MULTI-CRITERIA DECISION SUPPORT INTERFACE IMPLEMENTATION FOR SITE SELECTION

Serhat DOĞRAMACI[1], Fatmagül BATUK[2], Hülya DEMİR[2]
[1]Yatirim Real Estate Valuation Co. Inc., Istanbul, Turkey.
serhatdogramaci@hotmail.com

[2]Yildiz Technical University, Department of Geodesy and Photogrammetry Engineering, Istanbul, Turkey.

ABSTRACT

Locational decision analysis made via using multi criteria is based on uniting various cross-examinations of the decision, under a single denominator by adding them on top of each other. Multi-Criteria Decision Making (MCDM) includes criteria, where the importance of these criteria is dependant on the priorities of the decision maker. Therefore information about the relative importance of these various criteria should be obtained. The weights of the criteria are formed based on the choices of the decision maker and then these normalized criteria data are put into a set of mathematical transactions to get the synthesis layer. This layer, gives an idea to the decision maker through the use of various criteria examined about the alternative which best fits the purpose. In this paper, used MCDM method, parameters in site selection for mass housing, and developed interface were explained.

1. INTRODUCTION

Multi-Criteria Decision Analysis is a decision making method that enables to make selection amongst multiple alternatives in line with a purpose. It is generally used as a synonym for MCDM. It's based on a logic that ranks analytically the alternatives that meet the requested multiple criteria fully. Today this method is widely used in various areas from management of ground water sources to technology selection in mobile data system designs (Pietersen, 2006; Ondrus, 2005).

SAW, Value/Utility Function Approaches, Fuzzy Aggregation Operations and AHP are some of the methods that are used in MCDM. One of the most commonly used MCDA method is Analytic Hierarchy Process (AHP) analysis. This method, which is preferred in decision problems of different sectors from economy to industry, serves mankind in decision making processes like urban land assessments, selection of routes for gas pipelines and conformity analysis of nuclear waste disposal sites (Kryvobokov, 2005; Nataraj, 2005; Huang et al., 2006).

Another area that decision analysis is commonly used in is the problems that include selection of land that best suits one's goals. In such processes, MCDM, which is supported with Geographical Information System (GIS) that is carried out by receiving aid from geographical data, is called G-MCDM. A wide range of implementations such as, land management, selection of highway locations in cities and site selection for high budgeted investments for reinforcement areas, has been performed in this respect (Joerin and Musy, 2000; Klungboonkrong and Taylor, 1998; Eldin and Eldrandaly, 2004).
In this paper, an MCDM supported study for site selection of mass housing carried out in Istanbul Anatolian Site is presented.

2. METHOD AND MATERIAL

In this paper, an MCDM supported study for site selection of housing development carried out in Istanbul Anatolian Site is presented. Project's flow diagram was depicted in Figure 1.
In the developed practice, the mass housing land selection is focused on the satisfaction of the housing environment. Malczewski used, proximity to major roads, to the city, to the airport and to rivers and the distance from wetlands as criteria in his parameter selections (Malczewski, 2006). In this study in the light of expert opinion and literature review, the parameters of proximity to the major roads, to the shopping centers, to the hospitals and to the schools and distance from solid-liquid waste treatment plants have been selected. The data from various sources has been arranged in ArcGIS platform and new data have been added. Shopping centers, hospitals, schools and treatment plants which were chosen from the land-use data on the basis of city block, have been used. The city blocks of the criteria have been converted to point data. Ten pieces of free land among which a selection will be made have been designated and the city blocks of these alternatives have been converted to point data.

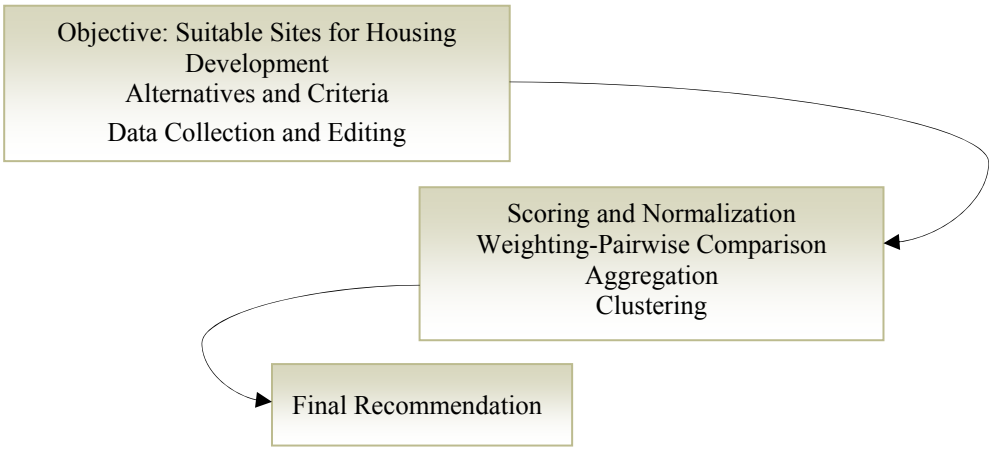

Figure 1. Project's flow diagram

For each data, raster data which shows the distance to the feature data has been produced with 50 m pixel size. Then, these raster data has been standardized according to the proximity and distance terms as required by the criteria. With the pair-wise comparison method, the weights of the entire criteria have been identified. The highest value of identified weights appears to be the proximity to the major roads criteria, and the lowest value appears to be the proximity to the hospitals criteria.

The entire data has been multiplied by their weights deriving pixel based value and then the synthesis layer has been produced by adding these pixel based values on top of each other. The grading has been done by appointing the synthesis layer values to the alternative lands by the use of ready-made script. The Interface program was depicted in Figure 2.

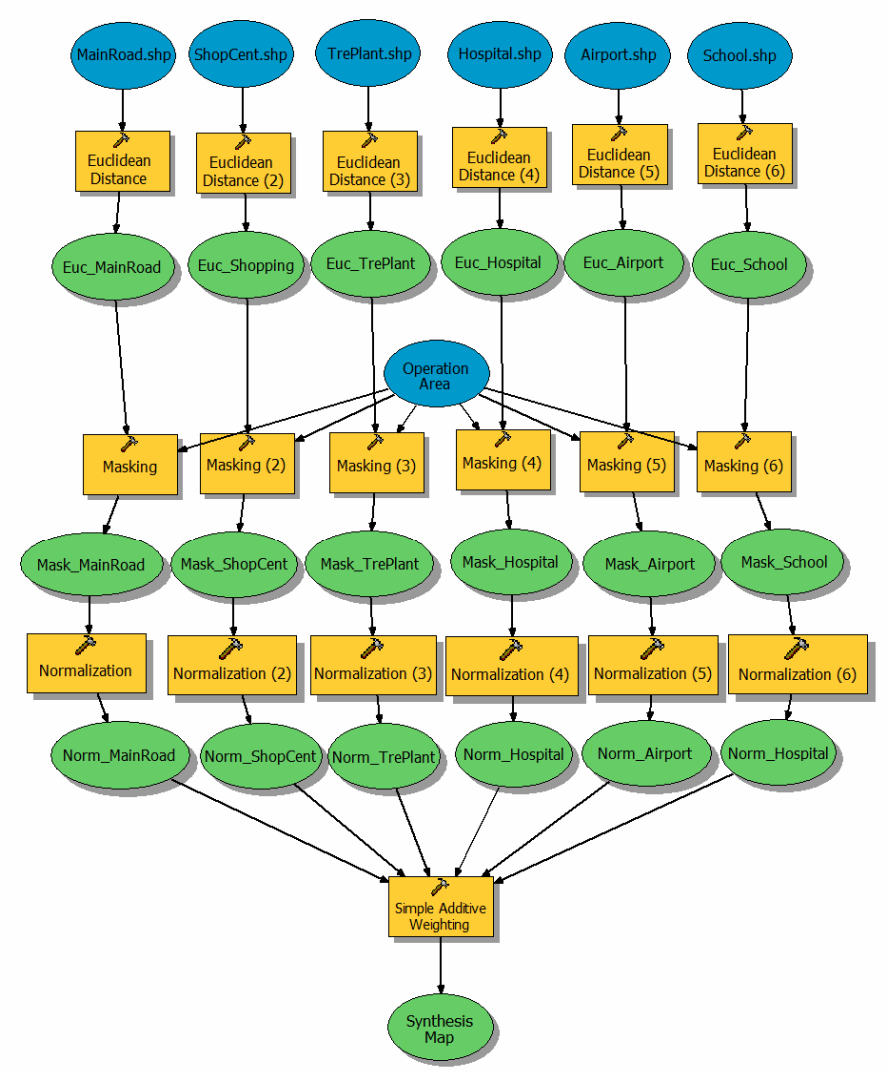

Figure 2. Developed Interface program

2.1. Normalization

During normalizing criteria layers, "Maximum Value" method is used, since the method protects ratios of the input data. With the help of ArcGIS Map Algebra tool, the formula shown in (2.1) is applied in the main road, hospital, AVM, schools and airport layers in which the condition of being close is expected. Thus, new pixel values are assigned converging to 1 for the points that are closest to these layers, and converging to 0 for the points that are farthest to these layers.

$$x_{ij}^{'} = 1 - \frac{x_{ij}}{x_j^{\max}}$$

(2.1)

The formula shown in (2.2) is applied on the "wastetreatment" layer related to the location of the solid and liquid waste treatment plants. So, new pixel values are assigned converging to 0 for the points closest to treatment plants, and converging to 1 for the points that are farthest to the treatment plants.

$$x_{ij}^{'} = \frac{x_{ij}}{x_j^{\max}} \qquad (2.2)$$

Criteria layers take new attribute values between [0,1], by normalizing in such a way that the ratios are conserved. Thus, the normalized criteria layers that project different distributions due to nearness and farness conditions, and which become more convenient in order to be treated with each other, are now ready for the applications to create the synthesis map. Normalized criteria layers are shown in Figure 3.

2.2 Weighting

The weight values of criteria that are indicated related to site selection appropriate to mass housing, are obtained by pairwise comparison method. Relative significance comparisons are made based on the research made, for this study. (Table 1.). Consistency Ratio calculated to determine if there is consistency in the pairwise comparisons and it is found out to be 0.045. Since this value is lower than 0.10, the assessments are consistent.

	Main Roads	**Airport**	**Treatment Plant**	**Schools**	**Hospitals**	**AVM**	**w**
Main Roads	1,000	3,000	2,000	4,000	5,000	4,000	**0,3721**
Airport	0,333	1,000	0,500	2,000	3,000	0,333	**0,1196**
Treatment Plant	0,500	2,000	1,000	3,000	3,000	2,000	**0,2127**
Schools	0,250	0,500	0,333	1,000	2,000	0,500	**0,0800**
Hospitals	0,200	0,333	0,333	0,500	1,000	0,333	**0,0540**
AVM	0,250	3,000	0,500	2,000	3,000	1,000	**0,1616**
	2,533	9,833	4,667	12,500	17,000	8,167	**1,000**

Table 1. Pairwise comparison matrix of assessment criteria and calculated weights

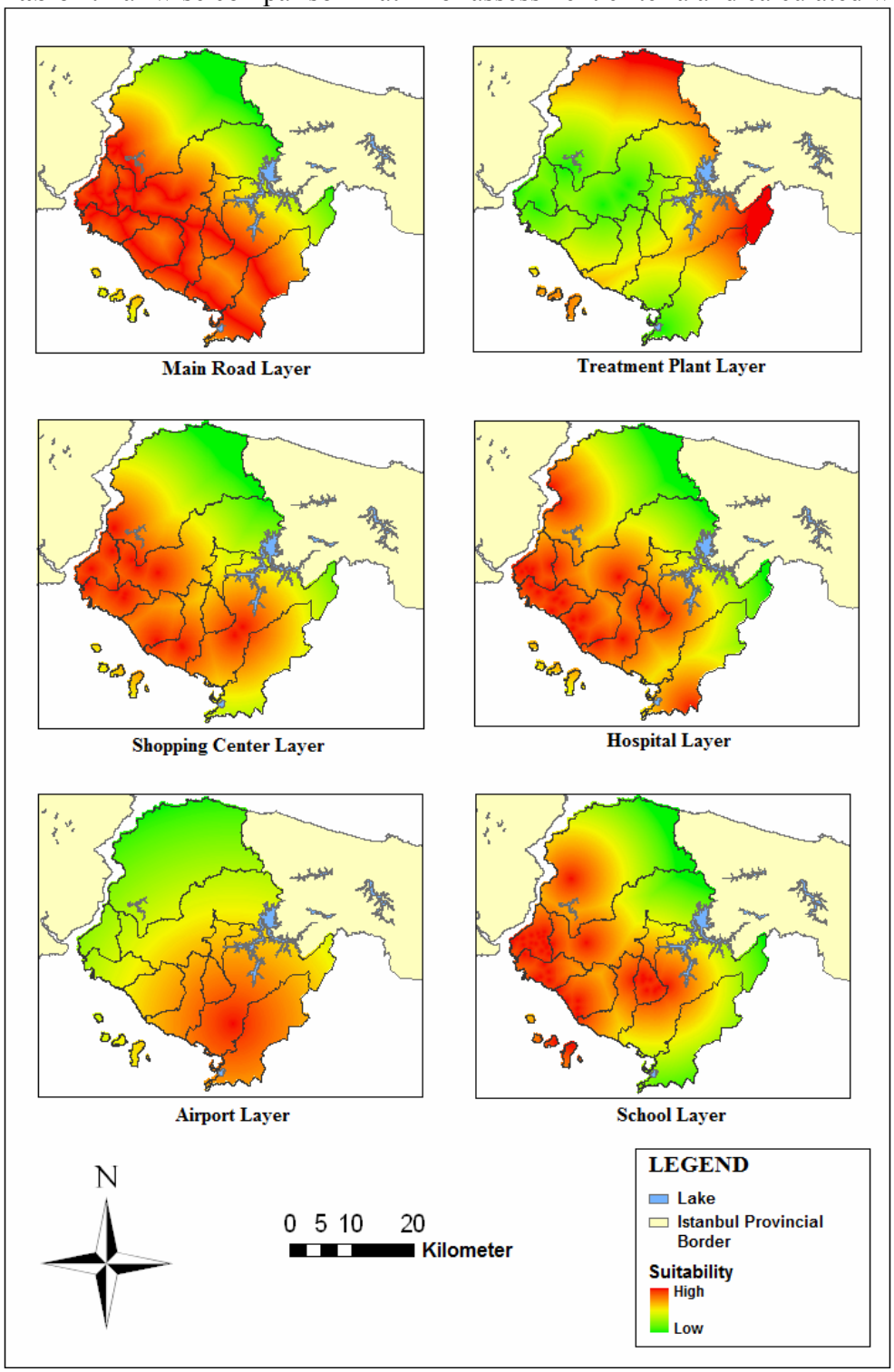

Figure 3. Normalized criteria layers that are formed by Euclidean distance values

3. RESULTS

The places that are suitable for the mass housing site selection are indicated as raster layer by the interface prepared via Model Builder in ArcGIS context (Figure 4. and Table 2.). Here, the red area that has the highest values demonstrates the convenient areas, and the dark green area that has the lowest values demonstrates the inconvenient areas. The class names are defined as: Inconvenient, low level convenient, medium level convenient, convenient, high level convenient and absolutely convenient, respectively.

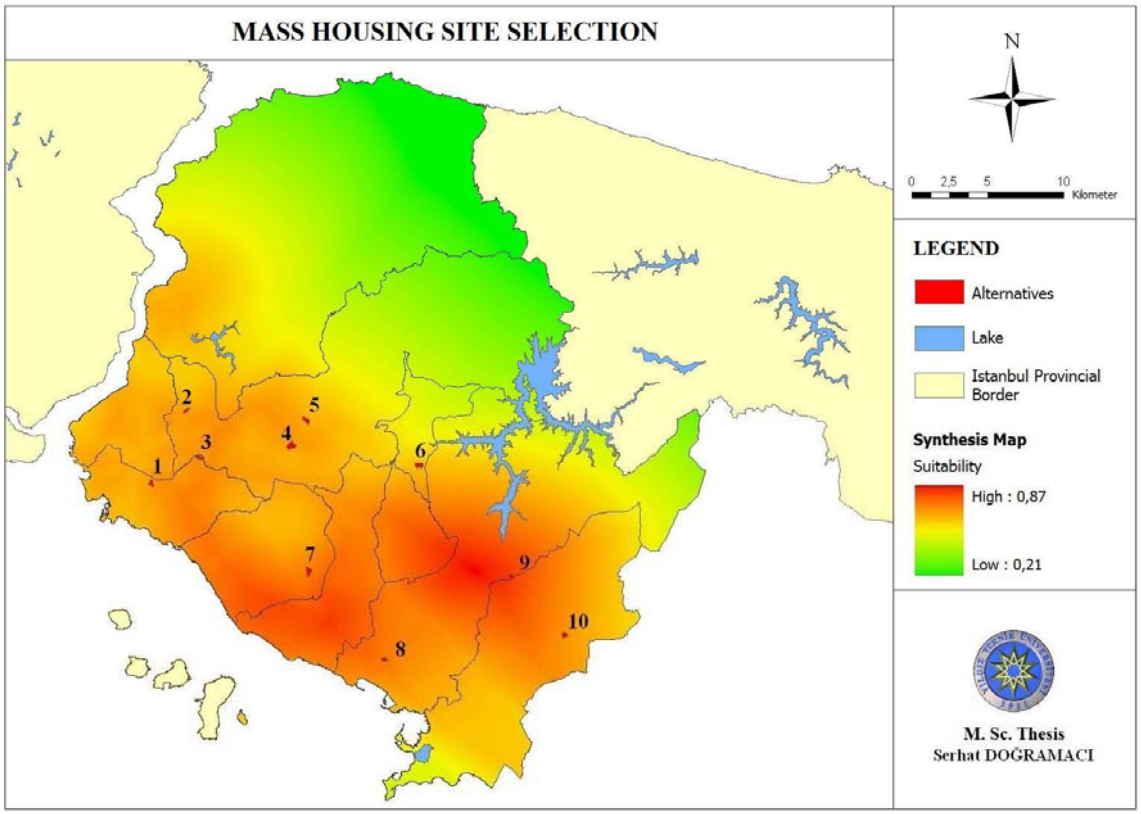

Figure 4. Synthesis Map

Thus, 9th alternative is the most convenient one in terms of housing environment satisfaction. After the examination of the grading of the alternatives, it was seen that the pieces of land placed on the top have become to be preferred for mass housing in real life as well. This is a sign that the decision model has been built correctly mathematically. The arranged model can be used for mass housing site selection in other areas as well.

Alternative No.	Synthesis Values	Order
1	0,723517	6
2	0,714166	7
3	0,727368	5
4	0,713721	8
5	0,696471	9
6	0,672231	10
7	0,761073	3
8	0,762462	2
9	0,830540	1
10	0,730226	4

Table 2. Values and alignment of alternative lands on the synthesis map

4. CONCLUSIONS

Since people's decisions are usually intuitive, the decisions that will shape the future should be based on more objective basis. Thus, MCDM has gained an essential significance in terms of decision processes as a result of coming to scientific conclusions by modeling all formulas mathematically.

GIS-MCDM who uses the geographical data, can immediately process the graphic or non-graphical data with different attributes by gathering them together, using computers. This gives decision-makers the freedom of making several changes on the application, correcting the mistakes between the processes if exists, and searching for different solution methods. By the way, it is possible to minimize the human mistakes originating from subjective decisions in spatial or non-spatial several different decision problems such as planning, risk management and personnel selection, which will increase the human life quality.
In this study, mass housing site selection application with focus on housing environment satisfaction is declared in İstanbul Anatolian side, with AHP which is a solution method widely used in MCDM. With the designed decision model, it is possible to draw scientific conclusions by means of modeling the site selection mathematically.

REFERENCES

Eldin, N.N. and Eldrandaly, K.A., (2004). A Computer-aided System For Site Selection of Major Capital Investments. 1st ASCAAD International Conference, e-Design in Architecture Dhahran.

Huang, L. X., Sheng, G., and Wang, L., (2006). GIS-based Hierarchy Process for the Suitability Analysis of Nuclear Waste Disposal Site. Environmental Informatics Archives. Vol.4, p. 289-296.

Joerin, F. and Musy, A., (2000). Land management with GIS and multicriteria analysis. Intl. Trans. in Op. Res. 7, p.67-78.

Klungboonkrong, P. and Taylor, M.A.P., (1998). A Microcomputer-based System For Multicriteria Environmental Impacts Evaluation of Urban Road Networks. Comput. Environ. and Urban Systems, Vol. 22, No. 5, p. 425-446.

Kryvobokov , M., (2005). Estimating the weights of location attributes with the Analytic Hierarchy Process in Donetsk, Ukraine. Nordic Journal of Surveying and Real Estate Research, 2:2, p.5-29

Malczewski, J., (2006). Ordered weighted averaging with fuzzy quantifiers: GIS-based multicriteria evaluation for land-use suitability analysis. International Kournal of Applied Earth Observation and Geoinformation.

Nataraj, S., (2005). Analytic Hierarchy Process as a Decision-Support System in the Petroleum Pipeline Industry. Issues in Information Systems, Vol.VI, No. 2, p.16-21.

Pietersen, K., (2006). Multiple criteria decision analysis (MCDA): A tool to support sustainable management of groundwater resources in South Africa. Water SA Vol. 32 No. 2 April 2006 p.119-127.

Ondrus, J., Bui, T. and Pigneur, Y., (2005). A Multi-Actor , Multi-Criteria Approach for Technology Selection When Designing Mobile Information Systems. Mobile Information Systems II. Springer Boston. Volume 191/2005. p.271-278.