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EVALUATION OF NATURAL GRASSLANDS DETERMINED BY REMOTE SENSING AND GIS APPLICATIONS IN THE HIGHLANDS OF EASTERN TURKEY

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Abstract

The aim of this study was to assess the natural grassland regions for livestock production in the highlands of Eastern Turkey by utilizing Remote Sensing (RS) techniques and Geographic Information Systems (GIS) applications.

It was concluded that the natural grasslands make up 2/3 of the whole study area in Kars province. However, in terms of plant cover density this only accounts for 1/3rd of the entire area. In other words, just 181 275.7 hectares out of a total of 638 393.5 hectares of grassland are in a better state for cattle grazing. Finally, digital maps of the greatest quality grasslands were produced.

Keywords: natural grasslands, remote sensing, geographic ınformation systems, satellite ımages, digital maps.

ОЦЕНКА ЕСТЕСТВЕННЫХ ЛУГОПАСТБИЩНЫХ УГОДИЙ, ОПРЕДЕЛЯЕМЫХ С ПОМОЩЬЮ ДИСТАНЦИОННОГО ЗОНДИРОВАНИЯ И ПРИМЕНЕНИЯ ГИС В ВЫСОКОГОРНЫХ РАЙОНАХ ВОСТОЧНОЙ ТУРЦИИ

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Реферат

Цель этого исследования в том, чтобы оценить естественные пастбищные районы для животноводства в высокогорных районах Восточной Турции с использованием методов дистанционного зондирования (ДЗ) и приложений геоинформационных систем (ГИС).

Сделан вывод о том, что естественные пастбища составляют 2/3 всей исследуемой территории Карсской области. Однако, с точки зрения плотности растительного покрова, это составляет только 1/3 всей площади. Другими словами, только 181 275,7 га из 638 393,5 га лугопастбищных угодий находятся в лучшем состоянии для выпаса скота. В заключении были составлены цифровые карты лугопастбищных угодий с высоким разрешением.

Ключевые слова: природные пастбища, дистанционное зондирование, геоинформационные системы, спутниковые снимки, цифровые карты.

Introductıon

Remote sensing (RS) is known as a science of acquiring and interpreting information from a distance using sensors that are not in direct contact with the item being viewed. In this definition, aerial, satellite, and spacecraft observations of the surfaces and atmospheres of the planets in the solar system are included (Jensen, 1996).

A geographic information system (GIS) is a system for recording, storing, analyzing, and managing geographically referenced data and associated properties. In other word, it is a computer system that integrates, stores, edits, analyzes, shares, and displays geographically related data (Chandrakar and Thomas, 2010).

RS and GIS technologies have been of great use to planners in planning for efficient use of natural resources at national, state and district levels. Application of these technologies in the management of natural resources are increasing rapidly due to great strides made in spaceborne RS satellites in terms of spatial, temporal, spectral and radiometric resolutions (Venkataratnam, 2001). RS and GIS are being used increasingly as tools to assist in grassland resource inventory and integration of data and as a mechanism for analysis, modelling, and forecasting to support decision-making.

For the assessment of grasslands and the estimation of fodder availability, as well as the monitoring of natural range resources, remote sensing satellite images and Geographic Information Systems (GIS) are commonly implemented (Singh et al., 2011). Because in many developing countries, grazing resources are limited and natural grasslands are becoming more scarce, there is a higher need to effectively manage grasslands for maximum livestock feed production and environmental improvement (Roy and Singh, 2013).

Grasslands have been studied and monitored using satellite data in several different ecosystems and over seasonal and interannual periods to verify variability, production gains, and resilience. Because of its functions in maintaining atmospheric composition and improving local climate and soil moisture, grassland is an important aspect of terrestrial ecosystems. Grasslands provide the foundation for the existence and development of animal husbandry, in addition to their function in environmental conservation (Sala and Paruelo, 1997).

The composition of grasslands varies across the different topographic conditions due to variation in the species prevailing, rainfall patterns, animal grazing pressure, and successional status of plant species. Grasslands are often explored through field-based examinations in only a few places of the world (Pandey at al., 2021). Because grasslands cover a large spatial extent in isolated places and are physically difficult to reach, traditional evaluation methods are inefficient and expensive (Asrar et al., 1986). Remote sensing techniques that are more advanced are far more useful in scanning pastures, meadows and grasslands with fewer errors and corruption (Liu et al., 2001; Akiyama and Kawamura, 2007; Nayak et al., 2010).

Remote sensing technologies with proper representation of the number of pixels on a satellite picture that can be mapped with corresponding grass cover area can be used to determine percent grass cover (Friedl et al., 1994)

Overgrazing, inappropriate land use, drought, and other natural and human factors have combined to cause serious problems with grassland resources in recent years, including a decrease in vegetation biomass and coverage, a decline in productivity, a decline in forage quality, and a general decrease in grassland livestock capacity (Zhang et al., 2013).

Therefore, it was aimed to classify grassland types and to determine the potential grassland areas to be utilised for beef cattle producition in the highlands of Eastern part of Turkey with special reference to Kars Province located in the North-East, using RS techniques and GIS applications.

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Material and methods

Beef cattle production is carried out in general in vast conditions and on grasslands in the Eastern portion of Turkey, where the study area (Kars Province) is located, accounting for 41.4 percent of the country's total grassland area (Avcioglu, 2000). In terms of both the number of cattle and sheep (big and small animals) and the larger area of grassland accessible, Kars province is unique in the region (Anonymous, 1984).

Study area covered provincial boundaries of study area with an altitude of above 2000 m. The area of Kars province is 918.117 ha. It lies between 260 000-390 000 km East, 4 420 000 - 4 530 000 km North according to UTM Geographic Coordinate System. Ardahan province is in the North; Agri is in the South; Erzurum is in the West and Armenia is in the East. Figure 1 shows geographical location of the study area.

ArcGIS, Arc-Info and ERDAS Imagine softwares were used for the correction of the data obtained, interpretation, analysis and mapping of grasslands. GPS (Magellan 315) connected intensive ground truthing (GT) and in order to obtain the geospatial data on pasturelands, field samplings were conducted. Moreover, for supervised image classification of satellite images, these grasslands were analyzed, sampled, and GPS positions (43 points: latitude, longitude, and altitude) were recorded.

LANDSAT 5 TM satellite images taken were used and land use and land cover classification maps were produced using GIS. In order to determine the current status of grasslands, red (0.45-0.52 µm), near infra-red (0.52-0.60 µm) and infra-red (0.63-0.69 µm) bands of Landsat images were used to find the grasslands and unsupervised classification was applied and the distribution map of grasslands showing the present status was produced (Figure 2).

Results and discussion

According to the findings, the grassland area in the province was 638968.3 ha, or 66.7 percent of the total area. The grassland types I, II, and III, which accounted for 22.6, 34.1, and 10% of the total grassland area in the research region, occupied 216917.7, 326334.7, and 95716 hectares, respectively.

As it is indicated in Figure 2B, land use types classified as lakes, horticultural areas, pasture and shrubs, irrigated and non-irrigated areas, viniculture, abandoned and industrial areas including settelment areas are shown. However, forestry areas are indicated with dark green in the West part of the study area. Garssland areas are scattered all over the study area and shown light green while yellow coloured areas are non irrigated agricultural lands.

It was discovered that grassland areas cover 2/3 of the total area of Kars province. However, this only accounts for a third of the entire area in terms of plant cover density. In other words, just 181 275.7 ha of the total grassland area of 638 393.5 ha is in a better state in terms of plant cover for cattle to graze on. It was also discovered that the greatest quality grasslands for beef cattle production are found in the province's northwest corner, from the west of the Sarikamis forests to the north-western range of the Allahuekber mountains and the foothills of the Erdagi mountains (Figure 3).

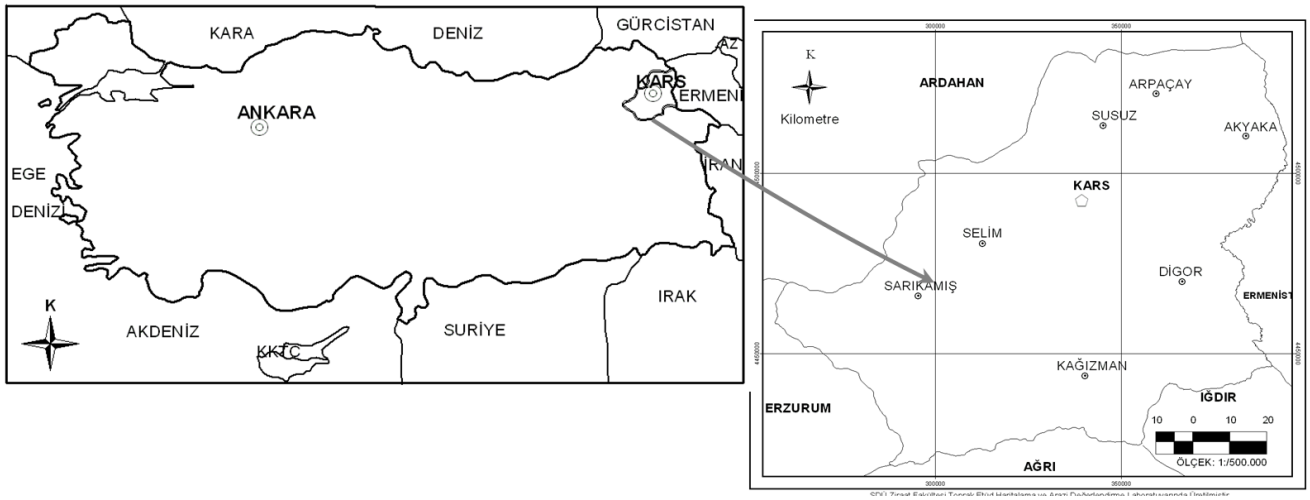

Figure 1 – Geographical location of the study area

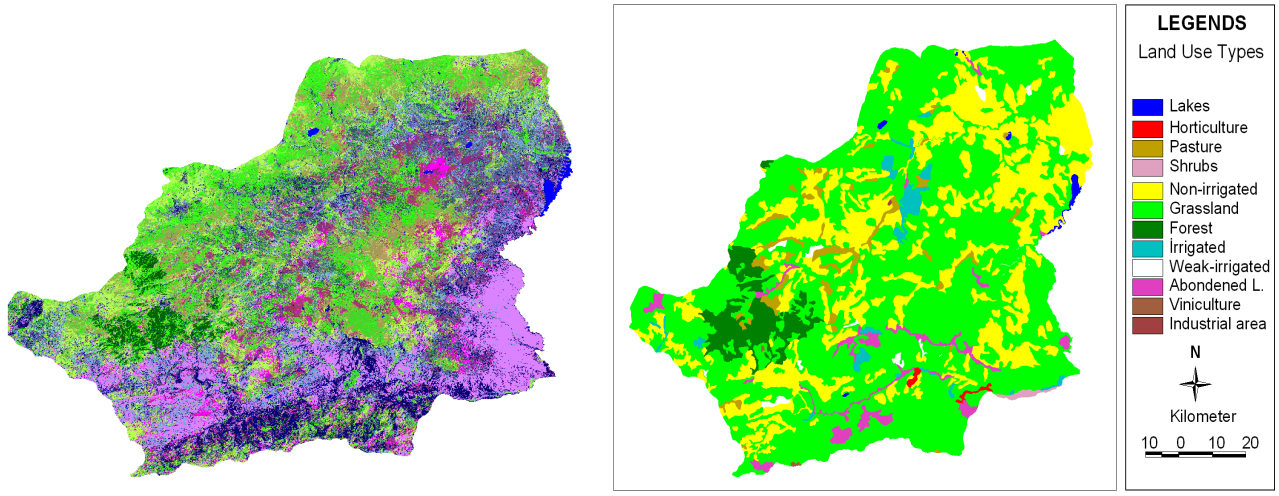

Figure 2 – Classified satellite data (A) and the map produced from these data (B)

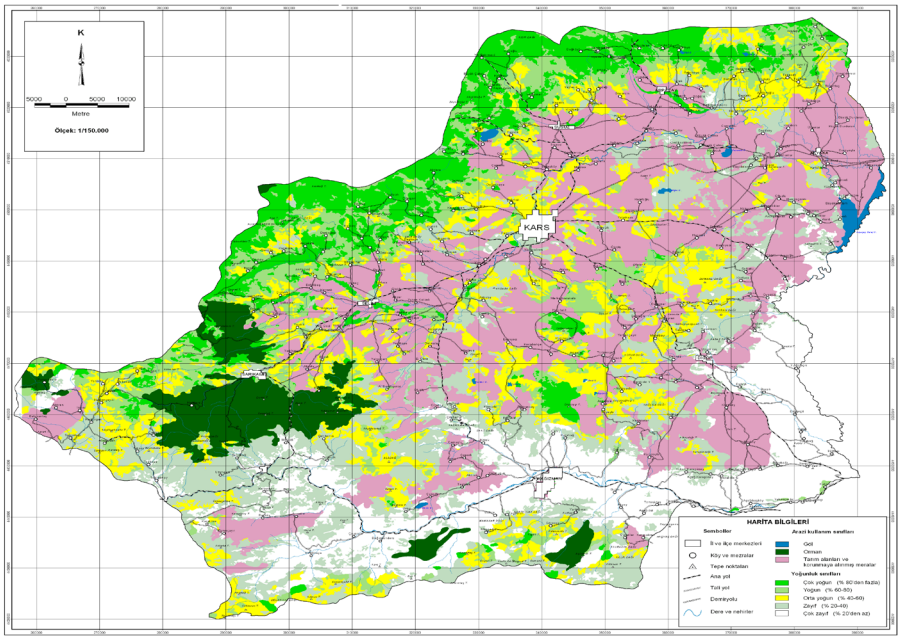

Figure 3 – Land use map of Kars and grassland classification distribution

As it is indicated in Figure 3, lakes are blue coloured, irrigated and non-irrigated agricutural areas are shown in pink colours. However, forestry areas are indicated with dark green in the West and some part of the South of the study area. Garssland areas are classified according to biomass intensity all over the study area and those shown in green areas lie upwards in the North West with very intensive level of more than 80% and light green areas with intensive level between 60-80% while yellow coloured areas are mid-level intensity between 40-60%, grey coloured areas are weak intensity level between 20-40% and white coloured areas are very weak intensity of less than 20%.

The grasslands in the study area have also been classified as Type I, II and III together with 3 sub-classes within each type according to biomass quality and vegetation cover and compared according to NDVI (Normalised Difference Vegetation Index). This work will be published in the future.

Conclusıons

It was concluded that in this region, where the economy is based on animal production, determination of grassland areas, stocking rates, estimation of biomass available for grazing, the length of vegetation period, and monitoring the change in grassland must all be included in Regional Development Plans, and the findings of this study can help improve beef cattle production in the region.

The results will undoubtedly influence grazing management decisions such as determining the start date of the grazing season, stocking rate, and the most appropriate grazing systems for the region. Therefore, monitoring the biomass and productivity of vegetation in a timely and accurate manner is an important subject for grassland resource management and of great significance for the scientific utilization and development of grassland resources.

To reduce the degradation of grassland and to keep grazing ecofriendly and sustainable, it is essential to study its current status with a degree of its severity both spatially and temporally so that appropriate pasture management strategies can be made.

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