Application of Multi Criteria Decision Making Method and the Integrated ANP- DEMATEL Model for Agricultural Land Suitability Analysis (Case study: Qazvin Plain)

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Abstract

Peri-urban area development process decreases agricultural land use because of significant trend of city sprawl. In the agricultural sector, goals for sustainability generally include maintenance or enhancement of the natural environment, meeting of human needs for food, economic viability, and social welfare. As agriculture has enormous environmental impacts on peri-urban regions, it is necessary to evaluate agriculture land use.Therefore, agricultural land suitability analysis is a prerequisite to achieve optimum utilisation of the available land resources for sustainable agricultural production. This paper presents an integrated technique of Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) to evaluate the land for peri-urban agriculture. Ecological word model, slope, climatic soil properties, water resources and vegetation density were chosen as the major factors affecting the peri-urban agriculture. Then, in a model, it was evaluated by Multi Criteria Decision Making (MCDM) with the Analytic Network Process (ANP) and DEMATEL after overlaying the layers by Simple Additive Weighting (SAW). Assessment of results confirmed presence of six classes of agricultural land use. according to the results, northern parts are not suitable for the agriculture development. However, the layers determined that 98598.20 ha of the polygons are extremely high suitable to medium suitable for agriculture. In fact, the specific model represented a effective solution to help group decision making of evaluators.

Introduction

Agricultural land suitability classification based on indigenous knowledge is vital to land-use planning (ecological capacity evaluation). Execution of development and creation of appropriate areas for agriculture land use without considering ecological capability will result in the appearance of several environmental, economic and social problems. In the agricultural sector, goals for sustainability generally include the maintenance or enhancement of the natural environment, meeting human food requirements, economic viability, and social welfare. As agriculture has enormous environmental impacts on peri-urban areas, it is essential to investigate agriculture land use suitability.Therefore, agricultural land suitability analysis is a prerequisite to optimum utilisation of the available land resources for sustainable agricultural production. The objective of the present study is to evaluate the arable land suitability using the decision making models such as analytic network process (ANP) and simple additive weighting (SAW). In this paper, we determine agricultural land suitability classifications using case spatial data sets from Qazvin Plain.

Matherial and Methods

This research was done in framework of the ecological model and multicriteria decision making methods such as DEMATEL, ANP, SAW by using ArcGIS 9.3, Excel 2007, Super Decision 2.0.8, MATLAB 7.11.0 software, with the aim of choosing the suitable locations for agriculture land use in Qazvin plain. Suitable ecological model for evaluation of capability of study area for agriculture land use in Iranian special ecological models was prepared in six-degree value and based on special conditions of concerned region and existing data. DEMATEL

is a comprehensive method for building and analyzing structural model involving causal relationships between complex factors. ANP is based on the creation of a control network which describes dependency among decision elements. The method involves numbers of pairwise comparisons for deriving the priorities of different alternative evaluation. The consistency ratio (C.R.) in the method should be less than 0.1. Simple Additive Weighting (SAW) is a multi attribute decision technique. The method is based on the weighted average. In the method, an evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance. Therefore, ecological criteria of slope, climate, soil properties, water resources and vegetation density were chosen as major factors affecting the peri-urban agriculture. The study area is located in Qazvin plain. This area is limited in 31°, 36° to 36°, 30' north of latitude and 49°, 30' to 50°, 30' east longitude.

Discussion of Results

Analyzing the criteria objectively involved using specific GIS techniques to break the analysis down into quantifiable measurements. From the available 10 m interval contour map of the study area in ArcGIS, a Digital Elevation Model (DEM) was generated from which a grid DEM was derived and the slope data was obtained. The Reclassify Tool was then used to reclassify all the variable data sets by Iranian ecological model. It is favourable to use the DEMATEL to handle the problem of inner dependencies, since it can provide more valuable information for decision-making. For example, from the causal table (r + c and r – c matrix) it can be directly and visibly seen that the most important criterion is slope (Table 1).

This study also shows that using DEMATEL to normalize the unweighted super matrix in the ANP procedure is more reasonable than using the assumption of equal weights in each cluster (Table 2). In final, all the digital layers were integrated using the simple additive weighting method to evaluate each alternative. Fig.1 shows the final layer of evaluation.

Table 1. Sum of criteria effects

Ecological criteria	r	c	r - c	r + c
Soil Fertility	2.297	3.176	-0.880	5.473
Soil Texture	3.152	2.388	0.764	5.540
Soil Deep	2.378	2.232	0.146	4.609
Soil Erosion	3.108	3.389	-0.281	6.498
Soil Granulation	2.870	2.639	0.231	5.508
Soil Drainage	2.442	3.574	-1.133	6.016
Slope	3.454	2.459	0.995	5.914
Vegatation Density	2.815	3.753	-0.937	6.568
Water	3.407	2.895	0.512	6.302
Temperature	2.619	2.037	0.583	4.656

Table 2. Final Weights of criteria

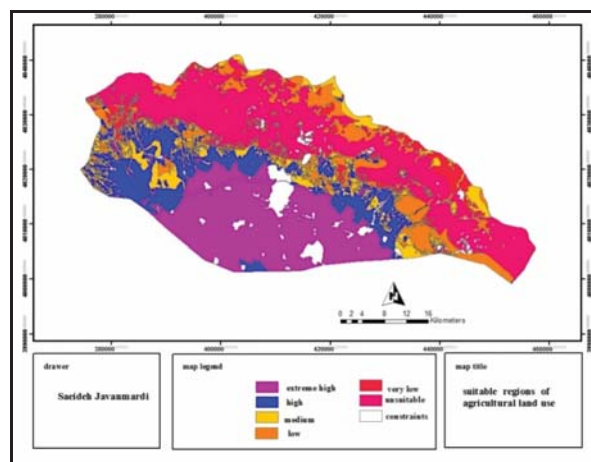| Temperature	Water	Vegatation Density	Slope	Soil Erosion	Soil Granulation	Soil Drainage	Soil Deep	Soil Texture	Soil Fertility	**criteria**
0.033	0.169	0.131	0.200	0.133	0.096	0.018	0.035	0.035	0.150	**Final Weight**

Fig. 1. The final layer of agriculture land use evaluation

Conclusions

Ecological capability of the region was distinguished by agriculture ecological model and implemented based on land suitability. The results indicate the presence of total classes of agriculture land use in the region. There are limiting factors for agriculture land use in the region such as unsuitable soil in north, gardens and forest land uses in south.

Keywords: agriculturalland use, analytic network process, decision making trial and evaluation laboratory, simple additive weighting.