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DETERMINATION OF GRASSLAND AREAS BY USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS, WITH SPECIAL REFERENCE TO ISPARTA, TURKEY*

Cihan DOGAN, Yalçın BOZKURT

Suleyman Demirel University, Faculty of Agriculture, Department of Animal Science, Isparta, Turkey

Corresponding author e-mail:yalcinbozkurt@sdu.edu.tr

Abstract

This study was carried to determine the size and quality and potential of pastures by using Remote Sensing (RS) and Geographic Information Systems (GIS),in the province of Isparta located on the West Mediterranean Region of Turkey. In this study, Merkez, Şarkikarağaç and Yalvaç districts were chosen as test areas which comprise of 80% of whole grassland area of Isparta Province. A digital map showing areas of pasture belonging to the district of Şarkikaraağaç was prepared and the grassland area was estimated. Sowing times for grass samples was identified as May\ July and September in 2011 to determine dry matter (DM) in the amount of biomass, botanical composition and ADF, NDF and crude protein (CP) values. The amounts of biomass on DM basis per hectare in the districts of Merkez, Şarkikaraağaç and Yalvac 3.11, 2.71 and 2.69 ton/ha, respectively. Botanical compositions for Merkezleguminosae 21%, Gramineae 37% and 42% others respectively; Şarkikaraağaç 36%, 40% and 25%; Yalvaç 36% and 33% was 31%. Average ADF and NDF contents were increased during the vegetation period; CP rates were decreased. Both DM yields and protein contents towards the end of vegetation period were reduced. Therefore, the most appropriate animal grazing period was determined as between the beginning of May and the early September, and also in relation to the botanical composition of grasses in grassland areas, Gramineae was found to be greater than other species. Therefore, cattle grazing would be a more appropriate grassland management system in the study area. When setting up an inventory that is required for animal pasture and the results of similar studies related to Isparta province, the realization of an effective pasture management and exploitation of RS and GIS technologies and techniques will help to make decisions about the use of these technologies in terms of both time and economic contributions.

Key words: *Geographic Information System, Remote Sensing, Grassland, Isparta Province, Botanical composition.*

INTRODUCTION

Remote sensing in general is often described as acquiring information on physical and spatial characteristics of objects without physically touching them by using satellite images, and their objects are defined as spatial and qualitative perception (Lillesand and Kiefer, 1994; Eastman, 2003, Jensen, 2005).

Geographic Information Systems (GIS) is the whole set of tools that collect, store, make query, transfer and display earth-referenced data for a specific purpose. It is also an information system that references spatial coordinates or geographic coordinates and designs to work with these data (Aronoff, 1989; Hummer, 1991; Burrough, 1992).

Remote Sensing (RS) technology, when combined with Geographic Information Systems (GIS) technology, provides up-to-date information about the Earth's resources and techniques compared to conventional methods for agricultural applications (Derenyi, 1991; Alparslan and Divan, 2002).

RS and GIS were used in a research conducted in the eastern part of Turkey, the boundaries of grassland areas were determined and the rangeland quality classes were determined. In the same study, the grazing potentials of the grassland and the grazing capacities were also determined by grazing the animals (Bozkurt et al., 2010).

Therefore, in this study it was aimed to determine the rangeland boundaries and the suitable grazing times and the grazing systems for animal production by RS and GIS in the province of Isparta, Şarkikaraağaç region.

MATERIALS AND METHODS

Geographical location

Isparta has an average altitude of 1050 m and an area of 8.933 km^2. It is located between $30^0$20' and $31^0$33' East longitudes and

$37^0$18'and $38^0$30' Northern latitudes Geographical Coordinate System (UTM). It is surrounded by Burdur province in the West and the South-West; Afyon province in the North and West; Northeast, Konya in the east and south-east and Antalya in the South.

Topographic structure and climate

Isparta and the area around its vicinity is quite mountainous and rugged. 68.4% of the Isparta Province's surface area is composed of mountains. In addition, 40.9% of the province's surface area is very steep (Anonymous, 1994).

According to meteorological parameters and natural vegetation cover, Isparta province is located in the transition zone between the Mediterranean climate and the continental climate prevailing in Central Anatolia. As averages for many years, the total annual rainfall in Isparta is 501.5 mm. The distribution of rainfall within the year, the minimum precipitation is 11.6 mm between August and December with the highest rainfall of 71.5 mm.

Study Area and Sample Collection

In this study, Merkez, Şarkikarağaç and Yalvaç districts were chosen as test areas which comprise of 80% of whole grassland area of Isparta Province.

This research was carried out for a total of 11 months in 2011 and the botanical composition and the vegetation measurements were conducted in the pasture areas which were presserved as non-grazing areas for 5 months before the experiment started. The weight and quadrat methods were used to determine the quantitative characteristics of grassland vegetation.

A total of 27 samples were taken by using a 0.5 m^2 quadrat at 3 different time periods (May-July-September) from 3 test areas and for each 3 regions so-called Merkez, Şarkikaraağaç and Yalvaç respectively.

Five replicates of grass heights were taken from the quadrat before the sowings were performed in each area, and the grass samples were cut at a height of 3 cm above the ground level in the quadrat. The fresh weights of the samples were determined using a scale with 2 g sensitivity (TEM-30 kg capacity) immediately after sowing.

The botanical composition was determined on weight basis and samples were taken from plant cover, species were separated and weighed separately. This method is the most reliable in critical studies. For this reason, it is the most appropriate method for determining the species in grasslands (Avcıoğlu, 1983).

Chemical and Statistical Analysis

The sampled materials were dried in a laboratory for 24 hours at 70°C, then weighed to obtain dry weights and the results were calculated in ton/ha. Kjehdahl method was used for CP analysis and Ankom 2000 fiber analyzer device was used for ADF and NDF (AOAC, 1995).

Statistical analysis were performed using Minitab 10 statistical software program and one way analysis of variance was used for significance of probabilities at 5% significance level. Tukey pairwise multiple comparison test was used to determine the differences between means.

Image processing and Geographic correction

Aster 2006 satellite data was obtained from Süleyman Demirel University Remote Sensing and GIS Centre. The satellite image with a 15 × 15 resolution taken in May was used due to the suitable temporal resolution as well as the obviousness of the green parts of vegetation in the areas outside the agricultural area in the spring months. Therefore, this satellite image was used to coordinate the digital topographic maps of Şarkikaraağaç district as reference by the Erdas 9.2 software program.

Specifying and filtering study area boundaries

The boundaries of the Şarkikaraağaç district were determined and filtering processes were performed using the boundary layer on the image to obtain an image of the Şarkikaraağaç district.

Supervised Classification

Coordinates were determined at the controlled points in the field studies where the supervised classification process is performed and the reflected values of these points and the histograms of the images generated from the satellite images are combined according to the supervised classification method.

RESULTS AND DISCUSSIONS

The average fresh and dry weight of herbage biomass, and chemical composition of vegetation by test areas are shown in Table 1.

There were no statistically significant differences in average grass height between test areas (P>0.05). Grass height means were 20.64, 21.93 and 21.36 cm in Merkez, Şarkikaraağaç and Yalvaç respectively. There were no statistically significant differences in average fresh weight of herbage biomass between test areas (P>0.05). Fresh weight of herbage biomass means were 9.4, 7.59 and 7.79 ton/ha in Merkez, Şarkikaraağaç and Yalvaç respectively.

Table 1. Average fresh and dry weight of herbage mass and percentage of crude protein, ADF and NDF means by test areas

Test Areas	[(1)]Grass Height Means (cm)	Herbage Mass Fresh Weight Means (ton/ha)	Herbage Mass Dry Weight Means (ton/ha)	Crude Protein Means (%)	ADF Means (%)	NDF Means (%)
Merkez	20.64	9.4	3.11	10.13	31.62	51.21
Şarkikaraağaç	21.93	7.59	2.71	11.26	31.41	51.65
Yalvaç	21.36	7.79	2.69	10.43	32.10	51.39

(1) Average of 3 sampling time May, July, September

There were no statistically significant differences in dry weight between test region (P>0.05). Dry weight means were 3.11, 2.71 and 2.69 ton/ha in Merkez, Şarkikaraağaç and Yalvaç respectively. However, there was a tendency for fresh and dry herbage biomass values to be higher for Merkez test area.

Average yields of dry weights were found to be 3.11ton/ha in Merkez district, 2.71 ton/ha in the Şarkikaraağaç district and 2.69 ton/ha in the Yalvaç district. However, Babalık (2008) found that dry matter yield in non-grazed areas was 1582 kg/ha in Isparta Merkez district. This value was almost 2 times less than the value obtained in this study. The difference between these two studies is thought to be due to the differences in elevation and botanical composition of both study areas.

Crude protein contents were 10.13, 11.26 and 10.43% in Merkez, Şarkikaraağaç and Yalvaç respectively and the differences were not statistically significant between test areas (P>0.05).

In line with these results, the content of the average crude protein was very close to each other in the test districts. However, the highest crude protein content was found for Şarkikaraağaç test area with 11.26%.

There were statistically significant differences in ADF and NDF values of vegetation between test regions (P>0.05). ADF values were31.62, 31.41 and 31.1% in Merkez, Şarkikaraağaç and Yalvaç respectively. NDF were 51.21, 51.65 and 51.39% in Merkez, Şarkikaraağaç and Yalvaç respectively.

It was observed that ADF and NDF contents increased in all the districts as the vegetation season progresses. For this reason, as the vegetation time progresses, it is obvious that it is caused by the increase of the fibrous structure within the plant

Distribution of botanical composition by species is shown by test areas in Table 2.

According to the results obtained from the test areas, the botanical compositions on dry basis were 21, 37 and 42% for Leguminosae, Gramineae and others as respectively in Merkez district; 35, 40 and 25% in the Şarkikaraağaç, and 36, 31 and 33% respectively in Yalvaç.

Table 2. Distribution of botanical composition by species are shown by test areas

Botanical Composition	Test Area			
	Merkez (%)	Şarkikaraağaç (%)	Yalvaç (%)	Means (%)
Leguminosae	21	36	36	31
Gramineae	37	40	31	36
Others	42	24	33	33

[#]Only none significant regression coefficients had superscripts (ns), the rest were significant at P<0.05.

In a study carried out in 2008 in Merkez by Babalık (2008), it was found that distribution of species of botanical composition in protected areas was 58.89% for Gramineae, 11.36% for Leguminosae and 29.75% for others. The botanical composition values obtained in this study in Merkez district, Leguminosae were found to be 3 times more; Gramineae 2 times less; and others 1.5 times more than those found in the study by Babalık (2008).

As a matter of fact, Gökkuş (2001) stated that in a grassland with a lot of Gramineae is more suitable for grazing cattle. In this study, it was determined that Gramineae were greater in test areas especially in Şarkikaraağaç district and therefore it can be emphasised that it is more suitable for cattle grazing than other animal species in terms of botanical composition in this test area.

According to a study carried out by Babalık (2007) on Isparta Davraz mountain Kozağacı plateau, the area covered with grasslands was found to be 23.1%, while in the botanical composition, 67.4% of Gramineae and 12.1% of Leguminosae and 20.5% of other families.

As a result of application of satellite image processing by RS and GIS and the vegetation studies performed within the scope of determination of the grassland areas of Şarkikaraağaç district, the following map of the study area was produced (Figure 1).

The fields are colored according to the situation of land use on the prediction map obtained as a result of image processing applications. Each color represents the use of land in that area. In the study, the 13 points were determined on the map as control points and these points were determined as grasslands in the field studies and 10 of them were classified as rangelands and 3 of them as rangeland+cultivated lands.

In Figure 1, irrigable agricultural fields of the province are shown in red, irrigated agricultural fields in yellow, rare vegetation covered in brown, and the estimated grassland areas, which mainly constitute our study area are symbolised in purple colour.

Estimated grassland for the Şarkikaraağaç district is 2325.4 hectare and the yield of dried grass from Şarkikaağaç is 2.71 ton/ha. After necessary calculations are made, the amount of dry biomass that can be obtained from these estimated pasture areas is calculated as approximately 6.5 ton.

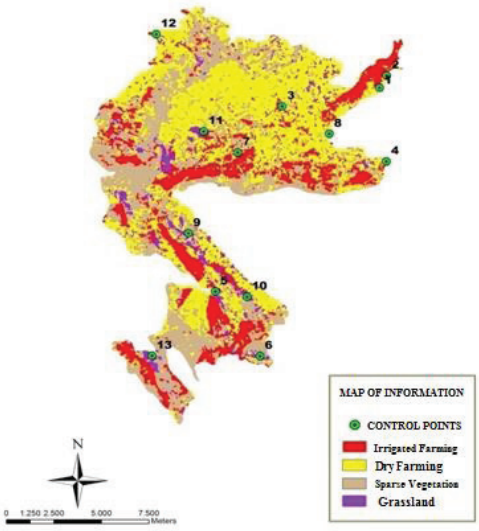

Figure 1. Grassland area map obtained from Aster 2006 satellite data in Şarkikaraağaç

The similar results were obtained in a study conducted by Babalık (2008) in which it was investigated the changes in the amount of biomass yield in grazing areas during summer and autumn periods and to provide information to be used by farmers to improve animal production in the region.

In a research carried out by Bozkurt et al. (2010), using RS and GIS, they prepared the maps showing the rangeland quality classes by determining the boundaries of Kars province metropolitan areas. In this study, the grazing potentials of the grassland and the grazing capacities were determined by grazing the animals.

CONCLUSIONS

It was found that the most suitable grazing time can be started at the beginning of May and terminated at the beginning of September since both dry biomass yield and protein ratios are reduced at the end of the vegetation period, and also that considering the vegetation cover and botanical composition the area is more suitable for both sheep and cattle production and the leader-and follower grazing system can be recommended for farmers in the region.

In terms of animal production potential, knowing the boundaries of pasture areas will guide farmers and decision makers in terms of

animal production and will help all the sectors involved to use the available resources correctly. Determination of pasture areas with their locations determined by digital maps and determination of suitable grazing times and grazing systems in pasture areas are considered to provide great contribution to livestock potentiality of Şarkikaraağaç district and Isparta province as a whole.

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