangers that traditional landfill (buried in the valleys, sand holes, marsh and other regions) creates, today from landfill sites for waste (landfill) to be used. In recent years, high population growth, lack of adequate space for environmental parameters and importance of economic factors, takes hard work to locate landfill. A precise definition of location is not available but one look at the definitions of spatial planning and urban land use planning can be found in the inner concept of location. Spatial planning is method of distribution and organization of human and activities in the area of land (Ziari, 2002). Land use planning is science of earth and space division for different applications and uses of life to make effective use of land and proper and efficient spatial discipline (Pour mohammadi, 2003).

The location is part of spatial planning and urban and looking for the best conditions and opportunities for citizens (Khodabakhshi, 2006). Now the landfill is main disposal method in many countries and Iran (Monavvari, 1992). Municipal waste landfill requires the basic and detailed planning. Nayyerabady (2007) using a variety of spatial analysis operations, using GIS technology to locate suitable areas (with the least adverse environmental impacts) for the city's municipal solid waste landfill of Tabriz. The initial results of the study revealed the fact that the result of AHP method in the selection of landfill is acceptable. Ziari (2012) to select the appropriate location for disposal of municipal solid waste in sanitary and outside the residential areas used from criteria such as slope, aspect, distance to fault, distance from residential areas and lines of communication and transmission.

Layers were then weighted using the AHP method by using GIS. Finally one site in the North West of the city was selected because of proper boundary fault and Aras River and acceptable standards of geology, vegetation and land slope.

Sumathi (2008) in a study using multiple criteria decision analysis and overlap analysis using GIS, select a new solid waste landfill. Several factors were considered in the localization process include: geology, water resources, land use, sensitive areas, air quality and groundwater quality. Weights for each criterion were determined and classified according to their relative importance according to the extent of impacts. The results obtained from the use of this system in various places, showed it to be effective in the localization process.

Zamorano et al. (2008) in his article stated that the presence of a landfill in southern Spain as a document is the proof of its negative effects on the environment of the region. Its effect has been widely influential elements on the site, it is important to measure the expansion of space. The first step in evaluating the environmental effects of burial, identify any parameters that are sensitive to these effects.

Uyan (2014) determine suitable landfill site selection by using the geographical information system and the analytic hierarchy process in the Konya, Turkey.

* Corresponding Author.

In this study, we try to choose the best place to bury waste city of Susa. Identification of suitable sites for landfills was prepared by appropriate information layers using GIS software and AHP method and preparation of pair matrices for determination of the parameters weights.

2. Material and methods

Susa located in the Khuzestan province, South West of Iran and to be allocated approximately 3577 square kilometers. The city is between 31 degrees and 41 minutes to 32 degrees 31 minutes north latitude and 47 degrees 49 minutes and 48 degrees 42 minutes east longitude.

In this study, in order to locate landfill of Susa, of 15 layers, including conservation areas, urban areas, rural areas, major rivers, roads, dams, highways, railways, historic areas, land use, soil texture, slope, elevation, wetlands and flood prone areas are used. The weighting of the criteria for analysis and classification parameters to be used in research in 4 categories of technical and operational, ecological, biological, socio-economic and physical After criteria determining, factor of their importance to standardize the criteria for comparison was performed. Hierarchical factor analysis was used to determine the importance factor of each criterion and sub criteria in order to create a linear combination for determination of coefficient of each parameter in their combination to determine the location of municipal solid waste landfill. Figure (4-1) shows a hierarchical tree analysis to determine the landfill.

AHP method is used in the pair wise comparison. Therefore, it is used viewpoints of the ecologists, natural resources, municipal and cultural heritage experts. After completing the questionnaire and analyzed by experts in their data, criteria weights and measures with the most weight, respectively, were identified.

The analysis of the results was performed using Expert Choice software.

In compliance with the inconsistency ratio less than 0.1 for the procedure, first single criteria to compare and evaluate the relative importance assigned to each pair of one to 9 and entered into a matrix. Then weights and ratio of the agreement were calculated. It is worth noting that this ratio was obtained for the study criteria and sub criteria 0.02 and 0.01, indicating the acceptability of the results.

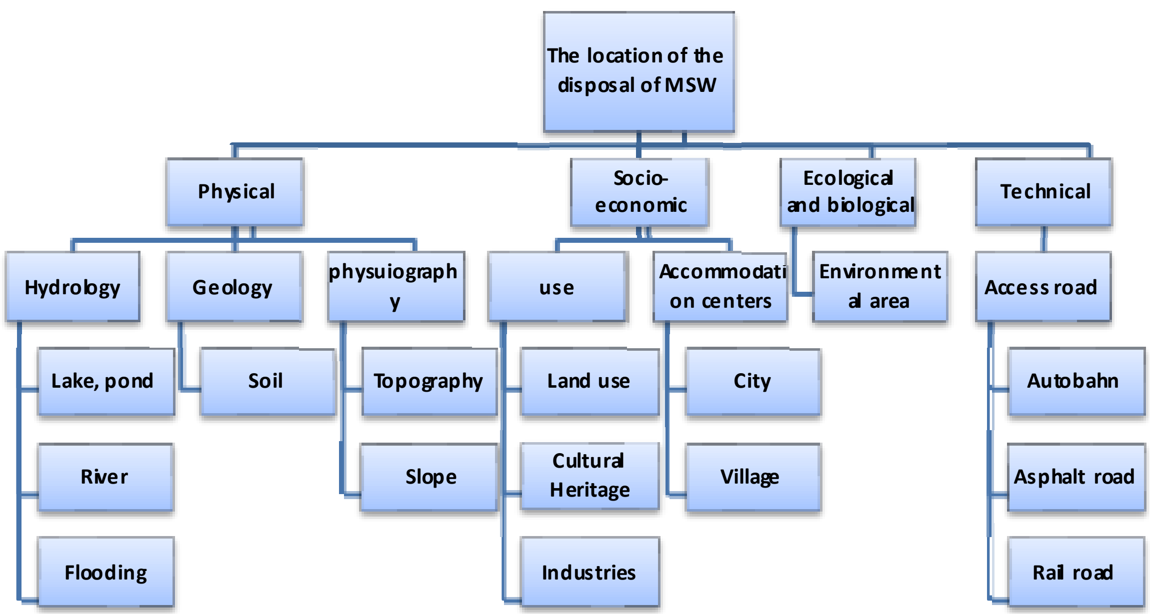

Fig. 1: The hierarchical tree analysis for landfill site selection

In the city of Susa, due to the specific conditions of culture, environment and agriculture generally keep the location of the landfill, is different from the rest of the country. Due to the presence of protected areas Karkheh, world heritage Choghazanbil world record as the first work in the country, the World Heritage city of Susa as the ancient world, Land under cultivation and irrigated agricultural land and Karkheh River. Tables 1 and 2 show the suitability and weights of criteria and sub criteria.

Table 1: Weight and suitability of criteria

Criteria	weight
Technical and operational	0.166
Ecologic and biologic	0.101
Socio- economic	0.567
Physical	0.166

Table 2: Suitability and weight of sub criteria

Sub criteria	weight
Urban residential areas	0.1
Cultural Heritage	0.1
rural residential areas	0.090
River	0.078
Flooding	0.077
Dams and ponds	0.076
Environment	0.075
Autobahn road	0.062
Soil	0.059
Land use	0.058
Slope	0.055
Topography	0.053
Industries	0.045
Asphalt road	0.039
Rail road	0.029

3. Preparation of criteria layers and fuzzification

The layers of the criteria considered for the process of navigation, mapping, then enter the fuzzification process until all layers have the same scale.

In fuzzy logic, each region received according to the desired criteria, the membership value that represents the degree of suitability. This means that each region with a higher membership level has a higher suitability.

In fuzzy logic, each layer is rated on a scale between zero and one. That is 1 of the highest suitability and non-suitability is zero and a range of colors are placed between the two. In addition to the choice of scale for fuzzy s, the fuzzy function must also examine the appropriate function for the selected criteria. Function should be considered in selecting the type of increase or decrease [10]. In this study, for all criteria (except for access roads) is used increasing function of Liner and Sigmouid for access roads criterion.

4. Results

In the present study, 15 criteria were considered in arriving at the suitable site for landfill site in Susa city. Each criterion is showed in figures 2 -17. Action to enforce any weight criteria used to criteria and mix together all based on the calculated criteria weights at the landfill site selection analysis, by means of the software ArcGIS MapAlgebra.

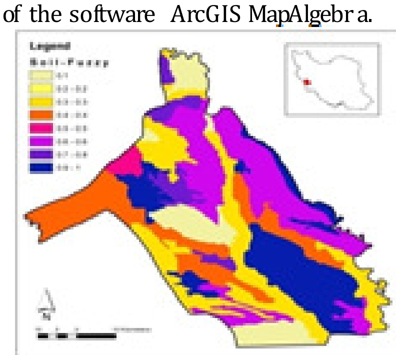

Fig. 2: The fuzzy soil map

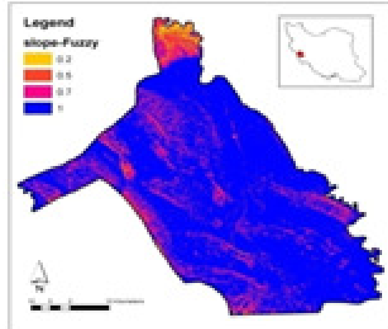

Fig. 3: The fuzzy slope map

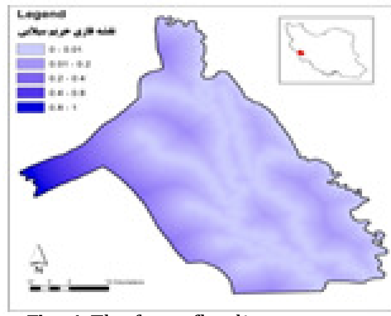

Fig. 4: The fuzzy flooding areas map

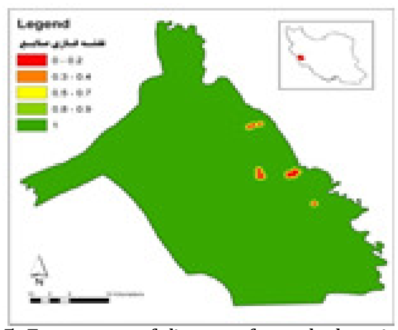

Fig 5: Fuzzy map of distance from the location of industries

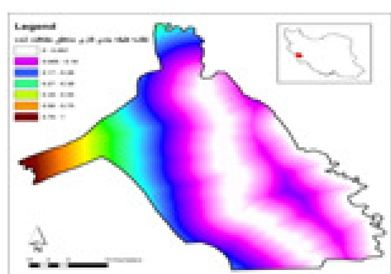

Fig 6: Fuzzy map of distance from the location of protected areas

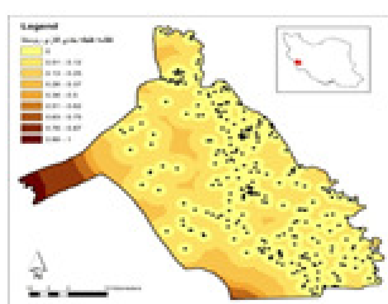

Fig. 7: Fuzzy map of distance from rural areas

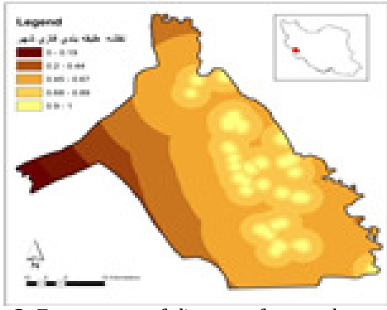

Fig 8: Fuzzy map of distance from urban areas

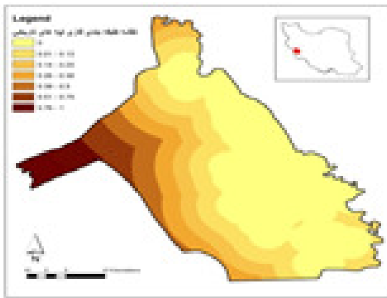

Fig. 9: Fuzzy map of distance of the historic hills

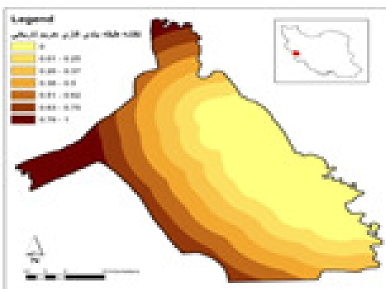

Fig. 10: Fuzzy map of distance from the realm of historical sites

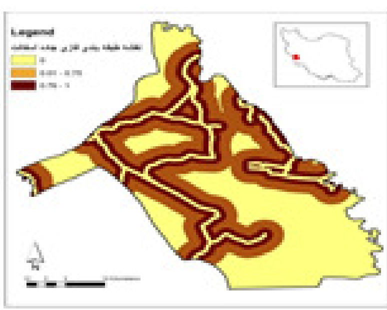

Fig. 11: Fuzzy map of distance from asphalt roads

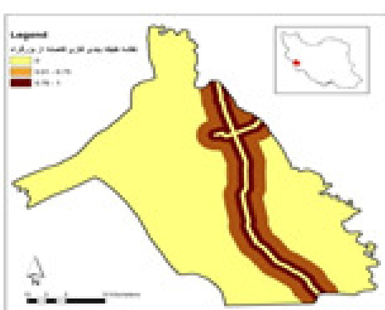

Fig 12: Fuzzy map of distance from ring roads

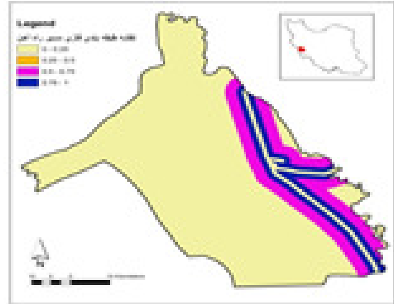

Fig. 13: Fuzzy map of distance from rail road

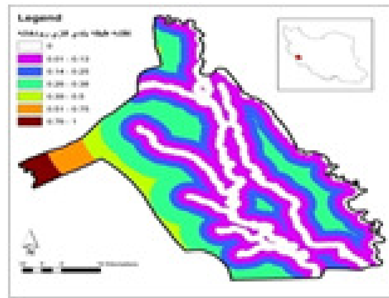

Fig. 14: Fuzzy map of distance from rivers

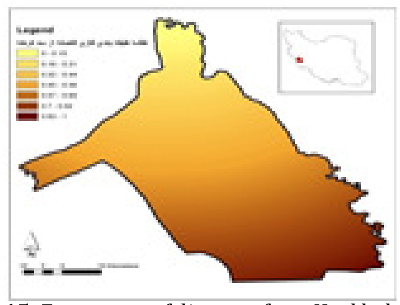

Fig 15: Fuzzy map of distance from Karkheh dam

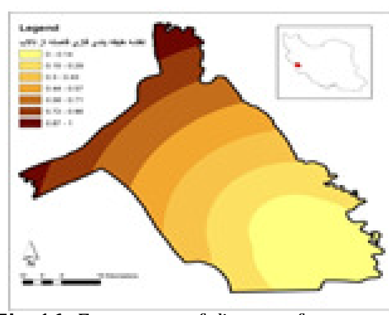

Fig. 16: Fuzzy map of distance from ponds

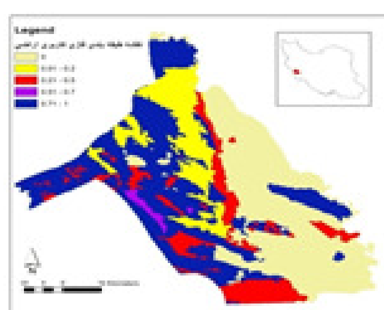

Fig 17: Fuzzy map of land use

By combining different layers in AHP method, the final map was prepared. This result is the production of the final map location as a range of numbers from zero to 1. The location is as close to 1, place considered suitable for landfill (fig. 18). As is clear, eastern and central city located in the lower range of values for locating landfills due to the all limiting factors such as world heritage privacy, protected areas Karkheh and Dez, Karkheh river and agricultural land. And from the eastern to the western part of the value increases.

According to the results, the best place in the western corner of the city is located at the highest value is assigned. This wide range is due to the remoteness of these restrictions is the best place for burial.

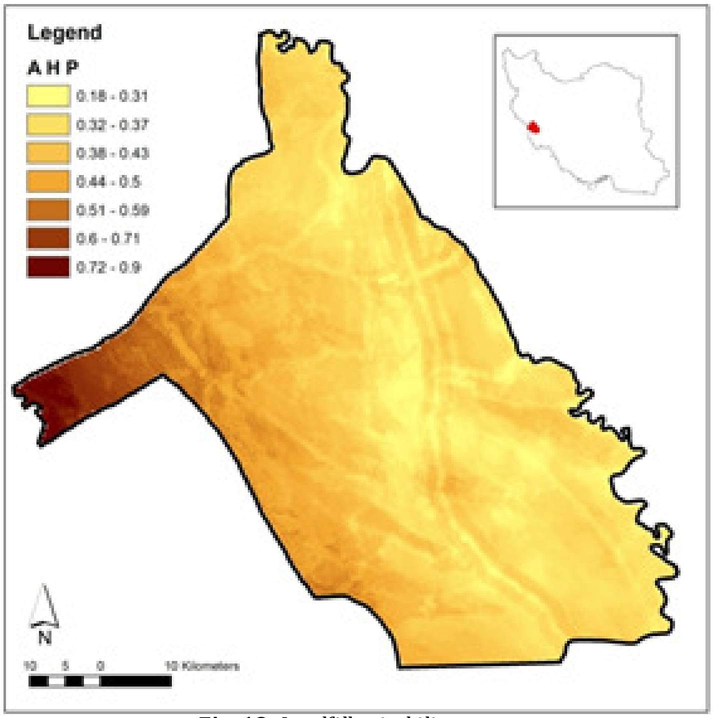

Fig. 18: Landfill suitability map

5. Discussion

GIS in combination with different methods has been used for landfill site selection. GIS-based AHP can provide fast feedback for decision making. It is easy for non-experts to understand, and helps to explore the decision problem by conducting a comprehensive yet easy-to-use procedure to examine weight sensitivity in both criteria and geographic space. In this study the landfill site selection for municipal solid waste was performed using GIS and AHP method. AHP is an update indicator and many parameters to consider in order locating the landfill and review all aspects of the study area. The AHP method was used to extract the relative importance weights of the evaluation criteria. GIS was used to create the spatial determination of the evaluation criteria and create the land suitability map.

In this research, 4 important criteria which have principal effect on landfill site selection are

Identified including technical and operational, ecological, biological, socio-economic and physical criteria. After determination of relative importance weight of each criterion and score value of sub criteria in the GIS environment, final suitability map was prepared. Based on the final suitability map, suitable areas for landfill construction are located in western part of the study area. The combination of AHP method with GIS in this research was found to be a proper tool for solid waste landfill site selection.

Acknowledgment

This paper is extracted from Master's Thesis.

References

Eastman, J. R. (1997). "Idrisi for Windows, User's Guide, Version 2.0, Clark Labs for Cartographic Technology and Geographic Analysis," Clark University, Worcester.

Khodabakhshi, Z. (2006). Analysis of urban land use planning using GIS, the city of Nishabour, region 2. MS Thesis, University of Yazd.

Monavvari, M. (1992). locate solid waste disposal sites, the Office of the Human Environment Department of Environment, Iran.

Nayyerabady, H, Mir Rahimi, M. (2007). Waste management with GIS, urban Conference GIS, University of North.

Pour mohammadi, M. (2003). Urban land use planning, Samt publications.

Sumathi, V. R., Natesan, U., & Sarkar, C. (2008). GIS-based approach for optimized siting of municipal solid waste landfill. Waste Management, 28(11), 2146-2160.

Uyan, M. 2014. MSW landfill site selection by combining AHP with GIS for Konya, Turkey. Environmental Earth Sciences, 71(4), 1629-1639.

Zamorano M, Molero E, Hurtado Á, Grindlay A, Ramos Á. Evaluation of a municipal landfill site in Southern Spain with GIS-aided methodology. J Hazard Mater 2008;160:473-81.

Ziari, K. (2002). Urban land use planning, Yazd University Press.

Ziari, K. (2012). Municipal solid waste disposal site selection model using AHP, a case study in Julfa, Journal of Geography and Environmental Studies, 1(3),21-30.