Site Selection for Green Space in Region 15 of Tehran City by Geographic Information System (GIS)

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Extended Abstract

Introduction

Nowadays integrated multi-criteria decision making (MCDM) and Geographic Information System (GIS) is commonly used in order to solve spatial problems. Different multi-criteria decision making techniques present different methodologies with certain limitations and advantages. Our proposed methodology focused on one of the vital problems of the cities shortcoming in the urban green areas, which can affect the human life from a variety of viewpoints. The levels of green areas of Iran cities not only are low in comparison to the standards of urbanism, but they also have been distributed in an improper way. Accordingly, the available spatial distribution caused so many problems namely, difficulty to access to them and inequality in distribution of the green areas. As a result, in order to answer the needs of urban residents in our country and overcome such problems, the urban managers and decision makers need to apply modern analytical tools. This article attempts to offer a new combinational method to propose suitability map for distribution green space in the region 15th of Tehran Municipality to the urban managers and decision makers using FAHP and TOPSIS techniques.

Methodology

Integrated Multi-Criteria Decision Making (MCDM) and Geographic Information System (GIS) are commonly used in order to solve spatial problems. Different multi-criteria decision making techniques present different methodologies with certain limitations and advantages. Our

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proposed methodology considered 8 green space related criteria to evaluate and priorities urban green space suitable sites. The proposed methodology has two steps: in step 1, AHP is improved by fuzzy set theory. In this regard, by using fuzzy set theory in AHP method, the qualitative judgment can be qualified to make comparison more intuitionistic and reduce or eliminate assessment bias in pairwise comparison. In step 2, obtained results have been used as input weights in TOPSIS algorithm. TOPSIS algorithm by considering ideal and non ideal solution helps decision maker evaluate ranking of locations to select the best one.

FAHP: To deal with ambiguity of human thought, Zadeh first introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the fuzzy domain. A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function, which assigns to each object a grade of membership ranging between zero and one. Essentially, the uncertainty in the preference judgments gives rise to uncertainty in the ranking of alternatives as well as difficulty in determining consistency of the preferences. These applications are performed with many different perspectives and proposed methods for fuzzy AHP. In this study, Chang's (1992) extent analysis on fuzzy AHP is formulated for a selection problem.

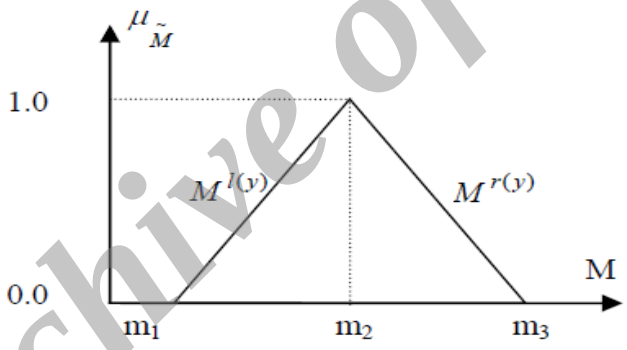

Fig. 1 A triangular fuzzy number

A triangular fuzzy number (TFN), M, is shown in Fig. 1. A TFN is denoted simply as (m_1, m_2, m_3). The parameters m_1, m_2 and m_3, respectively, denote the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event. The Analytical Hierarchy Process (AHP) is one of the extensively used multi-criteria decision-making methods. One of the main advantages of this method is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can effectively handle both qualitative and quantitative data. The use of AHP does not involve cumbersome mathematics. AHP involves the principles of decomposition, pairwise comparisons, and priority vector generation and synthesis.

Though the purpose of AHP is to capture the expert's knowledge, the conventional AHP still cannot reflect the human thinking style. Therefore, fuzzy AHP, a fuzzy extension of AHP, was developed to solve the hierarchical fuzzy problems. In the fuzzy-AHP procedure, the pairwise comparisons in the judgment matrix are fuzzy numbers that are modified by the designer's emphasis.

TOPSIS: An extension of TOPSIS (technique for order performance by similarity to ideal solution), a multi-attribute decision making (MADM) technique, is applied to a set of investigated criteria. TOPSIS is a practical and useful technique for ranking and selection of a number of externally determined alternatives through distance measures. TOPSIS is based on

the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution. It is a method of compensatory aggregation that compares a set of alternatives by identifying weights for each criterion, normalizing scores for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion.

Results and discussion

In our study, we have categorized suitability value of geographic locations for urban green spaces in region 15th of Tehran Municipality. These are categorized into, very low suitability, low suitability, moderate suitability, high suitability and very high suitability. Comparison of categorized suitability classes in relation to final suitability map indicates that the two suitable categories (High and very high suitability) of the proposed suitability map together occupy about 20% of the study area.

Conclusion

AHP is an effective problem solving methodology. Decision problem may contain spatial social, economic, technical and politic factors that need to be evaluated by linguistic variables. Then, AHP is one of the most commonly used techniques for such situations. The Criteria set is determined at the beginning in many multi criteria decision making methods. It was also modeled depending upon these criteria. Multi criteria decision making techniques based on the linguistic evaluations like FAHP helps make the best decision selection by using a weighting process within the current alternatives via pair wise comparisons. In this methodology by utilizing improved Analytical Hierarchy Process by Fuzzy set theory, weight of each criterion has been calculated for urban green space site selection. Finally, this article introduces an approach that integrates improved AHP with TOPSIS algorithm to support related decisions of urban green space site selection.

FAHP is the AHP improved by fuzzy set theory which is a useful approach for evaluation of the complex multiple criteria alternatives involving subjective and uncertain judgment. By using fuzzy set theory in AHP method, the qualitative judgment can be quantified to make comparison more intuitionists and reduce or eliminate assessment bias in pairwise comparison process. In further step, TOPSIS algorithm considered ideal and non-ideal solution in combination with obtained expert results which have been deducted from FAHP algorithm.

Keywords: Fuzzy AHP, Geographic Information System, green space, Multi-Criteria Decision Making (MCDM), TOPSIS Technique.