



Journal of Applied Sciences

ISSN 1812-5654

science
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Land Use Potential and Suitability for Areas of Arable and Garden Farming, Meadow-Pasture and Recreation-Tourism in Alpağut Village, Bolu, Turkey

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Abstract: In this study the most proper land-use type is determined in order to succeed a goal of rural development of a village near Bolu. Alpağut Village located within the Seben District of Bolu was chosen as a case study of this project, in which three different land-use types (arable and garden farming, meadow-pasture and recreation-tourism) were evaluated by assessing the village's selected features and putting them in order of importance. For this purpose, first, natural resources and social-cultural features of the village were determined. Then, using results from previous studies and recommendations of professional people factors have been determined for each alternate land-use type to create Suitability Values (SV). Then, factors affecting the study were grouped according to AHP, Analytical Hierarchy Process. Pair-wise comparisons and the experts' grading were used to calculate relative weight (eigenvector) of each factor. In this study, eigenvectors were treated as suitability coefficient (SC). Both suitability values and suitability coefficients were used to create suitability maps of each factor using geographic information systems (GIS). Results showed that the most suitable land use type is recreation-tourism to improve rural progress in Alpagut Village, Bolu. While next suitable land use type was found to be arable and garden farming, meadow-pasture was the least suitable.

Key words: Land use, suitability, rural development, landscape planning

INTRODUCTION

Suitable land use decisions are important for receiving optimal benefit from a land and continuation of environmental sustainability. It is one of the top priorities of physical planning to point out suitable lands correctly and "the evaluation (or assessment) of land suitability" is one of the effective methods in this regard (Baja *et al.*, 2001; Anonymous, 2005 a).

The evaluation of land suitability is also known as land evaluation in general. It was first defined by the Food and Agriculture Organization (FAO) as "the process of assessment of land performance when [the land is] used for specified purposes" (FAO, 1985, 1976). According to FAO, the land suitability had been known as rational cropping system for a long period. In land evaluations, predicting usage potential of a land is based on detailed information of that land (Rossiter, 1996; Ghaffari *et al.*, 2000). Within the frame of the land evaluation, land use potential is dependent on biophysical, socio-economical conditions and institutions (FAO, 1985, 1976; Ekanayake and Dayawansa, 2003)

Dent and Young (1981) provides two general approaches in determining the values and potentials of

the land suitability; qualitative and quantitative evaluations. The former approach is used to evaluate land potential in a larger scale and generally results in a kind of classification scheme ranging from highly suitable to not-suitable. In quantitative approach, on the other hand, status of a land can be assessed in details through various statistical analyses (Baja *et al.*, 2001; Rossiter, 1996).

Classification of data collected during evaluations of lands and preparation of land use plans is very important (Ekanayake and Dayawansa, 2003). Components determined in the classification stage are established according to studies' goals (Cooper *et al.*, 1994; Klosterman, 2001). Even though there are plenty of criteria types at the classification stage of these studies, factors including climate, soil, topography, water availability and vegetation cover are usually used more often (Ghaffari *et al.*, 2000; Ekanayake and Dayawansa, 2003). In many studies, land potential and land use suitability are formed through pointing out them as matrixes transformed from units representing each land (Takeuchi, 1983). Land evaluations performed by this method not only guide land use decisions to be made with the best way possible but also provide a better decision-

making for the optimal area of each category of the land use units. These two advantages of this method are classified as important foundations for determining landscape plans (Takeuchi, 1983).

There are various classification systems and analyses used in suitability determination efforts. For example, pointing and weigh systems (Anonymous, 2005a; David and Alhadeff, 2002), risk (Baja *et al.*, 2001) and safe scenarios (Anonymous, 2005a), the method of multiple criteria analyzing (Joerin *et al.*, 2001; Kalogirou, 2002; Rubin *et al.*, 2003), Analytic Hierarchy Process (AHP) and fuzzy (Baja *et al.*, 2001) are the ones used frequently by similar researches. In addition, mapping tools, computers, software programs and geographical information systems (GIS) have been used effectively in recent studies (Ghaffari *et al.*, 2000; Joerin *et al.*, 2001; Kalogirou, 2002; Ekanayake and Dayawansa, 2003).

Like anywhere in the world, efforts to prevent misuse of environmental resources have also been gaining importance in Turkey, mostly by applying various suitable land evaluation techniques and methods mentioned above. Moreover, the importance and the necessity of the ecological planning approaches and methods have been realized especially after recent research projects initiated in respect to land evaluations in Turkey (Ortaçesme, 1996; Mansuroğlu, 1997; Yüksel *et al.*, 2003; Çelikyay, 2005). There is still a need for more studies regarding land evaluations to prevent damages that may possibly be resulted in due to both current and/or future misuse of lands.

The main goal of this study was to determine an analyzing model for land suitability of Alpağut Village located in Bolu, Turkey. In order to reach this goal, the following objectives were set; (a) evaluating the village based on three different land use types (arable field and garden farming, meadow/pasture and recreation-tourism); (b) determining a priority usage of these land use types through considering the village's physical and thematic features; (c) and creating suitability maps for each land use type. It is important to note that this study was different compared to the earlier studies in respect to the fact that the data (eigen vectors) found using the AHP method were transferred into maps first time in this study.

MATERIALS AND METHODS

Alpağut Village (Turkey) was chosen as the study area. The Village is located 54 km south of Seben District, Bolu within the Eastern Blacksea Region (Fig. 1). Seben, is the border district of Bolu to the Interior Anatolia Region.

This study was done during 2001 and 2002 years. In this study using Arcview (version 3.2) program of the Geographical Information Systems (GIS) (Detailed study plan summarized in flowchart is shown in Fig. 2), 1:25000 scale maps were prepared through digitizing raw data collected for the following features: altitude, geomorphology, drainage, erosion, navigable water resources, plant presence, land use, transportation, historical values, land use capability class, soil depth, limiting soil feature, slope, aspect, precipitation, temperature. Total of 25 maps created for each of all the factors chosen for the land use types of arable and garden framing, meadow-pasture and recreation-tourism was separated into squared plans (grids) of 250×250 m. In order to determine the potential in the maps, Suitability Value (SV) of each squared plan for every land use type was multiplied with SC to reach Suitability Scores (SS). Then, by summing up suitability scores, Total Suitability Scores (TSS) was found (Ortaçesme, 1996; Mansuroğlu, 1997) as follows:

$$\begin{aligned}SV_n * SC_n &= SS_n \\TSS &= SS_1 + SS_2 + \dots + SS_n\end{aligned}$$

where:

SV is the suitability value given to of sub-factors for each land use type,

SC is the suitability coefficient of a factor for each land use type,

SS is the suitability score estimated for each factor and

TSS is the total suitability scores for each squared-plan of each land use type.

TSS values were graded as "First Degree Suitable", "Second Degree Suitable" and "Third Degree Suitable" to create suitability maps.

Determining suitability values (sv): With the help of evaluating both the results from the previous studies and the opinions of experts in similar subjects, factors were chosen for each land use type. For evaluations purposes, numbers from 1 through 4 were assigned to these chosen factors. There were also sub-units of these factors chosen and numbers were also assigned to each sub-unit between 1 and 4 as higher numbers being more important. Table 1-3 list the chosen factors and sub-units with assigned suitability coefficients and suitability values.

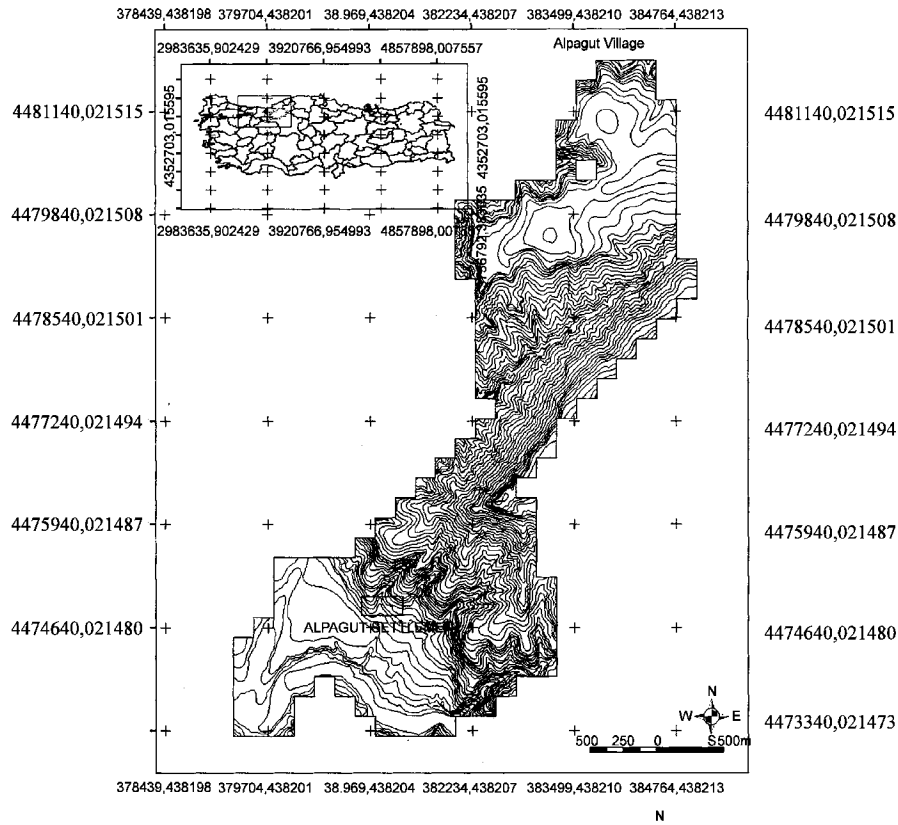


Fig. 1: Location of study area

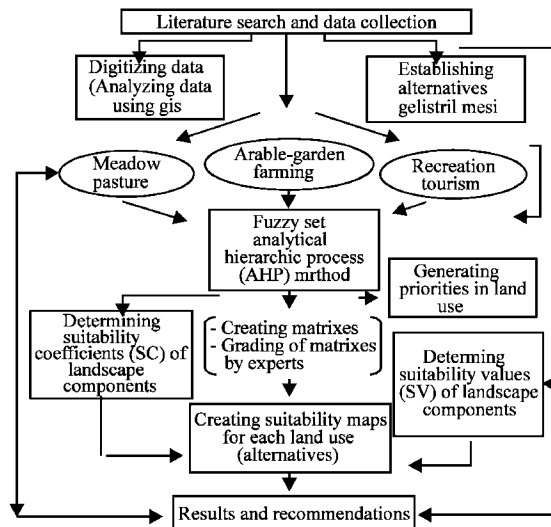


Fig. 2: Flowchart showing study plan

Determining suitability coefficients (sc): SC was determined through application of the AHP method. An original approach of considering eigenvectors as SC, it was made possible to transfer data into maps.

Application of AHP method: First described by Saaty (1974), AHP is one of the multiple-criteria techniques (fuzzy set) (Hacimenni, 1998). AHP is considered as a tool because not only it allows evaluation of quantitative

Table 1: Selected factors, suitability coefficients, sub-units and suitability values given to sub-units in determining suitable lands for arable and garden farming

Land use type	Selected factors	Suitability coefficient (Sc)	Selected sub-units	Suitability values given to sub-units (Sv)
Arable and Garden Agriculture	Land Use Capability Classes	0.65	I. Class	4
			II. Class	3
			III. Class	2
			IV. Class	1
	Soil depth	0.65	Very deep	4
			Deep	3
			Shallow	2
			Very shallow	1
	Limiting soil Feature	0.14	Non-present	4
			Present	1
	Drainage	0.53	Good	4
			Intermediate	3
			Impeded	1
	Erosion	0.14	None/Slow	4
			Intermediate	2
	Slope	0.12	0-2 %	4
			2-6 %	3
			6-12 %	2
			12-20 %	1
	Aspect	0.25	S, SE, SW	4
			E, W	3
			NE, NW	2
			N	1
	Water Resources	0.25	Lake, pond, stream	4
			Natural spring	3
			Intermittent stream	2
	Precipitation	0.1	550 - 700 mm.	4
			500 - 550 mm.	3
			700 - 800 mm.	2
			>800	
	Temperature	0.16	<500	1
			15 - 30°C	4
			10 - 15°C	
			30 - 40°C	3
			05 - 10°C	
			40 - 54°C	2
			5° <	
	Transportation	0.54	54°C >	1
			Asphalt road	4
			Stabilized road	2
			Dirt road	1

Table 2: Selected factors, suitability coefficients, sub-units and suitability values given to sub-units in determining suitable lands for meadow-pasture

Land use type	Selected factors	Suitability coefficient (Sc)	Selected sub-units	Suitability values given to sub-units (Sv)
Meadow pasture	Land use capability classes	0.28	IV. Class	4
			V. Class	3
			VI. Class	2
			VII. Class	1
	Limiting soil feature	0.24	Non-present	4
			Present	1
	Drainage	0.14	Good	4
			Intermediate	3
			Impeded	1
	Erosion	0.33	None/Slow	4
			Intermediate	2
			Severe	1
	Slope	0.23	6-12 %	4
			12-20 %	2
			20-30 %	1
	Aspect	0.25	S, SE, SW	4
			E, W	3
			NE, NW	2
			N	1
	Water resource	0.16	Lakes, ponds, streams	4
			Natural spring	3
			Intermittent stream	2

Table 2: Continued

Land use type	Selected factors	Suitability coefficient (Sc)	Selected sub-units	Suitability values given to sub-units (Sv)
	Precipitation	0.26	800 - 1200 mm.	4
			600 - 800 mm.	3
			400 - 600 mm.	2
			400 mm. <	1
	Temperature	0.25	20 - 25°C	4
			15 - 20°C	
			25 - 30°C	3
			10 - 15°C	1
	Plant presence	0.3	Unforested	4
			Open fields and forest openings	2

Table 3: Selected factors, suitability coefficients, sub-units and suitability values given to sub-units in determining suitable lands for recreation and tourism

Land use type	Selected factors	Suitability coefficient (Sc)	Selected sub-units	Suitability values given to sub-units (Sv)
Recreation and Tourism	Altitude	0.65	800-2000 m	4
			0-800 m	3
			2000-3000 m	2
			3000 m<	1
	Geomorphology	0.54	Mountainous	4
			High steeps	3
			Low plains	2
			Valley plateau	1
	Drainage	0.33	Good	4
			Intermediate	3
			Impeded	1
	Erosion	0.53	None/Slow	4
			Intermediate	2
			Severe	1
	Precipitation	0.64	500-1250 mm	4
			250-500 mm	
			1250-1500 mm	2
			0-250 mm	
	Temperature	0.6	1500 mm <	1
			15-25°C (mild)	4
			25 - 36°C (hot)	
			4 - 15°C (cold)	2
			< 4°C (very cold)	
			>36 °C (very hot)	1
	Navigable water source	0.6	0-500 m	4
			500-1000 m	3
			1000- 3000 m	2
			3000 m <	1
			41- 70 %	4
	Plant presence (Stand density)	0.54	11- 40 %	3
			0 - 10 %	2
			71- 100 %	1
			Residential	4
			Forested/Shrubby	3
	Land use	0.64	Meadow/pasture	2
			Agricultural	1
			0-1 km	4
			1-2 km	3
			2-3 km	2
	Transportation	0.3	3 km <	1
			Present	4
			Non-present	1
	Historical values	0.6		

criterion, but also enables decision makers to use their own knowledge and opinions (Ejder, 2000). It helps expressing feelings in mathematical form and at decision making stage (Saaty, 1988). Decision making consists of both quantitative and qualitative factors, causing it to be a very challenging task to choose the best

alternative there is. Selecting the best or the most logical alternative is the way to achieve the goals set (Buyukyazıcı, 2000).

In this study, factors and sub-units that possibly play a role in AHP method were chosen and grouped into according the method as follows (Fig. 3).

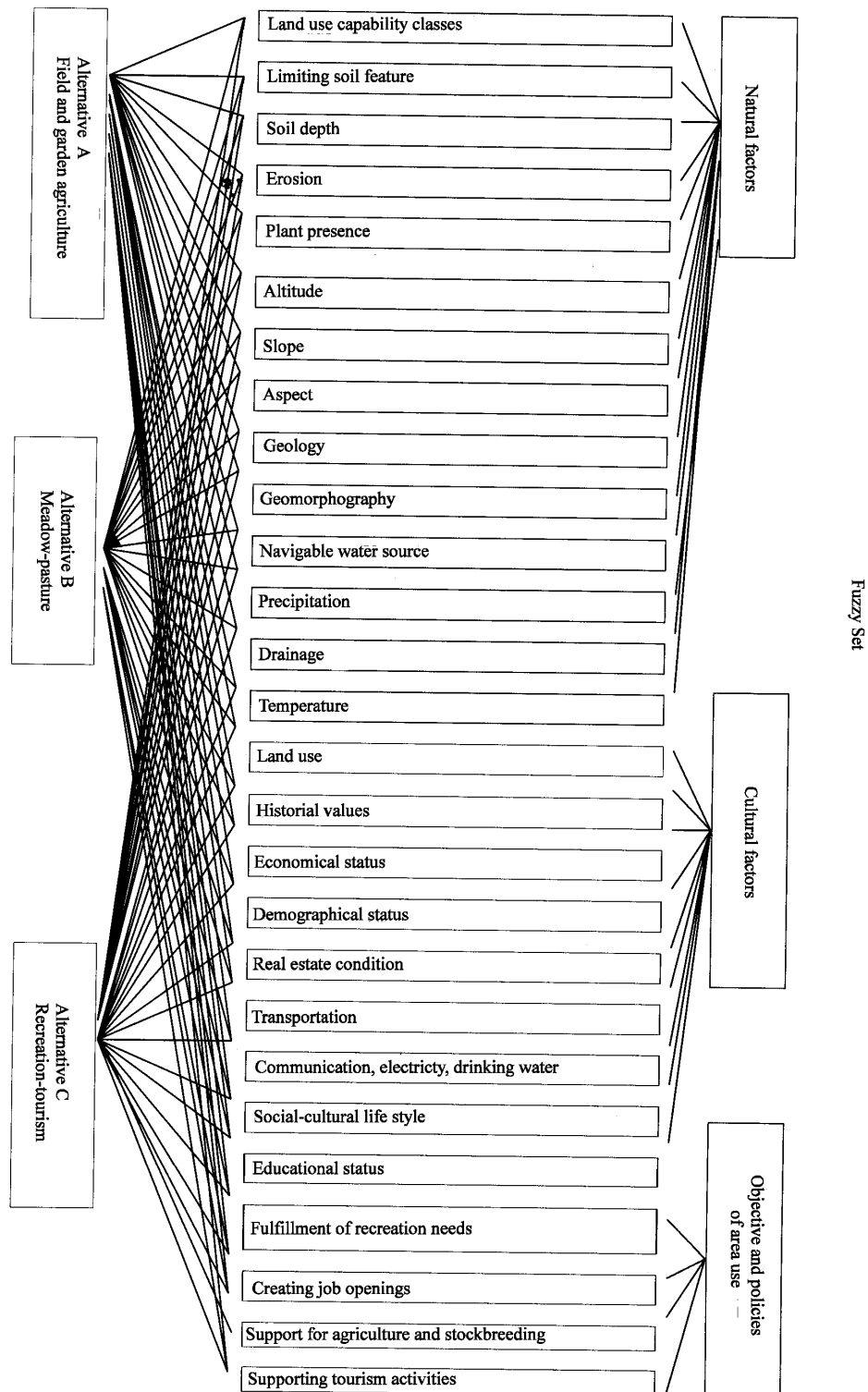


Fig. 3: Classifying the land use alternatives according to qualitative factors

Natural factors: Land use capability class, limiting soil features, soil depth, plant cover, altitude groups, slope, aspect, geology, geomorphology, water presence, precipitation, drainage, temperature.

Cultural factors: Present land use, historical areas, economical status, demographical status, real estate condition, transportation, communication-electricity and drinking water, social-cultural life style, education.

Factors related to land use targets and policies: Fulfillment of recreation needs, creating job openings, support for agriculture and stockbreeding and supporting tourism activities.

Therefore, these factors and their sub-units formed a hierarchy (order) for three alternate land use types (recreation-tourism, agricultural and garden farming and meadow-pasture). Within this order, matrixes were used to compare factors in pair as follows:

- Main quantitative factors (Natural and cultural factors and land use targets and policies),
- Natural factors,
- Cultural factors,
- Land use targets and policies and their sub-units.

Surveys done by scientists from various areas (landscape architecture, agricultural economy, agricultural plants, soil science and geography) helped us when we try to determine relative importance of the pairs compared with matrixes. Surveys were based on the "Saaty Measuring Scale" (SMS) Saaty (1980). Evaluations of pointing method were done with the help of a computer program, in which eigen vectors were used as SC. SMS can be explained as follows;

- 1 Equal importance (two factors contributing equally towards the goal).
- 3 One factor being little more important than another (one factor is somewhat preferred over another through experience and judgment).
- 5 One factor being strongly important than another (one factor is strongly preferred over another through experience and judgment).
- 7 Very important (one factor is very strongly preferred or its superiority has been proved in practice).
- 9 Very much important (confirmation of a proof that one factor is preferred over another is highly possible).

2, 4, 6, 8: In between values of two close scale units (used when there is a need for a compromise).

RESULTS AND DISCUSSION

In Turkey, immigration from rural to urban areas caused land use difficulties in the cities. These difficulties brought up new necessities such as effective use of land in urban areas and also appreciative reuse of the abandoned land in rural areas. Recently, Turkish national Government policy is concentrated on preventive solutions in loves to avert the rural areas getting useless situation, to gain economical input and to solve the land use difficulties in urban areas. According to these laws, the 3rd article of the Environmental Law with 11.08.1983 date and 2872 number has a statement that gives a guarding position to the authorized organizations responsible for source and land use decisions and project evaluation for protecting the principles of sustainable development and serving the need of the society (Anonymous, 2005b) Another dimension of the land use estimation and protection in Turkey is the Environmental Impact Assessment (EIA). According to 6.6.2002 date and 24777 number law, the EIA Reports- is the work of a team of experts of various disciplines-include the evaluatory process that prevent or minimize the negative effects of the planned activities on the environment (Anonymous, 2002). Besides these regulatory laws, economic development activities that a part of political land evaluation in rural areas were supported. Consequently, the recent studies on land evaluation and suitability have been increased. One of these studies is related to Alpağut village.

Alpağut village is one of the rural areas that the society is conscious about rural development. With its pioneer activities, the village is a model for the adjacent villages. The environmental damage caused by improper land use in village is not seen as considered amount. But, today's mistakes in land use decisions would be put in order for targeting more effective land use in the future. For this reason, the results gathered in this study should be applied to the land. According to study results; Data received after applying the AHP method was statistically analyzed and according to the results found, alternate land use types recommended for rural development of Alpağut Village was listed below in precedence:

- First recommended alternate land use is recreation-tourism (eigen vectors = 0.392)
- Second recommended alternate land use is arable and garden farming (eigen vectors = 0.386)
- Third recommended alternate land use is meadow-pasture (eigen vectors = 0.221).

It is clear from the results that eigen vectors calculated for land use types of both the recreation-

tourism and the arable and garden farming are very close. This suggests that the arable and garden farming type is as important as the recreation-tourism type for rural development of the village. Suitability maps were created after analyzing factors and suitability values used for determining above land use types.

Major findings for the alternate land use as recreation-tourism: When grading suitability maps of recreation-tourism areas, the following criterion was used;

- First degree suitable land uses represent high value areas in respect to architectural potential of the study area,
- Second degree suitable land uses represent areas with some limitations in respect to architectural potential when compared to 1st degree areas,
- Third degree suitable land uses represent areas with lower architectural potential when compared to 2nd degree areas (Fig. 4).

In addition, analyses revealed that 3rd degree suitable areas are made of river beds and floodplains for recreation-tourism model. As seen in (Fig. 4), it was found that 1st degree areas are usually represented by squared-plans found near residency areas.

In fact, the suitability degree of this research area is higher in respect to architectural potential since factors such as wildlife and endemic plants (particularly rhizomatous) were not included in the evaluations of this study because of incomplete data.

Even though there is a good potential for rural tourism in and around the study area, it has not been put in reality. Therefore, eco-tourism approach should be considered as an option for rural development in the area. However, this approach should be in accordance with the sustainability principle that there shouldn't be any fragmentation in natural, cultural and recreational resources and any damage to environment.

Major findings for the alternate land use as arable and garden farming: Arable and garden farming areas were graded based on factors that have long-time limiting effects on practices of agricultural areas. Thus, in evaluation;

- First degree suitable land uses of arable and garden farming represent areas where most of the products special to the study area can grow well.
- Second degree suitable land uses of arable and garden farming areas consist of some limiting features

creating less flexibility compared to the 1st degree areas, which, in turn, may cause lower productivity, but some products can still be grown.

- Third degree suitable land uses of arable and garden farming areas have severe limitations compared to 2nd degree areas (Fig. 5) and are used for unimportant products such as oats and barley.

In addition, areas classified as unsuitable contain conditions that are inappropriate for arable and garden farming. It is not recommended to plant anything in these areas unless it is necessary. Even though there is a well classification of land for agricultural activities in the village, it is hard to say that there is enough benefit from arable and garden farming economically because of low productivity, few varieties of products and lack of active man power.

Major findings for the alternate land use as meadow-pasture: In evaluation of data to create suitability maps of meadow-pasture areas, 1st degree suitable areas represent areas where all type of meadow and/or pasture products special to the study area can grow well. Second degree suitable areas for meadow-pasture, compared to 1st degree areas, are considered less productive because of some limitations. Third degree suitable areas are classified as including more limitations compared to 2nd degree areas (Fig. 6). In all those areas, management efforts should follow regulations stated in the "meadow law". Pasturing should be allowed only in the areas consisting of inappropriate conditions (e.g., high slope, low soil nutrition causing low productivity) for agriculture. For this reason, areas classified as suitable for arable and garden farming within the suitability maps of meadow-pasture can also be used as appropriate for pasturing. The 2nd degree suitable areas of the present arable and garden farming areas that are not left for fallowing can also be used as "meadows with sowing turns". These meadows are actually part of agricultural lands that first established by growing perennial feed plants on them for pasturing for certain time. Then, these areas are ploughed for growing cultivated plants are therefore called cultivated meadows (Ozaslan and Ekiz, 2001). Meadows with sowing turns enrich soils in organic matter content, prevent erosion, help drainage and increase productivity of soils; thus, enabling sustainable usage of lands.

Because of the content of the study (concept), the criteria determined for alternatives are considered in general. So, each alternative used for the future part of this study should separately be examined in detail. Moreover, in giving point in the certain scale and grading part of the study, the subjectivity would not have

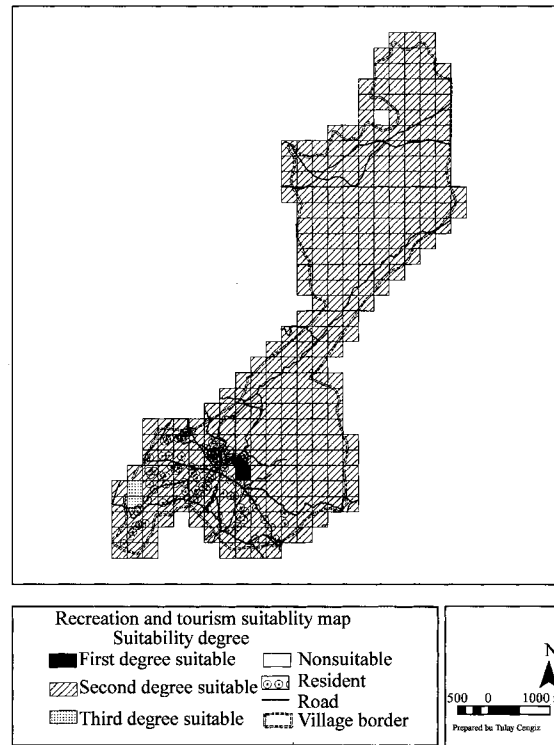


Fig. 4: Recreation-tourism suitability map

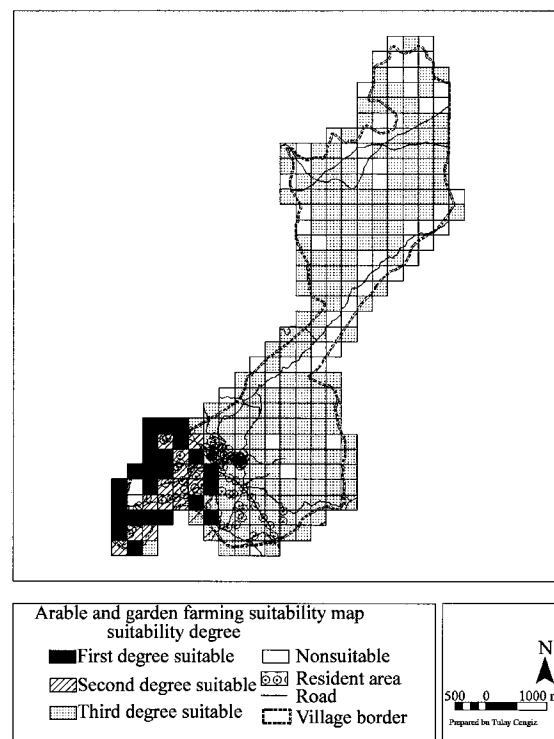


Fig. 5: Arable and garden suitability map

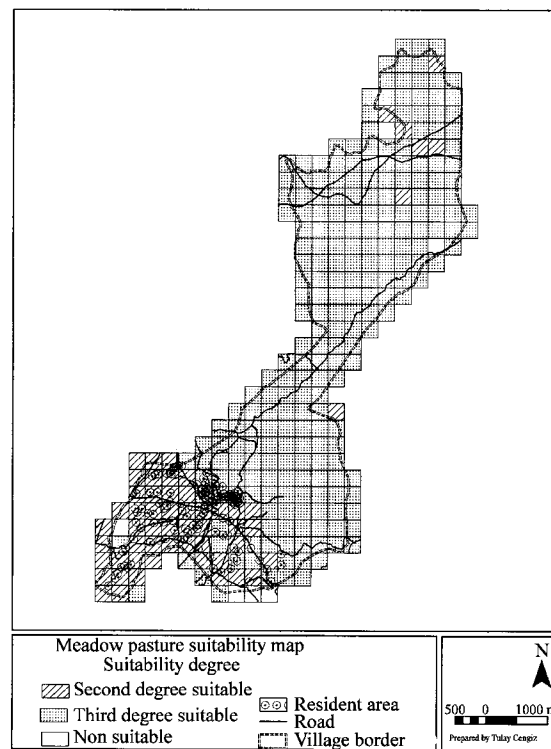


Fig. 6: Meadow-pasture suitability map

been avoided but tried to minimize by consulting a group of expert.

In the study the suitability line up performed between the determined alternatives by using the method of AHP that is also commonly used for the land evaluation studies till today.

The most clear difference between this research and previous ones is the possibility that the weight values gathered from AHP results could be applied to another formula (suitability formula) and enable weight points to transfer into the maps. In this way, the different and original approach was put forward to transfer the cultural data into the maps in physical planning. In this research, concentrated on the land evaluation issues that has increasing importance in current and prospective studies, land use decisions of Alpagut Village was determined.

ACKNOWLEDGMENT

We thank Professor Nevin AKPINAR for her ahp statistical programme.

REFERENCES

Anonymous, 2002. Environmental impact assessment regulations, 2002. <http://www.mevzuat.adalet.gov.tr/html/21668.html> (in Turkish).

Anonymous, 2005a. Analysis of suitability for urban expansion. <http://www.itc.nl/ilwis/applications/application21.asp>.

Anonymous, 2005b. The draft law related to proposed changes in environmental law: sub-commission text. http://www.yerelnet.org.tr/genel_yapi/cevreyasa.php (in Turkish).

Baja, S., D.M. Chapman and D. Dragovich, 2001. Fuzzy modeling of environmental suitability index for rural land use systems: An assessment using a GIS. Proceedings of the 6th International Conference on Geocomputation University of Queensland, Brisbane, Australia 24-26 September 2001. <http://www.geocomputation.org/2001/papers/baja.pdf>.

Büyükyazıcı, M., 2000. Analytical net process. University of Hacettepe Graduate School of Natural and Applied Sciences, Ankara (in Turkish).

Çelikyay, S., 2005. Strategical environmental impact assessment in environmental planning. http://sura.cevreorman.gov.tr/gelen_tebliğ/3_konu/selma_celikyay.doc.

Cooper, A., R. Murray and T. McCann, 1994. Sustainable land use planning: An environmental database for northern Ireland and its application to countryside management. (Ed.) Vanlier, H., C. Jaarsma and C.R. Jurgens, Netherlands, pp: 281-289.

- David, L.Z. and M. Alhadeff, 2002. Land suitability analysis: Assessing development potential in cherokee contry. http://csat.er.usgs.gov/education/georgia_tech/projects/2002/group2/index.
- Dent, D. and A. Young, 1981. Soil Survey and Land Evaluation. George Allen and Unwin: Boston.
- Ejder, E., 2000. Location choice for furniture industry firms by using analytic hierarchy process (ahp) method. University of Hacettepe Graduate School of Natural and Applied Sciences, Industrial Engineering School of Vocational Technology, M.Sc. Thesis, Ankara (in Turkish).
- Ekanayake, G.K. and N.D.K. Dayawansa, 2003. Land suitability identification for a production forest through GIS techniques. Map India Conference 2003, India. <http://www.gisdevelopment.net/application/environment/overview/pdf/148.pdf>.
- FAO, 1976. A framework for land evaluation. FAO Soils Bull., 32.
- FAO, 1985. Guidelines: Land evaluation for irrigated agriculture. FAO Soils Bull., 55.
- Ghaffari, A., H.F. Cook and H.C. Lee, 2000. Integrating climate, soil and crop information: A land suitability study using GIS. Fourth International Conference on Integrating GIS and Environmental Modeling (GIS/EM4): Problems, Prospects and Research Needs. Banff, Alberta, Canada, September 2 - 8, 2000. <http://www.colorado.edu/research/cires/banff/pubpapers/129>.
- Hacimenni, E., 1998. Analytic hierarchy process and its application for data processing technology decisions. Ph.D Thesis, Social Science Institution, Ankara, (in Turkish).
- Joerin, F., M. Theriault and A. Musy, 2001. Using GIS and outranking multicriteria analysis for land-use suitability assessment. Intl. J. Geograph. Inform. Sci., 15: 153-174.
- Kalogirou, S., 2002. Expert systems and GIS: An application of land suitability evaluation. Comput., Environ. Urban Sys., 26: 89-112. <http://www.csa.com/partners/viewrecord.php>.
- Klosterman, R.E., 2001. Using what if? Community analysis and planning systems. http://www.what-if-pss.com/Using_What_if.pdf.
- Mansuroglu, S., 1997. A Research on the optimal land uses in Duzce Plain. University of Çukurova, Graduate School of Natural and Applied Sciences, Ph.D, Adana (in Turkish).
- Ortaçesme, V., 1996. Determine the optimal land use of the Mediterranean coasts of Adana province with respect to ecological planning principles. University of Çukurova, Graduate School of Natural and Applied Sciences, Ph.D, Adana (in Turkish).
- Özaslan, A. and H. Ekiz, 2001. Crop rotation in pasture land. J. Agric., Vol. 5, Ankara, (in Turkish).
- Rossiter, D.G., 1996. A theoretical framework for land evaluation. Elsevier Sci., 72: 165-202.
- Rubin, E.J., C.A. Shaffer, N. Ramakrishnan and R. Dymond *et al.*, 2003. From landscapes and to waterscapes: A PSE for landuse change analysis. Eng. with Comp., 19: 9-25, London.
- Saaty, T.L., 1974. Measuring the fuzziness of sets. J. Cybernetics, 4: 53-61.
- Saaty, T.L., 1980. The Analytic Hierarchy Process. Published by McGraw-Hill, New York, USA.
- Saaty, T.L. 1988. Mathematical Methods of Operations Research. Dover Publications, New York.
- Takeuchi, K., 1983. Landscape planning methodology based on geoecological land evaluation. Geo J. (Historical Archive), 7: 167-183.
- Yüksel, M., O. Dengiz, N. Özdoğan and C. Göl, 2003. Potential land use situations. Ankara University, J. Agric. Sci., 9: 373-380.