Integrating Ordered Weighted Average(OWA) techniques with geographic information Systems for landfill site selection (Case study: Metropolis of Mashhad)

Mohammad Rahim Rahnama [1 *] Aghajani. H[2] Fattahi. M[3]
Department of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN
[2]M.S Student of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN
[3]M.S Student of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN

Received 14 November 2012
Accepted 13 January 2013

Introduction

Environmental protection is one of the most priorities in Land use planning. In this regard, place and location have the greatest role and its importance is increasing when the adverse effects of environmental neglect, can cause irreversible situation.

Selection a suitable location for the burial of solid waste can prevent the unfavourable ecological and socio – economic effects. Landfill site selection requires spatial data analysis, acceptable rules and standards.

Choosing the various factors and therefore the number of Map layers, decision-makers to lead them unconsciously into a system that in addition to high accuracy also has high speed and simple of operation.

Nowadays, these processes are using spatial models and GIS in the desired method is provided.

A selected landfill is an important process in urban planning that effect on economic and environmental sectors and environment hygiene.

Multi-criteria evaluation methods and GIS can use as an efficient tool for managing and applying layers seeking information in the place. In developed countries and also in Iran, a great deal research has been done in this field.

This study with utilize past experiences and applying GIS technology want to provide a method for landfill site selection.

Material and Methods

This paper is studied multiple criteria decision analysis method based on GIS to select the appropriate location landfill in the metropolis of Mashhad. According to limited variables in the southern and south west areas of metropolitan Mashhad, average 18 km radius has been determined. This area has been calculated approximately 2465 Km^2 and include the cities of Mashhad, Torghabeh, and the town Shandiz Razavieh (the eastern most point of the urban area). Growth Population, pilgrim of Imam Reza (AS), uncontrolled urban development, business activities and focus industrial and office in Mashhad increased waste generation which has adverse effects on the quality of the environment in Mashhad. At present, the volume of waste generated in the city of Mashhad, about 1,500 tons during peak travel to Mashhad (spring and summer), the figure is well over 2,000 tons. Method sin this study, is combination of site selection models and GIS.The multi-criteria decision framework considers environmental and economic factors which are standardized by fuzzy membership functions and combined by integration of analytical hierarchy process (AHP) and ordered weighted average (OWA) techniques. The AHP is used for the elicitation of attribute weights while the

* Email: Aqajani_h@yahoo.com Corresponding Author 00989151079466

OWA operator function is used to generate a wide range of decision alternatives for addressing uncertainty associated with interaction between multiple criteria. The usefulness of the approach is illustrated by different OWA scenarios that report landfill suitability on a scale between 0 and 1. The OWA scenarios are intended to quantify the level of risk taking (i.e., optimistic, pessimistic, and neutral) and to facilitate a better understanding of patterns that emerge from decision alternatives involved in the decision making process.

Ordered weights in a decision making that involves three factors take [1, 0, 0] for the AND operator, [0, 0, 1] for the OR operator, and [0.33, 0.33, 0.33] for the arithmetic mean (i.e. risk neutral). Finally, this is a multi-objective decision problem to consider environmental and economic criteria's, the landfill allocation used a WLC to aggregate suitability maps created by each objective.

Environmental criteria's, including: surface water springs, rivers, dams, groundwater level, slope, elevation, faults socioeconomic criteria, including population density, habitat settlements (city or villages) and the distance from the road. The type of fuzzy membership functions used to standardize the factors such as J-shaped – decreasing، Sigmoidal – decreasing, Linear – increasing

Results and Discussion

According to applied models, specific feathers in different parts of the study area were identified in different scenarios;. In some models, a large area of stains and patterns with a lower risk of these devices was limited. The OWA weights were used to generate different patterns to control the levels of trade-off and risk. This study presents an application of GIS-based multi-criteria evaluation approach for characterizing and assessing favourable landfill sites in Mashhad.

Aggregation procedures to generating a wide range of decision alternatives needed for landfill suitability problems. The AHP methodology is used to evaluate the importance of criteria and generates the global weights, which are used in conjunction with the local weights in OWA procedure for producing the decision alternatives. The AHP/ OWA aggregation procedure incorporates uncertainty through a fuzzy membership function and expert opinions. In addition, local weights are used to provide leverage for controlling the level of uncertainties associated with different decision alternatives and risk taking (i.e., optimistic, pessimistic, and neutral).

The decision alternative is associated with the AND operator and produces a risk averse

Solution. According to this alternative, the most suitable areas for landfill sitting are located in north and north-western and south-eastern of Mashhad.

Total of six decision alternatives used for landfill suit ability associated with the environmental factor and The OWA weights were used to generate different patterns to control the levels of trade-off and risk.

The maps of the WLC alternatives show three different scenarios generated by different weights applied to the objectives. For instance, first alternative applies a weight of 0.75 to the environmental objective and a weight of 0.25 to the economic objective, second alternative uses equal weights and third alternative applies a weight of 0.25 to the environmental objective and a weight of0.75 to the economic objective.

In this paper the appropriate places based on the models in three scenarios be identified and used to locate a landfill around the Mashhad metropolis has been introduced.

Extent of suitable areas for landfill sites in the first scenario, which had the lowest risk, with an area of 491.5 hectares, less than 0.199 percent of the study area, the second scenario 543.3 hectares and 0.22 percent and the third scenario has the highest risk of approximately 3041 hectares 1.233% of the study area as suitable locations for landfill indicates show respectively.

Conclusion

The results from this study demonstrate that the aim of the approach is not to find a single 'optimal' solution, but to show other strengths associated with the weighting flexibility of the OWA approach. For example, the OWA approach provides a robust interactive toolset for adjusting trade-offs and compensation between criteria that allows a rapid assessment and inter predation of possible alternative scenarios and relationships between criteria. Other strengths of this approach include the ability to integrate heterogeneous datasets such as quantitative and qualitative criteria using expert knowledge, the flexibility to select specific criteria for different study areas or different problems under consideration, to implement a single or a group decision-making, the flexibility to change the importance level of criteria, and the freedom to develop

Various modeling scenarios for acceptable levels of decision risks. However, since landfill sitting depends on political and public opinion forces in conjunction with scientific analysis, we posit that this methodology holds significant potential to support the complexity of decision-making in real world applications.

Key Word: GIS Modeling, AHP, OWA, landfill site selection.