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Research Article

Determination of Greenhouse Potential in Siirt Province and Districts by Using GIS and Recommendations to Producers

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Abstract

The main source of income is livestock, and the most cultivated plant is pistachio (*Pistacia vera*) for agricultural purposes in Siirt and districts. Dry agriculture is practiced due to lackness of water sources and rainfall in the province. This limits the possibilities of generating income. The province is not sufficient in terms of agricultural production and migration from rural to other provinces is seen as a big social problem. In order to prevent this problem, agricultural supports have been increased and projects have been supported by government. However, greenhouse cultivation has not been adopted well enough in the region due to the fact that the climatic conditions are not perfectly suitable and the appropriate locations are not selected in the projects. In this study, appropriate location analyzes for greenhouses (climate and topography) were mapped with the geographical information system. In this way, it is aimed to increase the existing potential of the greenhouses of the province. An analysis was performed on open source QuantumGIS software during the study. The bioclimatic raster data set containing the climate data for the are were obtained from the World climate database. These sets, which contain temperature and precipitation data, are resolution 30 arc-seconds 1 km^2. After the formation of raster maps containing temperature and rainfall values for the region, the climatic data are separated into three categories as suitable, partly suitable and unsuitable classes. In order to determine suitable areas, climate and structural features required for the greenhouse were obtained from the literature and the raster analysis was made. According to the results of the study, City center, Kurtalan, and Baykan were considered partially suitable for greenhouse cultivation and other districts were not suitable. However, due to the snow and wind loads that may occur in these districts, It has been found that greenhouses need to be constructed with structurally reinforced profiles and alternative energy sources are necessary for heating greenhouses. With the maps created by QuantumGIS, the areas that are currently being used for greenhouses are overlapping with results. In addition, according to the results of this study, structural and practical recommendations were made for the producers in the region.

Keywords: Siirt, Greenhouse, Geographical Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA)

Siirt İli ve İlçelerindeki Seracılık Potansiyelin CBS Kullanılarak Belirlenmesi ve Üreticilere Öneriler

Öz

Siirt ili ve ilçelerinde temel geçim kaynağı hayvancılık olup, bitkisel üretimde en fazla Antep fıstığı (Pistacia vera) yetiştiriciliği yapılmaktadır. İldeki su kaynakları ve yağış yetersizliği nedeniyle kuru tarım yapılmaktadır. Bu durum gelir olanaklarını sınırlamaktadır. İlin gerek tarımsal açıdan yeter düzeyde olmaması gerekse kırsaldan diğer illere göçü büyük bir sosyal sorun olarak görülmektedir. Bu problemi önlemek için bitkisel üretimde tarımsal destekler artırılmış, projeler hükümet tarafından desteklenmiştir. Ancak seracılığın yaygınlaştırılması için yapılan projelerde gerek iklim koşullarının dikkate alınmaması gerekse uygun lokasyonlar seçilmemesinden kaynaklı seracılık yörede benimsetilememiştir. Bu çalışmada, seracılığın Siirt ili ve ilçelerinde yapılması durumunda uygun lokasyon analizlerinin (İklim ve topografya) Coğrafi bilgi sistemi ile haritalanması yapılmıştır. Bu sayede ilin mevcut potansiyelinin arttırılması amaçlanmaktadır. Çalışma analizleri açık kaynak kodlu QuantumGIS yazılımı ile yapılmıştır. İklim verilerini içeren raster veri seti Worldclimate veri tabanından elde edilmiştir. Sıcaklık ve yağış verilerini içeren bu setler 1km^2 çözünürlüktedir (30 saniye). Bölge için sıcaklık ve yağış değerleri içeren raster haritaların oluşturulmasından sonra, iklim verileri uygun, kısmen uygun ve uygun olmayan sınıflar olarak üç kategoriye ayrılmıştır. Uygun alanların belirlenmek için, serada ihtiyaç duyulan iklim ve yapısal özellikler literatürden

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elde edilmiş ve raster analizi yapılmıştır. Çalışma sonuçlarına göre Merkez, Kurtalan ve Baykan ilçesi seracılık için kısmen uygun görülmekte olup, diğer ilçeler uygun görülmemektedir. Ancak bu ilçelerde de oluşabilecek kar ve rüzgar yüküne karşılık seraların yapısal olarak güçlendirilmiş profiller ile yapılması ayrıca seraların ısıtılması için alternatif enerji kaynaklarının gerekli olduğu ortaya çıkmıştır. Şu anda seralar için kullanılan alanlar QuantumGIS ile oluşturulan haritalardaki sonuçlarla örtüşmektedir. Ayrıca, bu çalışmanın sonuçlarına göre bölgedeki üreticiler için yapısal ve pratik önerilerde bulunulmuştur.

Anahtar Kelimeler: Siirt, Seracılık, Coğrafi Bilgi Sistemleri (CBS), Çok Kriterli Karar Analizi (ÇKKA)

1. Introduction

The applications that the climate conditions are kept under control and the production can be carried out all year is called greenhouse cultivation. Greenhouses can be used to produce plants, seeds, seedlings, to protect plants by controlling factors such as temperature, light, and humidity without being totally or partially dependent on climate-related environmental conditions. It is a plant production structure made with different shapes (Öneş, 1986; Yağanoğlu and Örüng, 1997; Yüksel, 2000).

Greenhouse production in Turkey consists of mainly plastic covered structures. As of 2011, the total greenhouse area has reached 60000 hectares, 32000 hectares of which are defined as high tunnel systems. Modern greenhouse cultivation, which has been developing rapidly with the introduction of big investor groups in the sector, has shown a great improvement in the last decade and has reached 1000 ha levels. Approximately 150-200 ha of land is added each year. Nowadays, 3% of the greenhouse areas are modern greenhouses. This rate is expected to reach 15% in the next ten years (Eker, 2012).

In order to meet the future food needs of the countries by taking into consideration the population growth, it is necessary to make the existing agricultural production cheaper and more efficient. Today, the profitability of agricultural production decreases due to the inability to increase the agricultural areas, the shrinkage of the lands, the increase on the use of agricultural land and the decrease in the quantity and quality of the products taken from the unit area. Therefore, the importance of increasing the profitability of the unit area increases day by day. The realization of crop production under controlled conditions is one of the applications that increase the efficiency and profitability taken from the unit area (Filiz and Coşkun, 1996).

While greenhouse production was made in 51 provinces in Turkey in 2011, it has reached 70 provinces in 2014. The increase rate in the last 4 years (72%) is above 15% which is the average annual growth rate (Doğaka, 2015).

In Turkey, greenhouses are established 87% in the Mediterranean Region, and 0.1% in the Southeastern Anatolia Region. In particular, with the implementation of the GAP project, it is inevitable that the welfare level of the people in the region will increase with the use of the highest solar energy potential in greenhouse cultivation in the region where irrigated agriculture is underway. In the Karaali geothermal region, which is 45 km away from Şanlıurfa in the GAP center, the largest single piece (45 decares) greenhouses in our country have been established by showing a successful working example in Turkey with 42-48ºC temperature, 118 lt / sec flow, and 4.5 MW thermal potential. The first products were obtained in 1997 from the first established greenhouses in this area. Nowadays, vegetable and ornamental plants are produced in the greenhouses established in this geothermal area and the region needs are met and exported to many countries (Anonymous, 2010).

Small scale greenhouses have been built to many farmers in our region with the contributions provided by the GAP Regional Development Administration and other institutions in the previous years. But due to the lack of education and implementation, the yields on this issue have not been supported in the following years since there is not yield from these greenhouses.

It was carried out greenhouse activities in 65 (da) decares in Siirt (Kurtalan, Baykan, Eruh), which is 25 (da) with soil and 5 (da) in the village of Kılıçlı. In our greenhouses, two times crops are grown annually. Preferably, tomatoes and cucumbers produced from these greenhouses are under the income of the desired income. Furthermore, since 2009, the GAP Administration has requested them to aid the design of the Integrated Rural Development Umbrella Program in the GAP Region, predicted from GAP Action Plan (Anonymous, 2017).

Heating systems are applied in greenhouses built in recent years in Turkey. Heating in greenhouses increases product yield, quality, and quantity. Especially in greenhouses heated in the Mediterranean coastline, two-fold productivity can be increased. However, the need for heat energy increases in greenhouses where heat protection measures are not taken and an average of 100 $kWh.m^{-2}day^{-1}$ heat energy is needed depending on the climate values of the region during the production period. Increased energy costs cause the producer to discuss the profitability of heating. For this reason, it has been determined that energy conservation in greenhouses, as well as heating in greenhouses, is important in terms of profitability and energy efficiency (Baytorun and Gügercin, 2015).

In Kırşehir province, the use of double layer instead of single layer cover material in greenhouse sidewalls and good installation of heat curtains are reported to be very important in increasing the amount of energy saved. Therefore, the use of heat curtains in greenhouses in Siirt province and the shortening of ventilation times may also be effective in decreasing production costs by using low double layer PE or polycarbonate cover materials instead of single layer PE (Boyacı, 2018).

The ability to make a greenhouse is directly proportional to economic gain. In a study conducted by Boyacı et al., 2016, the greenhouse agricultural potential of Kırşehir province has been investigated considering the climatic data, geographical location and agricultural structure of the city for many years. When the long-term climate data of Kırşehir province between 1960 and 2015 are examined in terms of greenhouse agriculture, it has been determined that the temperature increases, and the relative humidity tend to decrease. Accordingly, when the average annual temperature is low, the number of frost days is higher than the heating costs in Kırşehir province, it was revealed that the use of greenhouse cultivation was not considered to be economical in that time (Boyacı et al., 2016).

In this study, meteorological information system (MEVBIS) and daily minimum temperatures, soil structure, altitude, wind direction and velocity values of Siirt were obtained and mapping was done by entering the data in layers in QuantumGIS database in the GIS system. The results obtained with Multi Criteria Decision Analysis and QuantumGIS were interpreted in order to reveal the potential of greenhouse cultivation in the Siirt region.

2. Material and Method

2.1. Material

The research material is greenhouses with different roof types, covering materials, structural features and bearing systems in the province of Siirt and its sub-districts in the southeastern region (Figure 1). These greenhouses are plastic covered greenhouses with spring roofs in terms of roof type and covering material. The locations where the greenhouses are located are completely determined by the experience and they are built based on existing options and without considering the scientific preferences. The use of greenhouses in suitable climatic locations is beneficial in terms of cost and durability.

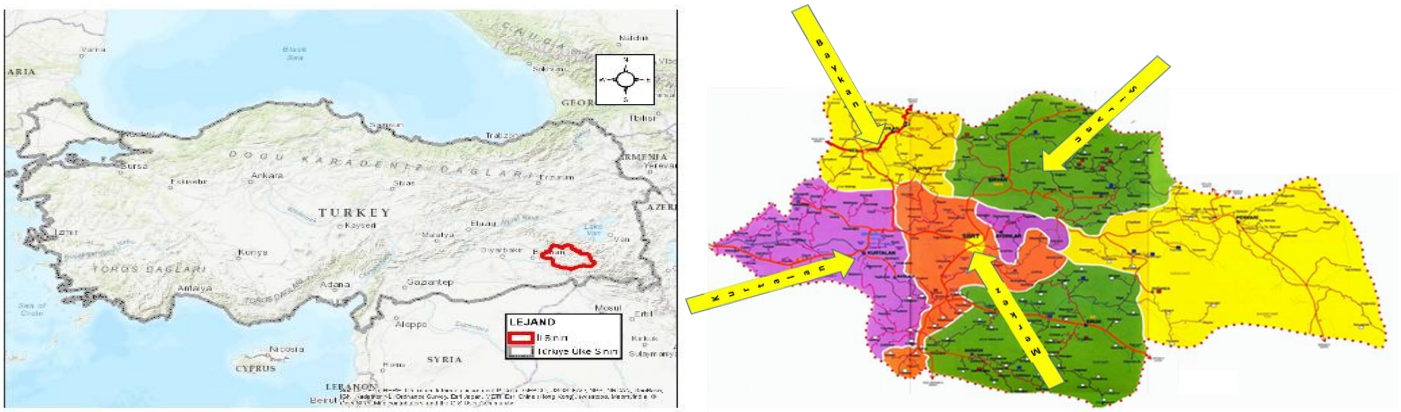

Figure 1. Maps showing the area of study

2.1.1. Climatic Situation in Siirt

According to the data of Siirt province between 1991-2017 years; average temperature 16,21 ºC, monthly average maximum temperature 21,8 °C, monthly average minimum temperature 11,1 °C, total rainfall average 677,8 mm, monthly total sunshine average 228 hours, monthly average wind speed 1,595 msn^{-1}. The monthly average maximum temperature was 40.8 ºC in June 2000 and the highest monthly average temperature was -4.7 ºC and the lowest value in January 1983 (Anonymous, 2018).

2.2. Method

In our study, spatial analysis was made with QuantumGIS using Multi-Criteria Decision Analysis (MCDA) in the Siirt region. 41 greenhouses were selected in 3 locations (Kurtalan, Baykan, and Merkez) in the province of Siirt. Multi-Criteria Decision Analysis (MCDA) is a solution applied when multiple criteria should be considered together. The basic method of solving the problem is to divide the problem into small, simple and comprehensible pieces so that a meaningful result can be obtained from these parts. The MCDA includes the definition of the problem, the selection criteria and the stages of determining the eligibility of these criteria (Malczewski, 1999). The MCDA is a process that must be chosen from among many criteria with a pre-selection that varies according to the decision-maker. The result is obtained by the weights given to the criteria, and these criteria may have different weights according to the decision maker, so the accuracy of the criteria criterion can be tested (Özturk and Batuk, 2007). GIS has been developed as a tool for making all types of land use planning. Multifunctional applications of GIS make it possible to analyze spatial data, to combine and store the information obtained from these analyses. The GIS helps to decide on the processing and distribution of agricultural land and can be used for administrative purposes (Sönmez,and Sarı, 2004).

The study was conducted based on the basic criteria that are effective in the selection of greenhouse sites from the literature and the mapping by QuantumGIS and Multi-Criteria Decision Analysis (MCDA). For this purpose, slope, maximum, minimum temperature,

precipitation and wind speed values were chosen as the study subject. For the creation of the inclination map, the maps of the ASTER GTOPO 30 DEM (Digital Elevation Model) have been obtained (30 arc-seconds 1 $km^{2)}$. from this map, the border area of Siirt masked by cutting the area to be processed by cutting the DEM map for the province of Siirt, the obtained Siirt DEM map, raster analysis to be carried out from the geographical projection on the metric projection has been re-coordinated a new layer has been made and the percentage has been subjected to slope analysis. The values obtained as a result of the slope map are subjected to the reclassification process, and the slope is divided into three classes as appropriate, partially suitable and unsuitable areas. It has been obtained from the MEVBIS (Meteorology Information System) system which includes climate data (maximum temperature, minimum temperature, precipitation) for many years and from Worldclimate internet source as a raster data set. Temperature and precipitation data are 1 km^2. After the factors mentioned in Table 1 were prepared, they were subjected to analyzes by taking a layer. After the formation of raster maps containing temperature and rainfall values for the Siirt region, it is divided into three categories: re-classification, climate data suitable, partially suitable and unsuitable classes. For rainfall, 600-800 mm is suitable, 400-599 mm is partially suitable, and 100-399 mm is not suitable. In the coldest months, the lowest air temperature is determined as 5-12 ºC suitable, 0-4.9 ºC is partially suitable and -1-5 ºC is not suitable. For the highest temperature in the hottest months, 18-22 ºC is suitable, 22-30 ºC is partially suitable, and 31-45 ºC is determined as unsuitable classes. In order to implement multi-criteria decision making, the above-mentioned data layers are formed by following the steps described. In the last stage; The trapping analyzes were carried out by multiplying the raster with each other, and by using this method, the trapping analysis was carried out with the matrix method and the greenhouse conformity maps (30m x 30m) were prepared for Siirt province. In this study, it is aimed to determine the potential areas of Siirt province and its districts for greenhouse construction. In this context, the climate (maximum temperature of the warmest month, the minimum temperature of the coldest month and the annual rainfall, wind direction and speed), topographic characteristics (height, slope, height) and land data were used (Table 1). These data are the main material of the study and are stratified in QuantumGIS environment and a Multi-Criteria Decision Analysis was performed. In addition, it is aimed to remind producers of the importance of greenhouse for the region and increase the greenhouse potential of the basin.

Table 1. Resources used in the study.

Factor Name (Parameters)	Description	Source
Slope	The slope in degrees obtained from altitude (%)	Derived from GTOPO30
BIO5	Max temperature of the warmest month (°C)	www.worldclim.org/current
BIO6	Min temperature of coldest month (°C)	www.worldclim.org/current
BIO12	Annual precipitation (mm)	www.worldclim.org/current
Wind	Wind speed (ms^{-1})	worldwindatlas.com

3. Results and Discussion

3.1. Current Situation of Greenhouse Enterprises in Study Area

When the greenhouses in our region are examined in terms of their locations and session areas, it is seen that the greenhouse areas per enterprise decrease in the provincial centers, whereas it increases in the Kurtalan district and neighborhoods. In cases where the outside temperature values fall below 0-12 ° C in order to obtain high-quality high yields from greenhouses, natural ventilation at 12-22 ° C, continuous ventilation at 22-27 ° C and/or cooling and cooling above 27 ° C. greenhouse production should not be made (Zabeltitz, 2011). Located in the Tigris Basin of Southeastern Anatolia Region, Siirt province shows terrestrial and arid climate characteristics. When the average temperature and daily total radiation values of these two cities with different geographical characteristics are examined, the districts of the central and Baykan districts of Siirt (Central and Baykan) show the heating need for six months in November due to average temperature values below 10 ° C in November-April period. In the district of Garzan Kozluk, the need for heating in the greenhouse in the Garzan Kozluk basin will take place in December-January-February in the three months of the year, and in the spring production season of the 3-month heating period. Even though natural ventilation and shading materials are used in July and August, it is seen that production cannot continue. The study area is drawn in 3 different colors for convenience. The first of these areas is green ( ) (suitable), second of these is yellow ( ) (partly suitable) and third of these is red ( ) (not suitable) In the research area, only 7% of the research area is considered suitable for greenhouse cultivation, 44% partly suitable and 51% unsuitable areas. The maximum temperature of the hottest months and the minimum temperature values of the coldest months are taken into consideration, the map is given in 300 dpi resolution. However, choosing a greenhouse location according to this value will result in a rather erroneous result (Figure 2). The areas designated as suitable for greenhouse are considered as unused areas. In the green area, only 9% of the villages in the central and southern villages were eligible, 27% were partially eligible, and 64% were unsuitable (Figure 3. The greenhouse cultivation is currently carried out in these areas and the selection of the place where the

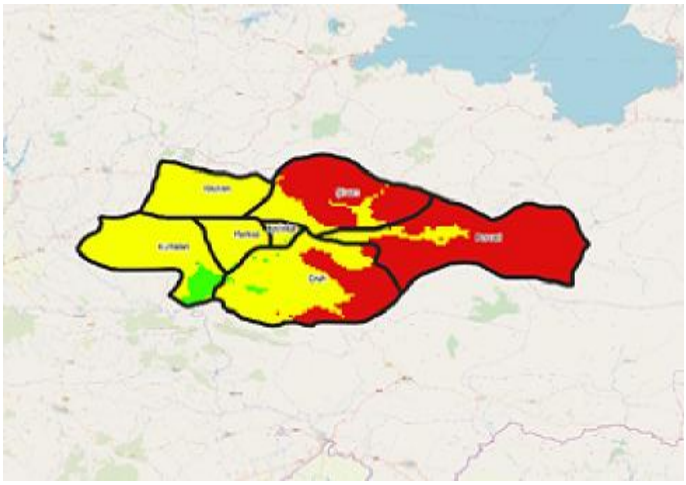

Figure 2. Suitability of temperature only of the study area on Qgis analysis.

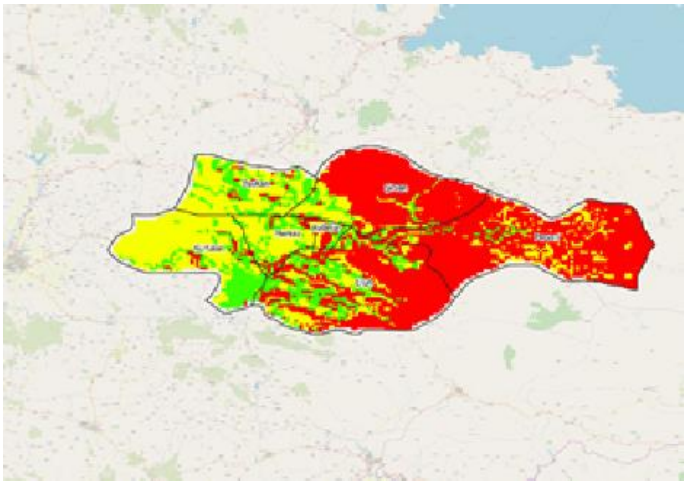

Figure 3. Suitability of slope only of the study area on Qgis analysis.

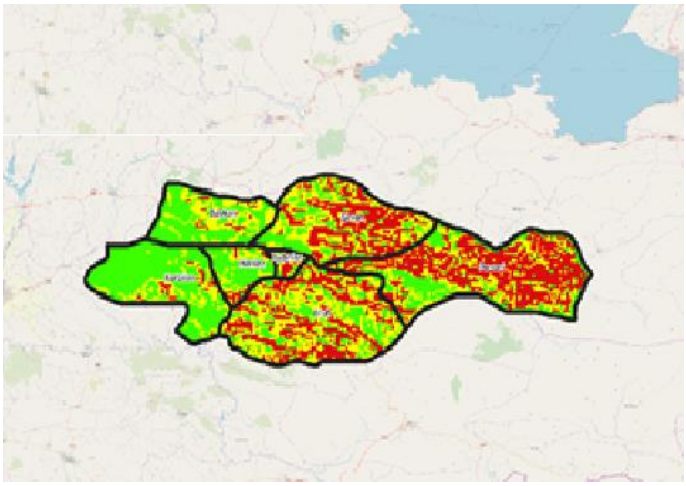

Figure 4. Suitability of wind speed of study area on Qgis analysis.

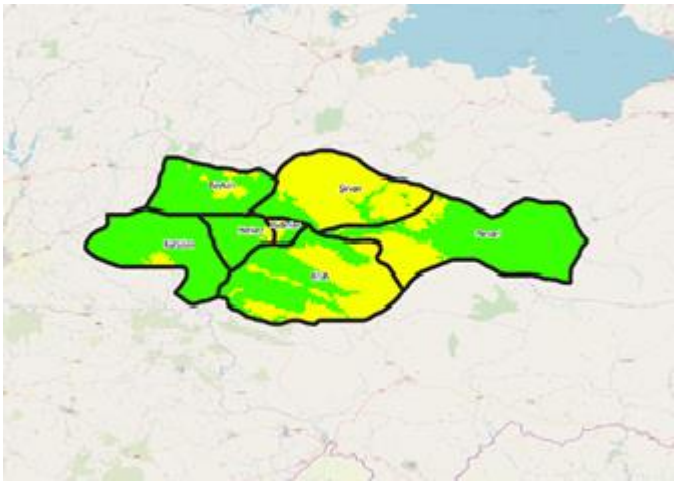

Figure 5. Suitability of annual precipitation only of the study area on Qgis analysis.

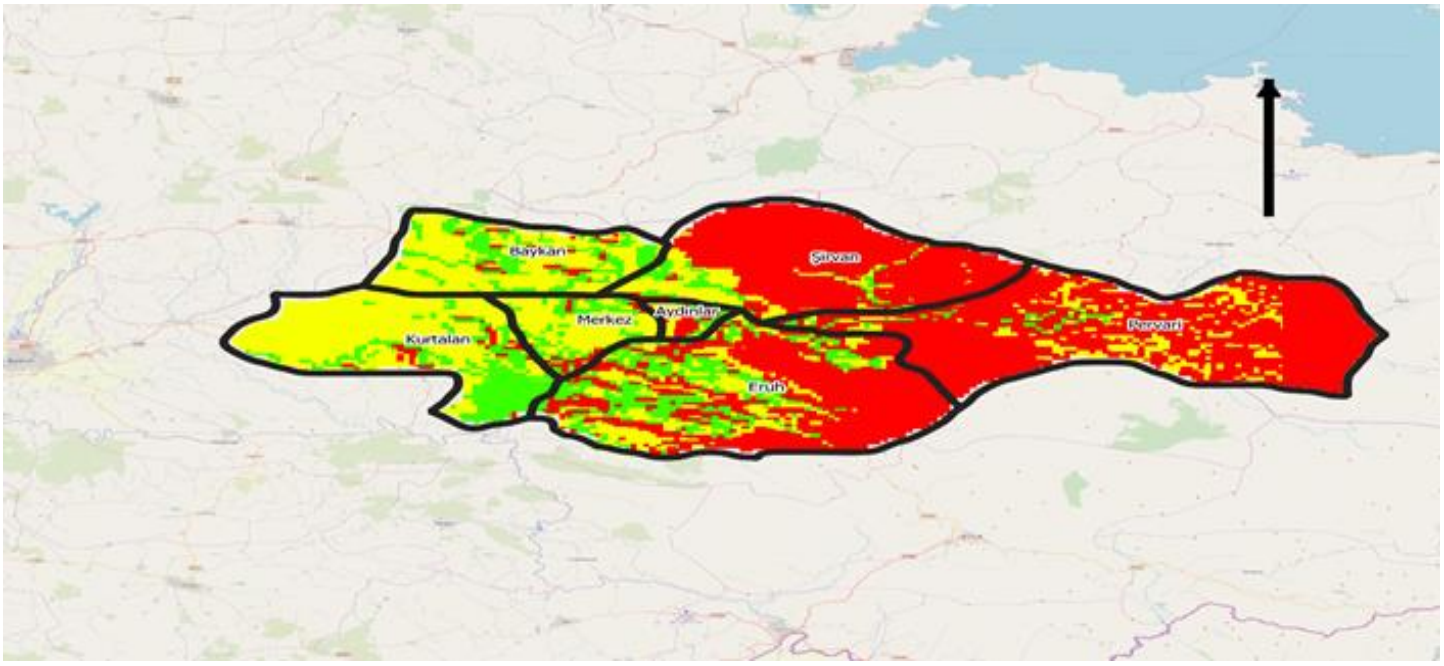

Figure 6. All factors analyzed with MCDA via Raster analysis in Qgis.

producers have made with the experience confirms our work. If the inclination is taken as the only factor, it is seen that the temperature and wind speed areas are the same as the current situation (Figure 4). Eruh district which has harsh climatic conditions has been suitable in this context and in Eruh district there is 400 m^2 greenhouse for experimental purposes only and producers are quite far from this subject. This district has the potential to be partly suitable for greenhouse cultivation, because of its satisfactory values in terms of the duration of the sun and low slope and low wind speed. It is thought that the greenhouse to be constructed by using photovoltaic energy in the Eruh district may have a positive effect on the economic balances of the region (Figure 5).

The evaluation of the components for greenhouse location alone does not give accurate results and the importance of obtaining results by evaluating together in other factors emerges.

In this study where the climatic and topographical values of Siirt districts and villages are evaluated, 11% of the map obtained by overlapping all the factors together is appropriate, 32% is partially suitable for greenhouse cultivation and 57% is inappropriate. (Figure 6). Natural heating or ventilation conditions were evaluated in the study. However, it is possible to make a greenhouse with appropriate regulations, but the economy will be the biggest problem. However, if it is possible to make possible these investments, greenhouse cultivation is very beneficial in terms of income generating business and social support.

In the present case, according to the meteorological measurements made inside and outside of the greenhouse with 11502 m^2 area covered by Polyethylene (PE) in Kılıçlı locality in the Central District of Siirt Province; In October, the temperatures in the greenhouse reach up to 40 ° C at noon, in which case the ventilation system is activated. In addition, the values of humidity at noon are low in the outdoor environment due to the indoor ventilation. In October, the lowest temperature value was 12 ºC on 31 October 03.35. During this period, it was realized as 15-25 ºC reference value for cucumber plant. During the month the total temperature for 4 days decreased by 12-14 ° C. The period did not last long and there was no damage to the plants. In the spring production season of the 3 months heating period during the autumn production period of Siirt province, production is terminated as of June. In July and August, it is seen that even if natural ventilation and shading materials are used, production cannot continue. In the first two weeks of October and the first two weeks of October, temperatures in the province of Siirt decreased from 12 ° C to 6 ° C over a period of four weeks, and temperatures continued to decline in the upcoming period (Saltuk et al., 2018). This study confirms the compliance map we have made.

As a result of the observations and interviews conducted in the field of research, the results are; since local producers have to increase their initial investment costs, they avoid making a greenhouse project and perform their production in very simple structures, making use of the existing ecological conditions, resulting in significant losses in yield and quality. cultivation was carried out as single crop and double crop period (spring and autumn); while 73,6% prefer double crop production; 26.4% prefer single crop production. Spring and autumn cultivation (double crop) are preferred due to low heating costs compared to single crop cultivation. In addition, since single crop cultivation also covers the cold period in winter, the costs of struggle against heating and diseases reach very high values, and that double crop cultivation does not cover the cold periods of winter, therefore heating costs are lower than in single crop cultivation. The producers in Kurtalan are based on their economic status, the current status of their land, the topographical and ecological characteristics of the greenhouse location and the quality of the workmanship in greenhouse production. The fact that enterprises cannot be effective in marketing their products and price formation cause the enterprises not to develop due to the decrease in yield and quality. This leads to a decrease in income and the family's inclination towards non-greenhouse activities. It was determined that the producers in the district of Kurtalan, Baykan were dependent on the existing land and financial opportunities in the dimensioning of the greenhouses in the research area. For this reason, the greenhouse areas remain small and the income from greenhouses is not enough for the families. Local people see greenhouses as covered areas rather than modern production structures. In areas where partially suitable for greenhouse cultivation (Baykan, Merkez), in order to prevent greenhouse demolitions that cause property losses, the smallest sections that can provide the required strength in planning and the largest openings to allow mechanization should be determined. For this purpose, healthy projects are needed. Type projects can be prepared by the Ministry of Agriculture and Forests to be used for the elimination of the problem. The implementation of the projects can be audited by public institutions. Thus, property losses can be minimized.

4. Conclusion

Estimating the indoor temperature values of greenhouses can prevent economic losses for producers. Especially during the seedling period, the temperature sensitivity of the plants is high. There are greenhouses in the central, Baykan and Kurtalan districts of Siirt province, and other districts are not considered as suitable for greenhouse cultivation. The mentioned Kurtalan, Merkez and Baykan districts are partly suitable for cultivation of undergrowth, and in case of production, it is considered that it is appropriate to make cultivation in places that can benefit from alternative energy (geothermal) resources. It has been concluded that heating costs are lowered from alternative energies (photovoltaic systems, geothermal resources, heat exchangers, etc.) and suitable for climatic greenhouse cultivation. For greenhouses in Siirt, heating systems in greenhouses have to be operated from the 3rd week of November. Because it is very important to keep the temperature values in the greenhouse at constant degrees, the costs of the heating load will increase the cost of production. However, in the case of production in Siirt province, there will be a decrease in the production cost as it will be less than the transportation costs of the products mainly transported from the Mediterranean region. Active or passive heating systems must be used in full performance throughout the duration of flowering and fruiting. In this period, the neglect of heating with economic concern may cause damage to the plant and less or no product. In order to reduce the amount of heating load of the greenhouse, it is concluded that it can be installed close to the geothermal fields or it can convert the solar energy into electrical energy (Photovoltaic) systems and reduce the heating costs. In addition, the building curtains in the greenhouse will have an effect on heat conservation. In terms of aquaculture calendar of Siirt, different from the provinces with Mediterranean climate, it is thought that the production date for the

autumn production date is two weeks early, and that taking two weeks late in terms of spring cultivation can have a positive effect in terms of lowering the costs of heating in the greenhouse.

Recommendations to Producers in Siirt Province and districts;

• Ignoring engineering services in order to make the greenhouse cheaper means faults in the selection of material types and sections of materials for the structural systems of greenhouses are made. Even worse is the fact that local producers have built greenhouses without projectors. This situation may cause greenhouses to collapse and consequently large financial losses.

• Construction of inner columns with wooden or metal profiles in greenhouses for carrier purposes limits the mechanization of the greenhouse.

• Greenhouse systems with spring roofs are preferred in greenhouses in the region, which are more advantageous for easy installation and ease of use.

• The need for air outlet openings that provide ventilation and ventilation, which is undeniably important in terms of plant growth and disease protection, is not known to most manufacturers. Although Kurtalan, Merkez, and Baykan are the most developed regions in terms of greenhouse cultivation, it is not even possible to say that greenhouse mechanization is sufficiently developed.

• Agricultural engineers or technicians who have the knowledge and skills to follow the progress of the technology and carry them to the enterprises and follow up the plant development and take timely measures are not given the necessary places in the greenhouses.

• It should be ensured that applications such as heating, irrigation, fertilization, ventilation, and construction planning, which require technology in greenhouses and thus bring high plant costs, should be carried out with computers and current programs in automatic control. The use of technology will affect efficiency and quality positively.

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