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Determination with geographic information systems (GIS) of the existing vineyard areas in Hizan District of Bitlis Province

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Abstract

In this study, the vineyard areas of Gayda, Akşar and Harmandöven villages which have intensively viticulture in Hizan province of Bitlis, were determined by Geographical Information Systems (GIS). The 1/25000 scaled topography maps, numbered of L48c2 and L49d1, obtained from General Command of Mapping was used as the base map in the study area. ArcGIS 10 software utilized to transfer the images into the computer and 3D Analyst Tools. Magellan brand GPS instrument with meter scaled was used to determine the coordinates of the existing vineyards. According to the results, it was determined that villages are located generally very steep slope and steep terrain. 204.539 da in Gayda village, 84.864 da in Akşar village and 44.409 da in Harmandöven village were determined estimated as a vineyard area Aspect analysis result indicated that the vineyards in Gayda and Harmandöven villages located within South, South-East aspects, while North aspects in Akşar village. Climate (temperature, rainfall, solar radiation and frost damage) analysis results indicated that the climate values were at the limit values for economic viticulture in the three villages. As a result of interviews, it was concluded that cultural practices were not performed in a timely and conscious manner.

Key words: Vineyard, Remote sensing, Climate, Topography

Introduction

In today's world, information technology serves humanity intensively in many different areas. Geographic Information Systems (GIS) play an important role in the applications requiring complex analysis such as management and integration of many economic, political, social and cultural resources, especially in the management of the location-based information (Akbas et al., 2008; Peşkircioğlu et al., 2013).

The use of GIS is becoming more important in the area that is totally dependent on ecological conditions such as agriculture (Keskin et al., 2015; Karaaslanlı et al., 2017; Sancan and Karaca 2017). GIS has been widely used for many purposes, such as estimation of plant pattern in agriculture, yield estimation, determination of meadow and pasture areas, determination of fallow areas, monitoring of plant growth, soil classification, irrigation and drainage studies, water resource conservation planning, resource estimation for agriculture and determination of rural settlements. GIS is also effective in agricultural improvement, identifying diseased areas of vegetation and agricultural taxation by detecting satellite imagery of agricultural areas (Delibaş et al., 2015).

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Materials and Methods

Study Area

The Gayda, Akşar and Harmandöven villages where viticulture was intensively in Hizan district of Bitlis province were selected as the study area (Doğan et al., 2017). The location map of the study areas was presented in Fig. 1. Gayda village is 56 km distance to Bitlis province and 13 km distance to Hizan district. Similarly, Aşkar village is 71 km distance to Bitlis province and 28 km distance to Hizan district. Harmandöven village is also 75 km distance to Bitlis province and 30 km distance to Hizan district.

The villages that rugged and sloping as geographically are located in the southeast of Bitlis province and south of Hizan district. As a result of interviews performed with growers, it has been concluded that viticulture has been done in the region since ancient times. The traditional low height goble training system was dominant in vineyards (Fig. 2).

The climate data were obtained from the meteorological stations and the numerical data were obtained from the study areas. Then the data were made available for the GIS analysis with the Excel software of the Microsoft Office program. ArcGIS ver:10.5 was used as the GIS program in the study. The 1/25000 scaled topography maps, numbered of L48c2 and L49d1, obtained from Mapping General Command were used as the base map in the study area. Current situation and problems of viticulture in the villages were evaluated by interviews and site surveys.

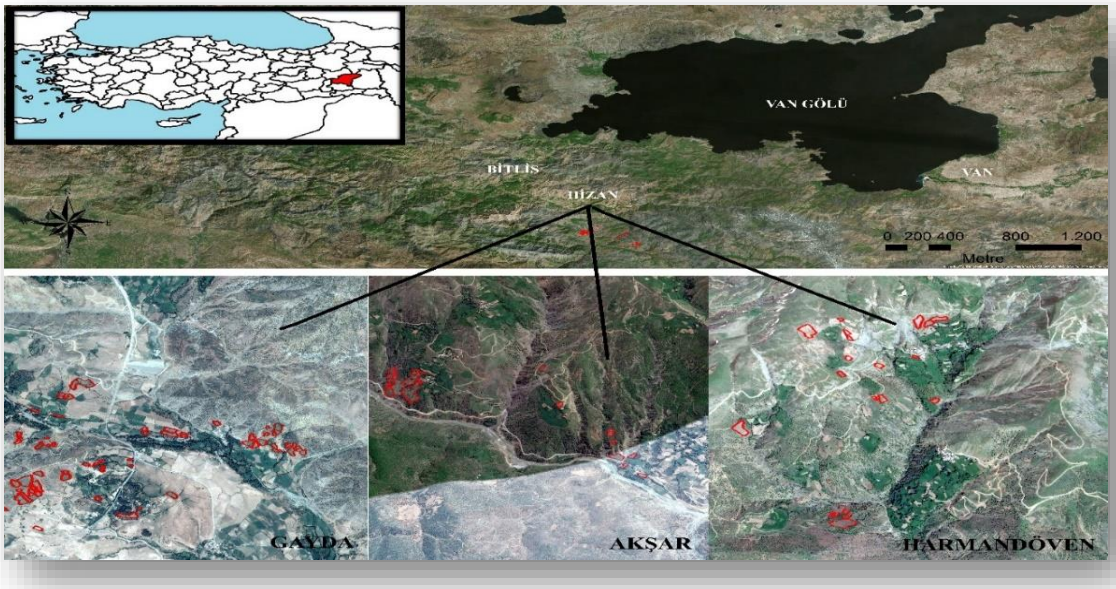

Fig. 1. Location map of the study areas

Fig. 2. Images from vineyards in Hizan district

Climate data

The climate data of the Hizan district, obtained from the 14th Regional Directorate of Meteorology (Bitlis), was designed (organized) with the Excel software of Microsoft Office 2010 program. In these regulations, the monthly average of climate data was calculated for many years.

Digitization of maps

Topographic maps scaled with 1/25000 obtained from Mapping General Command were used in this study. By topographic maps, isohips maps with 10 m intervals were drawn for height, slope and aspect analysis. Then the drawn

isohips maps were used to create slope and aspect maps. DEM data which express as a numerical terrain model was the basis for the creation of slope and aspect maps. Slope and aspect maps were created by using DEM data.

Determination of boundary areas

Magellan GPS (Global Positioning System) instrument was used to determine the coordinates of the existing vineyard area. For this purpose, the vineyards in the study area were visited one by one and the coordinates were taken. The coordinates of the vineyard areas arranged in Excel and overlapped with the Basemap map in ArcGIS software. Polygon data generated to determine the total area occupied by the bonding areas corresponding to these overlapping points. With the obtained polygon data, the total area covered by the vineyards was determined.

Results

Determination of existing vineyard areas

In order to determine the existing vineyard areas in the Gayda, Akşar and Harmandöven villages, the boundaries of the vineyard areas were determined in the GIS with the coordinates received from the study areas via GPS. The current vineyard areas in Gayda village were determined as 204.539 da. The largest vineyard area was recorded as 12.339 da, while the smallest vineyard area recorded as 0.191 da. The altitude of the vineyard areas in Gayda village where viticulture is very common varied between 1050 m and 2000 m (Fig. 3).

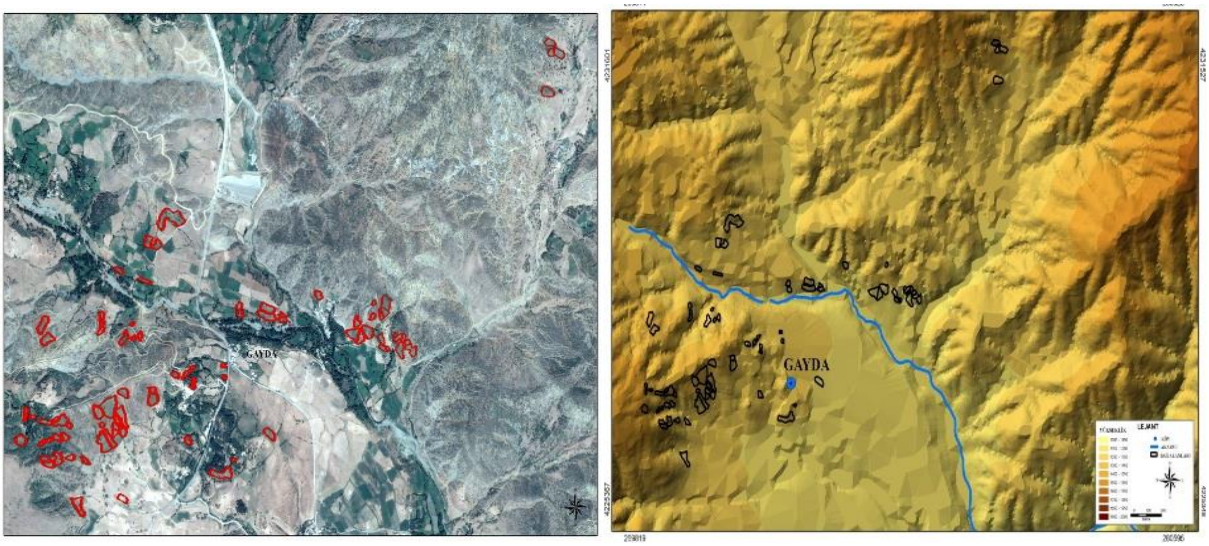

Fig. 3. Distribution (left) and altitude (right) maps of vineyard areas in Gayda village

When the slope distributions of the vineyard areas in Gayda village were examined; smooth areas (0-2% slope) were almost absent. Slightly slope areas (2-6% slope) were 5.32 da, medium slope areas (6-12% slope) were 12.85 da, steep slope areas (12-20% slope) were 37.58 da, very steep slope areas (20-30% slope) were 90.9 da and slope areas (30% and over slope) were 57.85 da. It can be stated that vineyard areas in Gayda village were located in the southeast (67.5 da), south (56.5 da), east (38.95 da) and the northeast (18.7 da) site (Fig. 4).

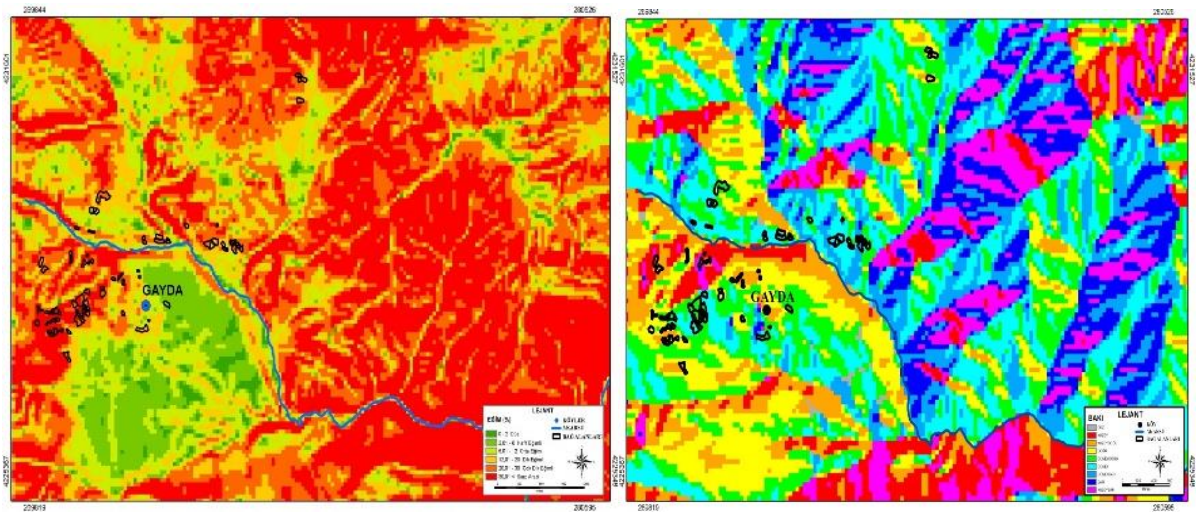

Fig. 4. Slope (left) and aspect (right) maps of vineyard areas in Gayda village

It was found that total vineyard area in Akşar village was 84.864 da, the largest vineyard area was 25.670 da, and the smallest vineyard was 0.814 da. It has been determined that the altitudes of the vineyard areas in Akşar village varied from 1050 m to 2050 m (Fig. 5). When slope distributions of the vineyard areas in Aşkar village were examined, it has determined that smooth slope areas with the gradient 0-2%, and slight slope areas with 2-6% slope were almost absent. Medium slope areas with 6-12% slope were 0.1 da, steep slope areas with 12-20% slope were 3.9 da, very steep slope areas with 20-30% slope were 5.5 da, steep areas with 30% and over slope were 75.5 da. The slope of the existing vineyard areas in Akşar village were generally distributed at the steep areas. When the site of the vineyard areas in Aşkar village was examined, it was determined that 63.6 da vineyard area was in the north site, 15.5 da vineyard area was in the northwest, 2.5 da vineyard area was in the northeast, 3.2 da vineyard area was in the west site (Fig. 6).

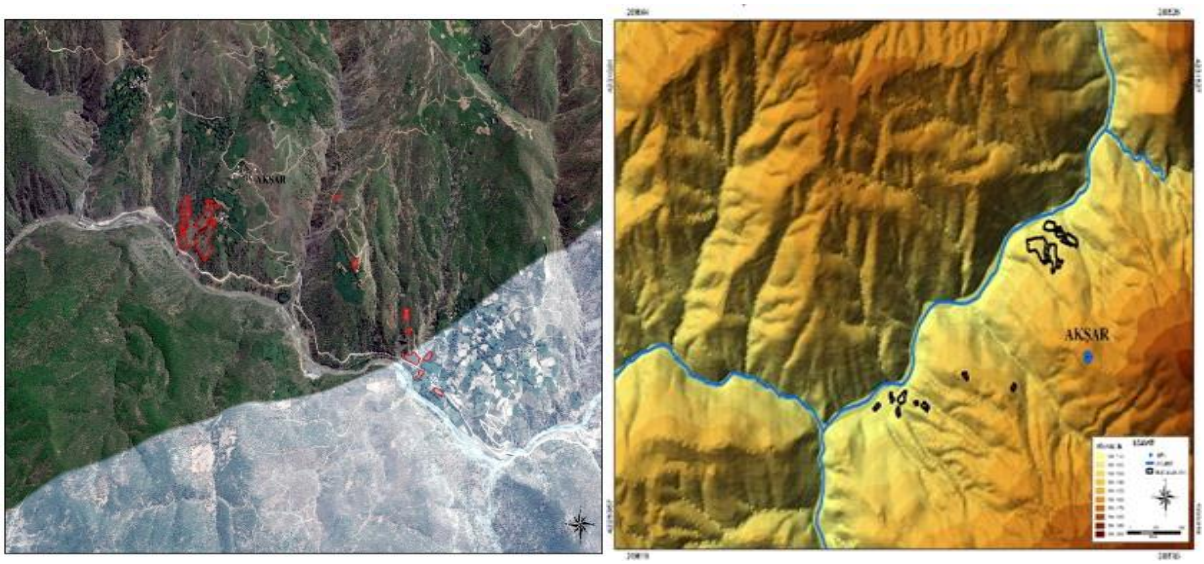

Fig. 5. Distribution (left) and altitude (right) maps of vineyard areas in Akşar village

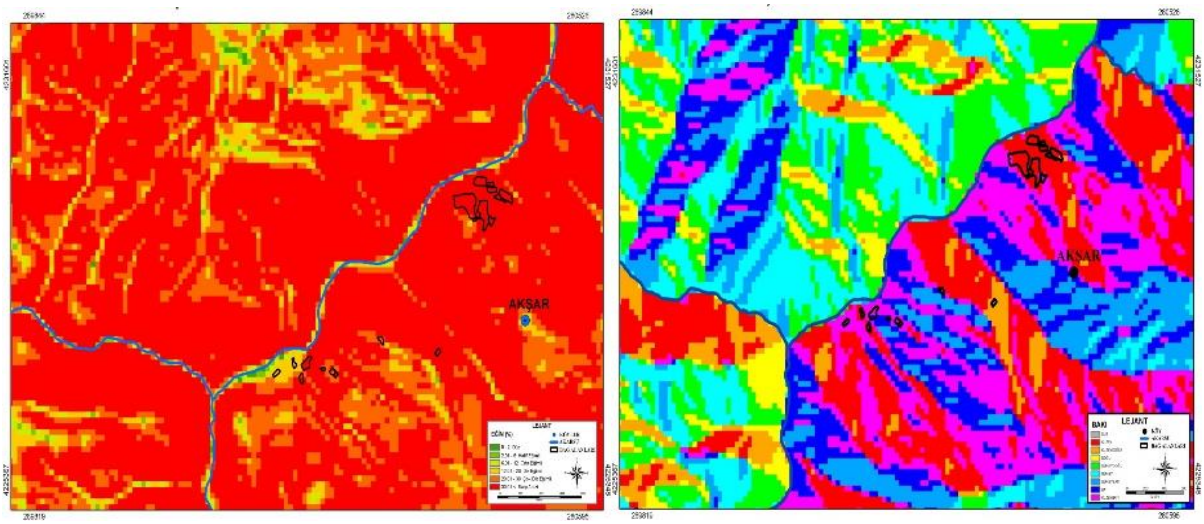

Fig. 6. Slope (left) and aspect (right) maps of vineyard areas in Akşar village

Total vineyard area in Harmandöven village was determined as 44.409 da, largest vineyard area was 7.467 da, and the smallest vineyard area was 0.553 da. The altitude of the existing vineyard areas in Harmandöven village varied from 1150 m to 2260 m (Fig.7). When slope distributions of existing vineyard areas in Harmandöven village are examined; it was determined that: smooth areas (0-2% slope), slight slope areas (2-6% slope), medium slope areas (6-12% slope) and steep slope areas (12-20% slope) were almost absent, very steep slope areas (20-30% slope) were 1 da and steep areas (30% and over slope) were 43.5 da. No vineyard area was determined in the north-west and west site in Harmandöven village. According to the results, 10.7 da vineyard area was in the northeast, 1.4 da vineyard area in the east t, 8.8 da vineyard area was in the southeast, 19.2 da vineyard area was in the south, 4.3 da vineyard area was in the southwest site (Fig. 8).

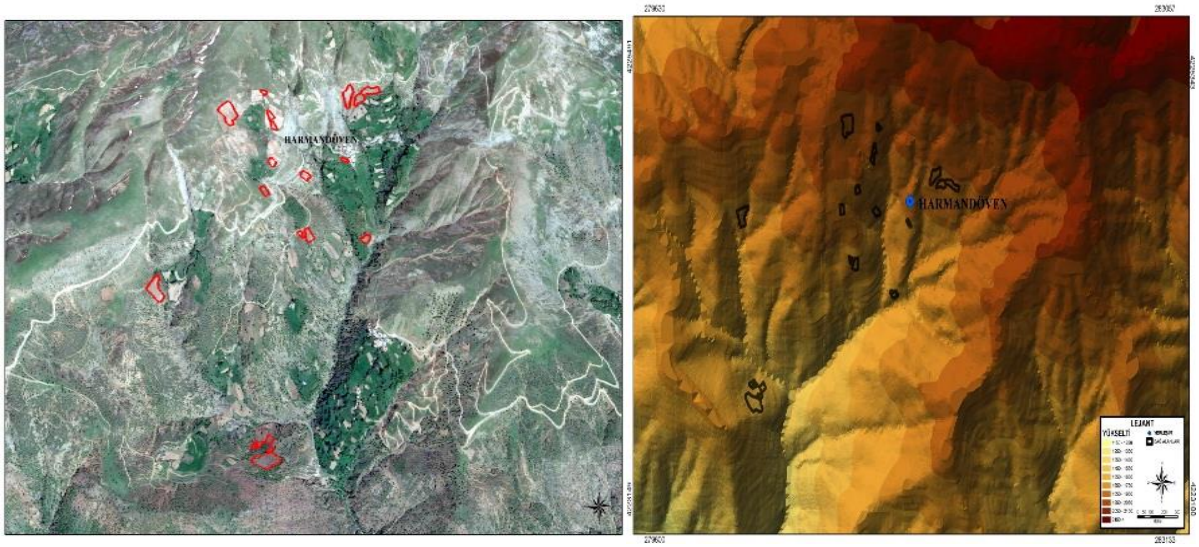

Fig. 7. Distribution (left) and altitude (right) maps of vineyard areas in Harmandöven village

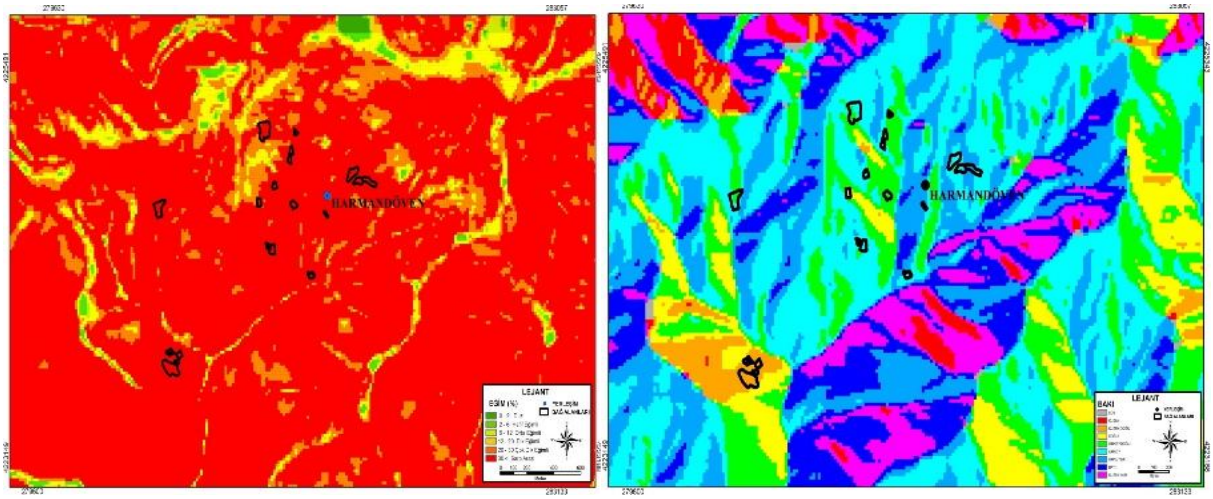

Fig. 8. Slope (left) and aspect (right) maps of vineyard areas in Harmandöven village

Climate and Viticulture

Climatic data were obtained from Bitlis meteorological station. According to evaluated data for 11 years, the average temperature was 9.7 ºC, average of the hottest month temperature was 22.7 ºC degrees which was recorded in August and average of the coldest month (December) temperature was -2.6 ºC. The average of summer temperature was 20.9 ºC and average temperature of vegetation period from March to November was 14.5 ºC. The average annual temperature and the mean of the coldest degree of Bitlis region were determined under of the limit degrees for viticulture. However, since the vineyards have established on sloping lands, frost damage was less harmful. It was observed that the average annual precipitation was about 1000 mm in Hizan. However, the distribution of precipitation during the year is also important. Although it was observed that precipitations have spread throughout the year in Hizan district, several times especially in the summer months (July-August) irrigation would be required.

The average solar radiation period of Hizan district was calculated as 2190 hours. When considering that the annual solar radiation should be 1500-1600 hours for economic viticulture, the value of solar radiation was convenient for Hizan region. Frost damage is the four months of the year in Hizan district. According to this situation, the Hizan district was accepted as the province in which physiological activities nearly slow down for 7 months of the year. Low temperatures can be observed in September, October, and November. As compared to other regions of Turkey, this case results in shorter development period (Doğan et al., 2017)

Discussions

As a result of the study, it was determined that the vineyard area in Gayda village was 204.539 da, the vineyard area in Aşkar village was 84.864 da and the vineyard area in Harmandöven village was 44.409 da. As in our study, the researches on viticulture by using GIS techniques in our country were carried out in pilot areas. These studies are either for the determination of existing vineyards (Uysal, 2009; Yücel, 2009; Sertel et al., 2011; Karaaslanlı et al. 2017), or for determining suitability areas on the basis of varieties in different pilot areas (Alsancak, 2005) or for the recommendation of viticulture area by doing analysis of suitability (Cengiz et al., 2013).

According to the result of the altitude analysis, the altitudes of existing vineyard areas in Gayda, Akşar and Harmandöven villages were 1050-2000 m, 1050-2050 and 1150-2260 m, respectively. Despite of these limited altitudes, viticulture was performed. As a result of the slope analysis, it was observed that there was no smooth areas in all three villages

and the vineyards were located on the very steep and steep areas. Thus, it can be concluded that existing vineyard area is not suitable for viticulture in terms of slope. The existing vineyard areas in Gayda and Harmandöven villages located in the southeast and south aspects. However, this situation did not cause any problems in terms of viticultural activities. It was determined that the existing vineyard areas in Akşar village were generally located in the north site and this situation caused some problems for viticulture. Climate (temperature, rainfall, solar radiation and frost damage) analysis results indicated that the climate values were at the limit values for economic viticulture in the three villages. As a result of interviews, it was concluded that cultural practices were not performed in a timely and conscious manner. Tillage, diseases and pests management, pruning, irrigation and fertilization have not performed adequately and properly in the vineyards.

Due to excessive crop load, limited growing of vines was common. The vineyards have been established with various cultivars. This have been a difficulty for applying technical and cultural practices. Disease and pest management has not been performed adequately.

In the region, viticulture has been performed by traditional knowledge. This has some advantages, however, the application of viticultural techniques such as pruning, shoot removal, disease and pest management is unknown. In addition, many native and non-standard varieties have been grown in the vineyards. These problems have caused to non-productive and unprofitable yield. Therefore, it is important to improve traditional growing techniques and to project selection-breeding studies for local varieties.

Conclusion

This study can be considered as important in terms of being the first study on the determination of vineyard areas with GIS in the region. GIS has provided great advantages in terms of time, cost and accuracy in determining vineyard areas. It is expected that this study will be leading for future studies. In addition, determination of potential vineyard areas will provide positive contributions to the development of viticulture.

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Conflict and Interest

Authors declare no conflict and interest.

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