Landfills site selection in southern cities of Khuzestan province using fuzzy set and AHP method

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1-Introduction

Landfill and waste disposal is still one of the most important methods for municipal solid waste management. Sanitary waste disposal is very important in maintaining the health of each area. Non-sanitary landfill of solid municipal waste and its negative environmental impacts have made traditional methods to be replaced by appropriate and scientific methods. One of the most important phases of sanitary landfill is selecting the best spatial location to minimize environmental, social and economic impacts. Although in Iran, Landfill has always been considered and used, but landfill in most cities of Iran is not done sanitary and in most cases, landfill sites have become uncontrolled pits or waste disposal sites. In most studies for landfill site location, geographic information system (GIS) and MCDM techniques have been used. GIS is a digital database management system and can store, manage and analyse large volumes of spatially distributed data from different sources (Sener et al., 2006). One of the most important multi-criteria decision-making methods is the AHP method that integrated with GIS is the most preferred method for selecting landfill sites in the literature. The integration of GIS and AHP is a powerful tool to determine the optimum place for landfill site (Kahraman et al., 2018; Rahmat et al., 2016; Ramjeawon and Beerachee, 2008; Eskandari et al., 2015; Uyan, 2014; Shahabi et al., 2014; Kumar and Mohammad, 2013; Gorsevski et al., 2012; Alavi et al., 2013; Sener et al., 2010; Melo et al., 2006).
The purpose of this study is to determine the proper location for landfills in Khorramshahr, Abadan, Shadegan and Mahshahr counties.

2-Methodology

The study area included Abadan, Khorramshahr, Shadegan and Mahshahr counties which are located in south and southwest of Khuzestan province. The effective criteria have been evaluated in three categories including environmental criteria (surface waters, coastal zones, sensitive and protected areas, faults, land uses, vegetation and climatic conditions), social criteria (settlements, commercial, industrial, tourism and historical areas, railways and airports) and economic criteria (access to road and landfill, and slope). Map of features were obtained from Iran National Cartographic, Iran Meteorological Organization and agriculture organization of Khuzestan province.
Geographic information systems (GIS), Analytical Hierarchy Process (AHP), and fuzzy logic have been used to analyze and integrate all criteria. Fuzzy membership functions were defined based on Iran's legislation, previous studies, conditions of study area, and expert's knowledge. The value of each layer is from zero to one that zero value shows the full restriction and non-exploitable location while the value of one shows the best place for landfill site. Analytic Hierarchy Process model was used to weight and integrate the layers of environmental, social and economic factors to create the final singular layer. Pairwise comparisons of the criteria were performed by 26 professional experts (group decision-making) with face to face questionnaire. The software of Expert Choice 2000 was used to do the AHP analysis. Non-exploitable layer was determined according to the legislation of Iran, similar studies and knowledge of experts based on the Boolean method and then is multiplied in the final layer resulting from the AHP process. As a result the areas that are non-exploitable will be getting zero value in the final layer, but the fuzzy value of other areas will not change. Finally, the final layer of land suitability for landfill sites in study areas was created in GIS environment.

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3-Results and discussion

Surface water and wetlands cause the most restrictions for the landfill site selection in study areas. Due to big rivers, flood prone area, protected areas, wetlands, agriculture lands, sea and Beaches, the study area is very sensitive to landfill environmentally. In term of access to road and transportation links, except wetland and protected areas, study area is relatively in good condition. Proximity to the transport links plays an important role in reducing shipping costs of municipal solid waste. According to the paired comparison and AHP analysis, the fuzzy layer of environment criteria with a weight of 0.441 was the most important layer among main layers. This layer is followed by the economic and social criteria areas layers with weight of 0.290 and 0.269, respectively. Finally, a map of suitable landfill sites has been prepared based on the fuzzy membership value that is shown in figure 1. The figure shows that a large part of the study area is inappropriate for landfill and that the county of Shadegan is facing the most constraints, mostly due to agricultural lands, wetlands and protection areas. About 295 hectares in Shadegan county have a fuzzy membership value of more than 0.9.

Based on the fuzzy membership value of final layer, the land suitability is classified into six classes, namely unsuitable (fuzzy value <0.5), poor (0.5≤fuzzy value< 0.6), moderate (0.6≤ fuzzy value< 0.7), suitable (0.7≤ Fuzzy value< 0.8), very suitable (0.8≤fuzzy value< 0.9) and excellent (fuzzy value≥0.9). About 715353 hectares of the study area have the fuzzy values less than 0.5 that are non-exploitable for landfill. The areas of region with the excellent and very suitable level were 37030 and 39957 hectares, respectively.

In all study area, some restrictions are overlapping that this region faces severe restrictions for landfill site selection. Finally, the prepared map of suitable landfill sites can be useful in municipal solid waste management in the mentioned counties.

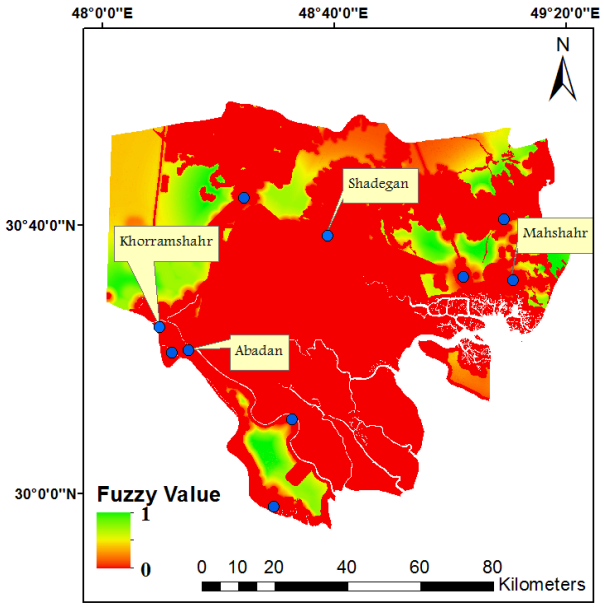

Figure 1. Land suitability layers for landfill site selection

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