SITE SELECTION TO HAZARDOUS WASTE LANDFILL OF GILANEGHARB TOWNSHIP IN KERMANSHAH PROVINCE, WESTERN IRAN BY USING REMOTE SENSING AND GIS

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ABSTRACT. The evaluation of a hazardous waste disposal site is a complicated process because it requires data from diverse social and environmental fields. Each of them has different effects on site selection of hazardous waste landfill. Some factors cause limits to site selection such as; climatic, topographic, land use, edaphic, quakeable, regions under conservation of environment organization and so on. these factors may be cause unsustainable and move hazardous waste to surface and under ground water and also air pollution according to wind aspect, consequently different contaminations. This study was conducted in Gilanegharb town in Kermanshah province west of Iran in 2012 to find best area of landfill of hazardous wastes. Each of the factors valued and weighted based on experts opinions and then evaluated each of the preperated layers in RS and GIS softwares. In the first evaluation of 19 sites, 6 sites were investigated. The results show that asphalt factory site is the best region and then Shahrdary, Tan Kooshk sites are better to landfill of hazardous waste respectively. The reasons for selecting of this regions were far form surface and ground water resources and as a result avoiding to be defiled of ground water. On the other hand, there is no air pollution and malodorous of Ghilangharb town because of wind blow aspect in the region.

Keywords: waste, landfill, water resources, air, soil, RS, GIS, Ghilangharb

1.INTRODUCTION

The evaluation of a hazardous waste disposal site is a complicated process because it requires data from diverse social and environmental fields. Each of them has different effects on site selection of hazardous waste landfill. Environment suppose internal and external factors which affect on biotic life. Therefore, environmental involve all of the biotic and abiotic such as air, water, soil and so on. To detect land fill in a environment, investigation of all mentioned factors are necessary. Locations of hazardous waste landfill sitting should be in nonsuitable for any land uses. Human activities are altering the land use at unprecedent rates, magnitudes and spatial scales (Vitousek *et al.*, 1997). Identifying an optimal site for hazardous solid waste is an extremely difficult process because it has to

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integrate diverse environmental, social and political factors (Linkov *et al.*, 2006). In developing countries, results of over five decades of challenges in management of solid wastes in many different contexts including legislation, administration, science and technology has ended in situations where in many countries waste management operations can be maintained by various degrees of landfilling, incineration with and without energy recovery, recycling and composting (Kollikkathara *et al.*, 2009). In Kermanshah Province there is no public or private institution responsible for collection and treatment of hazardous wastes, and industrial units are expected to treat their hazardous wastes. Most municipal wastes generated in Iran are dumped in open lands and create numerous environmental side effects. There are evidences that show municipal waste dumped without any treatment can produce highly toxic leachate. An in-depth estimatation of the amount of hazardous waste in Iran has only been conducted in few provinces. This amount of waste by industrial groups is classified as 31% by chemical industries, 16% by oil and coke industries and 53% by other industries. In Kermanshah Province which is smaller, less populated and less industrialized, the amount of hazardous waste should be much less than Fars Province. Land suitability analysis is the evaluation and grouping of specific areas of land in terms of their suitability or capability for a specific use (Dessalegn, 2010). Broadly defined, land use suitability analysis aims at identifying the most appropriate spatial pattern of future land use according to specified requirements, preferences, and predictors of specific activities (Baniya, 2008). Geographical Information System (GIS), which incorporates database systems for spatial data, was designed and developed to enable the acquisition, compilations analyzing and displaying topological interrelations of different spatial information (Venkataratnam, 2002; Bizuwork *et al.* 2006). Evaluation of various environmental, social and political criteria employed in a landfill sitting process depends on different types of technical inputs from various sources. Alternative processes involving decision making may offer little help on how to incorporate or judge the relative importance of diverse information from different sources (Linkov *et al.*, 2004). The absence of a systematic methodology to combine various information from a wide range of disciplines together with stakeholder views may lead the decision maker not to be able to utilize all available and necessary information in choosing between alternatives. The selection of appropriate remedial strategy for contaminated sites often involves multiple criteria such as costs and benefits analysis, environmental impact assessments, safety or ecological risk assessment, or stakeholder preferences. Consequently, a selection among many different alternatives often involves making trade-offs that fail to satisfy one or more stakeholder groups. The researchers attempt to evaluate the environment with social and political considerations in the process of site selection. Swallow *et al.*, (1992) suggest a multi-stage processes of landfill sitting to involve technical standards, social selection criteria and compensation or community acceptance. The landfill siting process is increasingly dependent on sophisticated spatial analysis facilitated by the development of Geographical Information Systems (GIS). However, others have demonstrated the use of a raster-based GIS with its associated Boolean logic map algebra to identify potential waste sites based on suitability of topography and proximity with respect to key geographic features (Sener *et al.*, 2006; Sharifi and Retsios, 2004). All map layers are then intersected so that the resulting composite map contains two suitable and un-suitable areas. With the aid of this functionality, GIS have been widely used in order to facilitate and lower the cost of the process of selection of sites for various proposes (Sharifi and Retsios, 2004). The ability of GIS to integrate maps to site selection for landfill decision making approach has been shown in studies related to site determination for many diverse subjects. Malczewski (2006) has provided a comprehensive review on integration of GIS and multi-criteria decision analysis and has shown that during the last two decades there has been significant interest in developing GIS-based multi-criteria decision analysis in many different fields of researches including ecological sciences, urban-regional planning, waste management, hydrology and water resource, agriculture, forestry, natural hazards, recreation tourism, housing real estate, geological sciences, manufacturing and cartography. Some examples of recent GIS application for landfill sitting includes: Sumathi *et al.* (2008), Changa *et al.* (2008) and Gemitzi *et al.* (2007). As a strategic national planning tool for management of hazardous and non-hazardous wastes in Iran Department of Environment has sponsored a series of landfill sitting projects for various parts of the country on the basis of administrative units or provinces. This paper presents a GIS-based hazardous waste landfill sitting study for Kermanshah Province in Western Iran. This paper was conducted to design for a large number of sites selected by preliminary GIS operations. The main aim of present study is to select landfill sites by using GIS-based data analysis.

2.STUDY AREA

Kermanshah Province with an extent of 24,622 km^2 is one of the thirty provinces of Iran located on the western edge of the Iranian plateau on the mid northern Zagros Mountains in the western part of the country. Gilanegharb township is located on the western edge of the Kermanshah province with geographical coordinates of 33º 40́ 09″ to 34º 42́ 39″ N latitude and 45º 24′ 20″to 46º 39́ 41″ E longitude. The weather condition is a semi drought-warm steep. Average annual precipitation in this area is around 710 mm. According to climatic analysis average temperature is 19.9 ºC, and the coldest and the warmest temperature are 6.9°C and 32.3 °C respectivaly. Also mean relative humidity is between 57 % to 64%, which in winter is the highest and in summer is the lowest. Mean evaporation in some months is between 16.8 to 458.5mm.

3.MATERIAL AND METHODS

This study was conducted in Gilanegharb town in Kermanshah province located in western Iran in 2012 in order to find the best area of landfill of hazardous wastes. Each of the factors was valued and weighted based on experts` opinions and then each of the preperated layers in RS and GIS softwares were evaluated. In the first evaluation of 19 sites, 6 sites were investigated. The sitting procedure consists in in few stages. First, in the present study 35 attributes are involved in the computation process, distinguished as exclusionary and non-exclusionary criteria. These attributes are clustered in five main groups including geology, hydrogeology, hydrology, climatology and various criteria and sub-criteria lumped into eco-sociology class (Fig. 1).

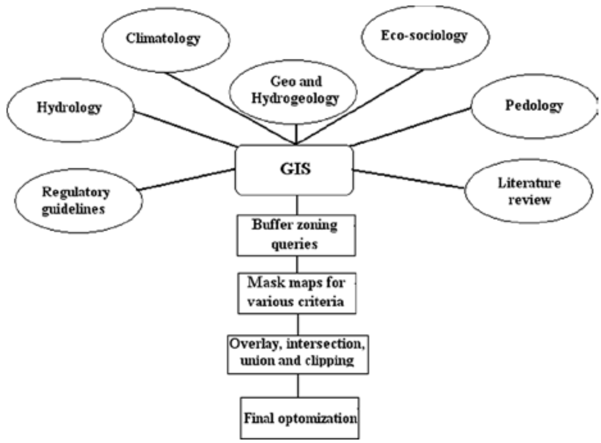

Fig. 1. ***A flow chart illustrating the methodology used in various stages in the hazardous landfill sitting in Gilanegharb town in western Iran(Mozafar Sharifi et al., 2009).***

In this study, excluding criteria are considered as decisive factors which have been employed to keep away from the landfill sitting process by assigning various buffers to these areas. These include constraining criteria such as aquifers, karst, springs, ganats, karst springs, wells, rivers and streams, areas with high slope, all faults, protected regions and areas with high biodiversity (hot spots), hydraulic structures, certain land use practices, all forests, human settlements and main roads. The second group comprises nonexcluding criteria relevant to environmental parameters and field observation. The non-exclusionary criteria used in this study include vicinity to industrial center, distance to aquifer, distance to spring, nature of the bed rock, distance to nearest fault, distance to nearest hot spot, distance to nearest surface water, land use, soil type, climatic regime, distance to human settlement and distance to protected areas and hot spots. In this study a criteria may be defined as a constraint that could exclude or prohibit a landfill from being placed within a specific area. Geospatial data for a complete GIS analysis in urban and regional planning are prepared by various organizations (Fig. 2).

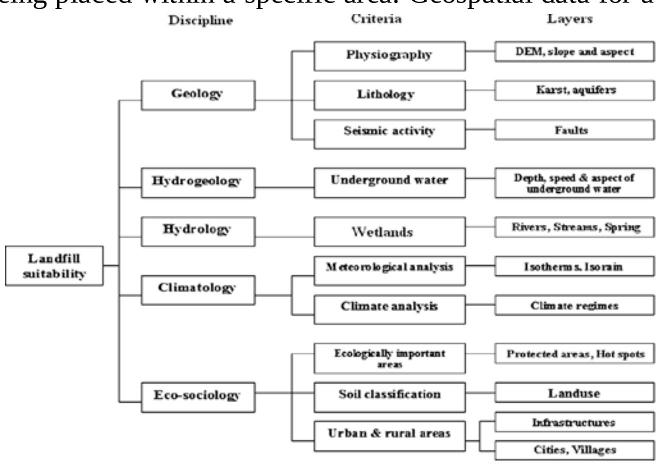

Fig. 2. ***The decision tree developed for the hazardous landfill site selection in Gilanegharb town, western Iran(Mozafar Sharifi et al., 2009).***

4.RESULTS

The result shows that Asphalt factory site is the best region and then Shahrdary, Tan Kooshk sites were the best and better respectively to landfill of hazardous waste for site selection. Figs. 3–8 are some of the maps which were used in this study and illustrate the typical procedure applying the GIS for initial landfill sitting involving preparation of mask maps, which divide the study area into suitable and un-suitable sub-area. These include mask maps for aquifers, faults, karsts, land use, all rivers and streams, all springs, karst streams and ganats, all wells, human settlements (villages and cities), infrastructures (highways, dams), highly eroded soils and all rangelands areas. Some of these criteria have also a buffer zone.

Fig. 3. ***Mask map prepared to exclude aquifer from hazardous waste landfill sitting process in Gilanegharb township, Kermanshah Province, western Iran.***

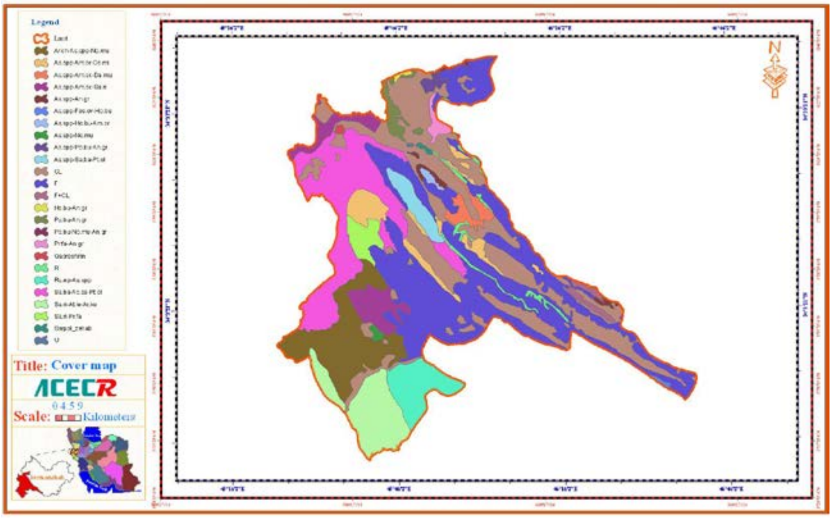

Fig. 4. ***Mask map prepared to exclude plant cover (Vegetaion types) from hazardous waste landfill sitting process in Gilanegharb township, Kermanshah Province, western Iran.***

Fig. 5. ***Mask map prepared to exclude fualt from hazardous waste landfill sitting process in Gilanegharb township, Kermanshah Province, western Iran.***

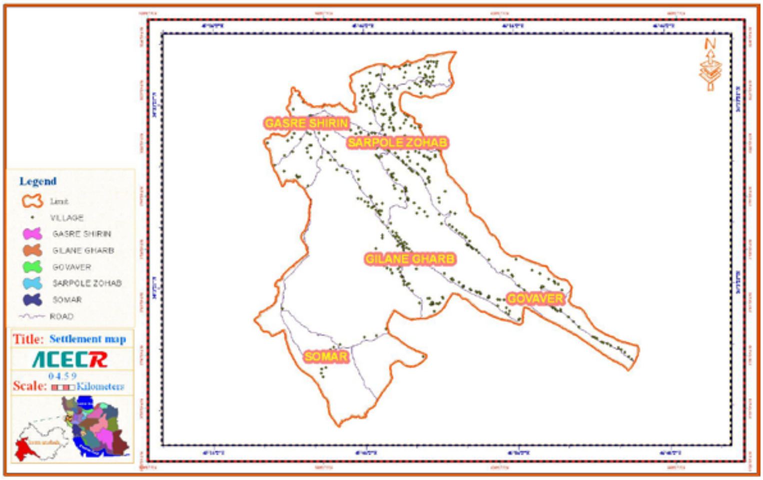

Fig. 6. ***Mask map prepared to exclude settelment from hazardous waste landfill sitting process in Gilanegharb township, Kermanshah Province, western Iran.***

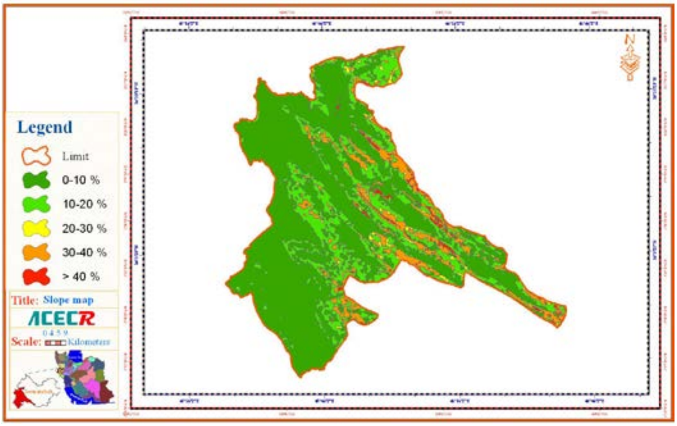

Fig. 7. ***Mask map prepared to exclude slope from hazardous waste landfill sitting process in Gilanegharb township, Kermanshah Province, western Iran.***

Overlaying of these mask maps has resulted to several groups of locations. Following determination of the most suitable sites by application of 21 different layers shown in Fig. 8.

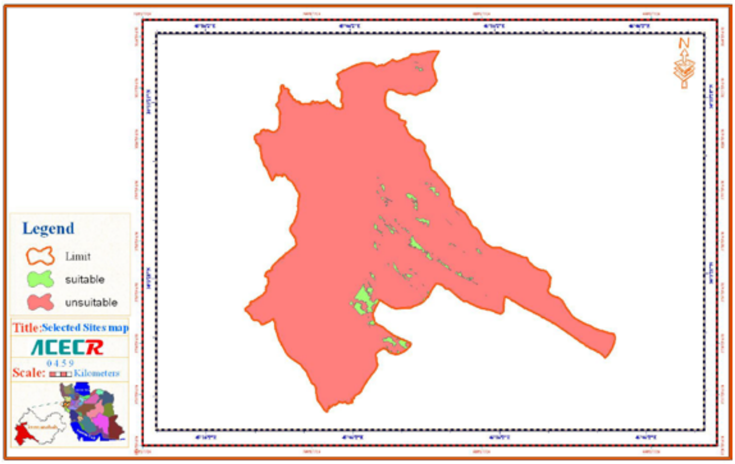

Fig. 8. ***Suitable areas for a hazardous landfill site selected based on 21 information layers***

Also field studies were implemented in terms of providing more information for a suitability evaluation. Several new criteria and characteristics have been considered in field studies. The criteria which used include vicinity to industrial center, distance from nearest aquifer distance to springs, lithology (nature of bed rock for any site), distance to nearest fault, distance to surface waters, and use, climatic regimes, distance to residential area, distance to protected regions and hot spots, rainfall, evapotranspiration, distance to nearest road, elevation. Weights were assigned to every non-exclusionary criteria according to how important each factor is considered to be using pair-wise comparison of the criteria (Saaty, 1977). Position of selected sites for hazardous waste landfill in the study area in relation to surface waters including all permanent and seasonal rivers and streams and their buffer zones.

5.DISCUSSION AND CONCLUSIONS

The reason for selecting this regions was far form surface and ground water resources and as a result avoiding to be defiled of regions waters. On the other hand, there is no air pollution and malodorous of Ghilangharb town because of wind direction in the region. Until recently multi-criteria decision analysis methods have largely been non-spatial and used in the areas such as selection of remedial technologies, resource optimization, and various other management problems (Linkov *et al.*, 2004). According to the study and other researches application of MCDA techniques in studying spatial problems can interpret simultaneously data on the geographical locations of alternatives or geographical data on criterion values using both MCDA and GIS techniques. Various investigators have implemented different optimization plans. For example, a mixed integer programming model was developed to obtain a site with optimal compactness and extended to include multiple sitting factors which the results are like this study.

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