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Relocation of Livestocks in Rural of Canakkale Province Using Remote Sensing and GIS

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***Abstract*—**Livestock production is one of the most important components of rural economy. Due to the urban expansion, rural areas close to expanding cities transform into urban districts during the time. However, the legislations have some restrictions related to livestock farming in such administrative units since they tend to create environmental concerns like odor problems resulted from excessive manure production. Therefore, the existing animal operations should be moved from the settlement areas. This paper was focused on determination of suitable lands for livestock production in Canakkale province of Turkey using remote sensing (RS) data and GIS techniques. To achieve the goal, Formosat 2 and Landsat 8 imageries, Aster DEM, and 1:25000 scaled soil maps, village boundaries, and village livestock inventory records were used. The study was conducted using suitability analysis which evaluates the land in terms of limitations and potentials, and suitability range was categorized as Suitable (S) and Non-Suitable (NS). Limitations included the distances from main and crossroads, water resources and settlements, while potentials were appropriate values for slope, land use capability and land use land cover status. Village-based S land distribution results were presented, and compared with livestock inventories. Results showed that approximately 44230 ha area is inappropriate because of the distance limitations for roads and etc. (NS). Moreover, according to LULC map, 71052 ha area consists of forests, olive and other orchards, and thus, may not be suitable for building such structures (NS). In comparison, it was found that there are a total of 1228 ha S lands within study area. The village-based findings indicated that, in some villages livestock production continues on NS areas. Finally, it was suggested that organized livestock zones may be constructed to serve in more than one village after the detailed analysis complemented considering also political decisions, opinion of the local people, etc.

***Keywords*—**GIS, livestock, LULC, remote sensing, suitable lands.

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I. Introduction

SINCE people living in rural areas face economic and social problems, they tend to migrate to urban areas for better living and job opportunities [1]. As a result of migration, the need for settlement is likely to increase which prompts the urban expansion process. Such processes may lead to rural-to-urban transition of especially villages which are close to expanding cities. One of the most important problems for adaptation to rural-to-urban transition process is related to livestock production as the legislations have some restrictions. Thus, the existing animal operations should be moved from the settlement areas. Moreover, the relocation should follow the pre-defined limitation criteria given in the literature [2], [3]. However, in many villages of Canakkale, there are still small family enterprises maintain livestock production by disregarding these limitations. In this study, an attempt was made to determine the areas that have potential for livestock production, and to evaluate the current status. In this context, land suitability analysis provides an appropriate planning approach by combining land properties and land use simultaneously according to predefined limitations, requirements, and preferences for specific purposes [4], [5]. Suitability analyses are important due to the fact that land use not only depends on preferences of user, but also land capability based on some properties such as; soil, topography, and current land use [2]. In this study, analysis was conducted using RS data and GIS which offer powerful, practical, and reliable platform for such analysis. The results were evaluated depending on village boundaries, and compared with the village-based livestock inventories. This study constitutes a basis as an evaluation of the current status, and may present a provision for further studies with employment of higher-resolution RS data, ground information and detailed soil attributions.

II. Materials and Methods

A. Study Area

The study was conducted in suburban areas of Canakkale province of Turkey, where transition process already started in some villages against rapid population growth.

Study area covers more than 100.000 ha. Fig. 1 shows the location of the study area Canakkale province (pink), and the Formosat 2 imagery.

B. Data Used and Progress of the Study

Landsat 8 and Formosat 2 imageries, Aster DEM, soil maps, administrative (village) boundaries, and village-based inventory were used for different purposes. The study was conducted in two steps. In the first step LULC and vector data were generated and used in elimination of inappropriate areas. In the second step derivation of slope map from Aster DEM, and evaluation of rest of the area in terms of suitability considering also LUCC of soil map were conducted (Fig. 2).

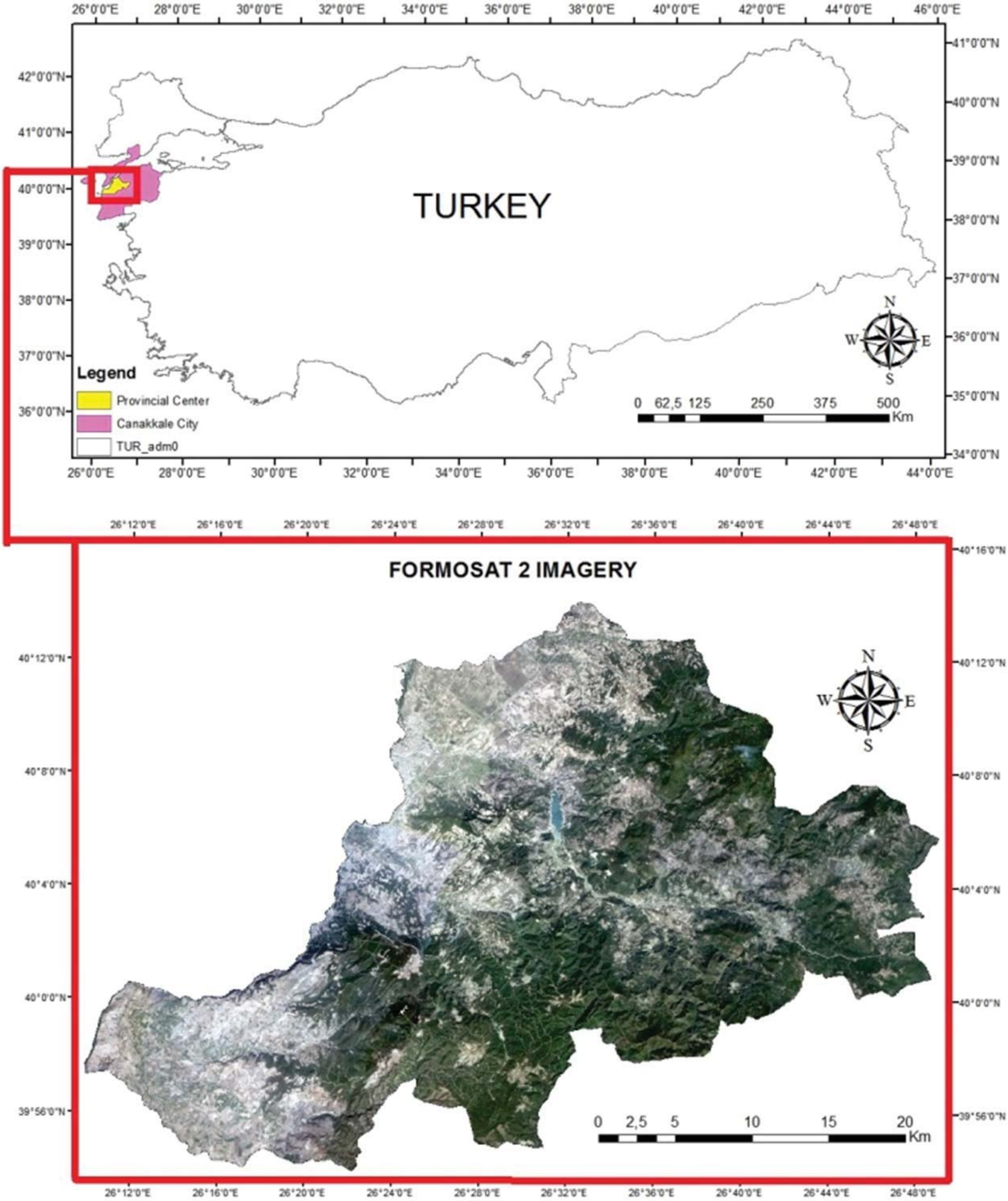

Fig. 1 Location and Formosat 2 imagery of study area

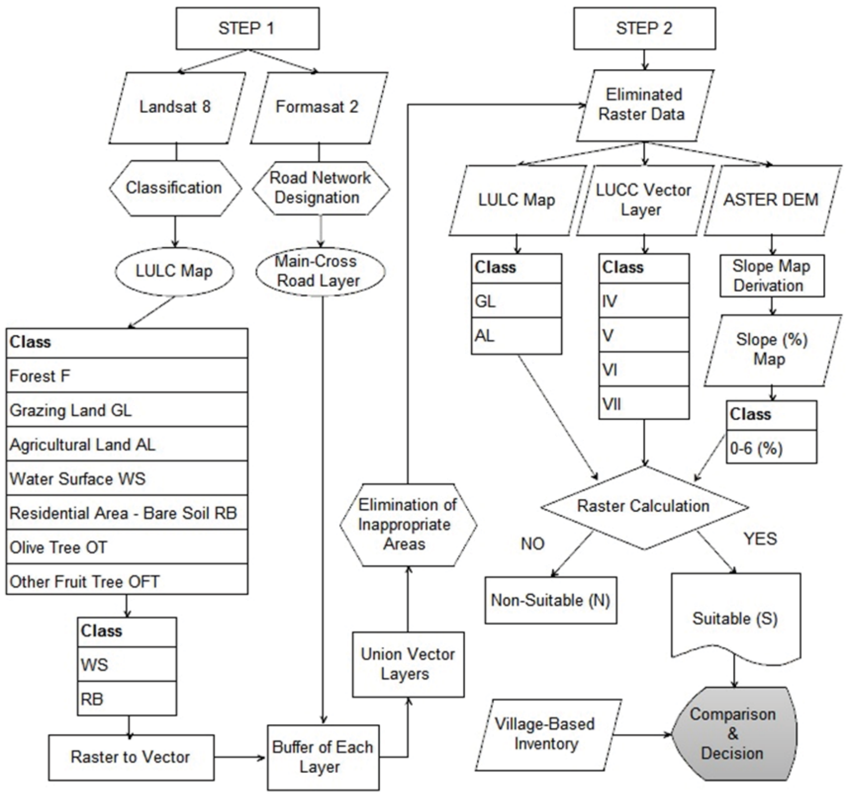

Fig. 2 Followed steps in the study

C. Determination of LULC Status

Publicly available Landsat 8 OLI-TIRS data (21 May, 2014) with 181/32 Path/Row (WRS) number was downloaded from USGS website [6]. The spatial resolution of the image is 30 m. Although, Landsat 8 imagery has eleven bands, six bands (B_2, B_3, B_4, B_5, B_6, B_7) were used in the study since the previous studies indicated the sufficiency of these bands to obtain satisfactory results [7]. These bands cover the range between visible and mid-infrared region of electromagnetic spectrum. Fig. 3 shows Landsat 8 imagery of the study area.

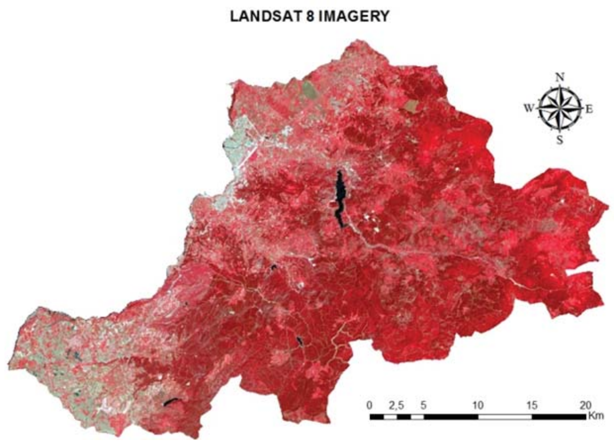

Fig. 3 Landsat 8 image covering study area acquired on May 2014

Image classification procedures were applied using supervised classification technique and maximum likelihood algorithm in Erdas Imagine software. The study area was classified into 7 main classes including Forest (F), Grazing Land (GL), Agricultural Land (AG), Water Surface (WS), Residential Area – Bare Soil (RB), Olive Trees (OT), and Other Fruit Trees (OFT). The WS and RB classes were converted into vector layer for further analysis (Fig. 2).

Classification accuracy was assessed using high resolution images in Google Earth. Accuracies of automatically and randomly selected 70 points were checked. Minimum of 5 points per each class were used depending on the area extents (Erdas Imagine Software).

D. Road Network Designation

In earlier studies, it was denoted that there are some distance limitations for building livestock structures since they tend to pollute the environment and have potential to decrease air quality resulted from the manure storages [2], [3]. Thus, distances from main roads, residential areas, water resources and crossroads are highly important in the determination of borders of suitable areas for livestock operations. However, there is a lack of digital maps showing especially the crossroads of Canakkale. Therefore, establishing road network is required to meet the goal of the study. Formosat 2 imagery with 8 m spatial resolution was used to establish road network (ArcGIS 10.3 Software) (Fig. 2). Fig. 4 illustrates the main and crossroads, delineated using Formosat 2 imagery.

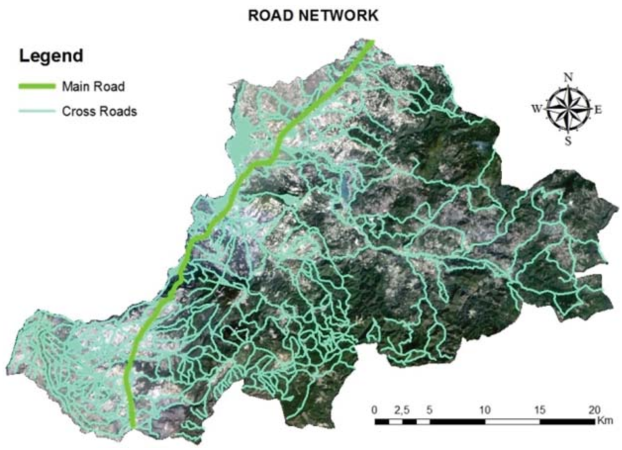

Fig. 4 Formosat-based road network

E. Generating Buffer Zones

As it was mentioned earlier, there are some distance limitations for building livestock structures. The distances from main roads, settlement areas, water resources and crossroads were given as 1000 m, 500 m, 300 m and 100 m, respectively [2]. National parks are also an important concern that should be considered [2].

The boundaries of settlement areas and water surfaces were exported from LULC map in raster format, and then converted to vector data. The whole vector layers are shown in Fig. 5.

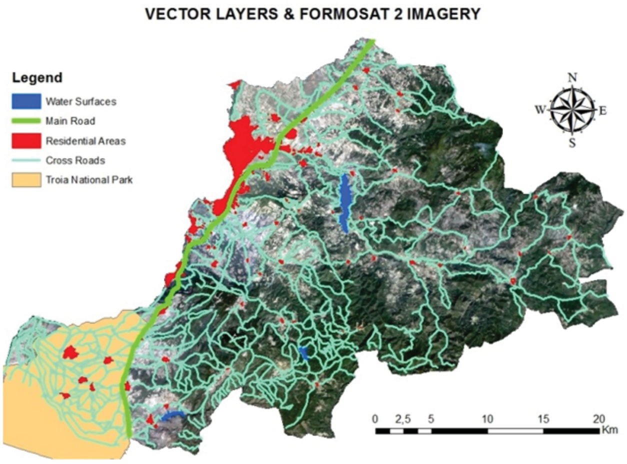

Fig. 5 Vector layers and Formosat 2 imagery

To eliminate inappropriate areas, each vector data was buffered according to their own limitation factors, prior to layer union (Fig. 6). Subsequently, since these zones were considered as inappropriate for livestock operations union-buffered zones were excluded, and disregarded in further analysis.

F. Formation of LUCC and Slope Maps

One of the most important components of performing suitability analysis is known to be soil properties, primarily LUCC values. Digitized 1:25000 scaled soil maps were used to evaluate the LUCC status of study area and also to investigate the S lands. The LUCC values of study area were ranging between I-VII with an exclusion of V^{th} class (Fig. 7). Fig. 8 shows the buffer zones-excluded LUCC map.

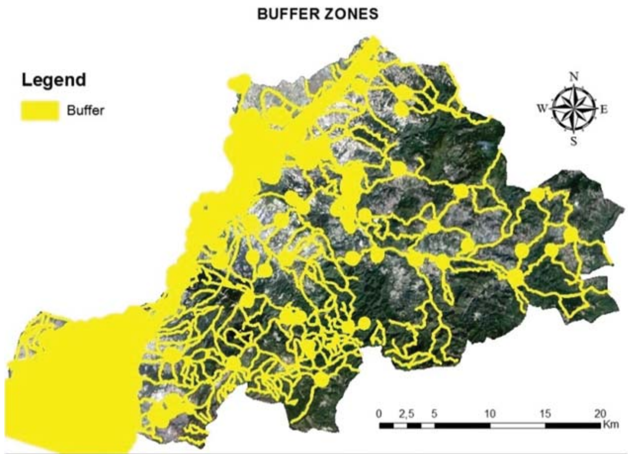

Fig. 6 Union buffer zones

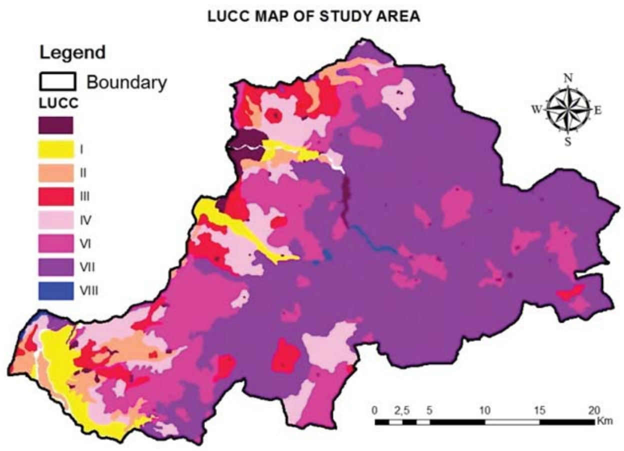

Fig. 7 LUCC map of the study area

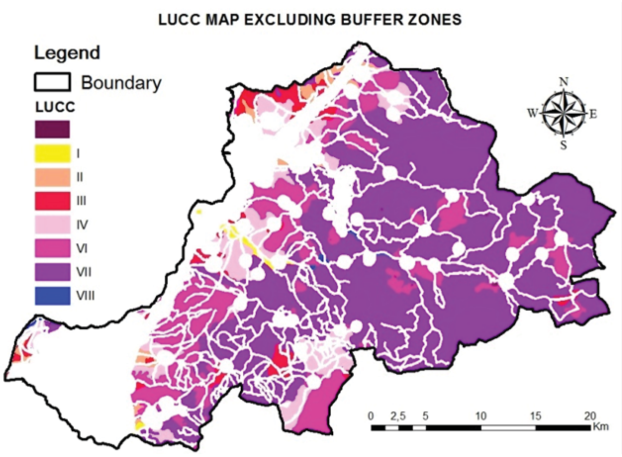

Fig. 8 Buffer zones excluded LUCC map

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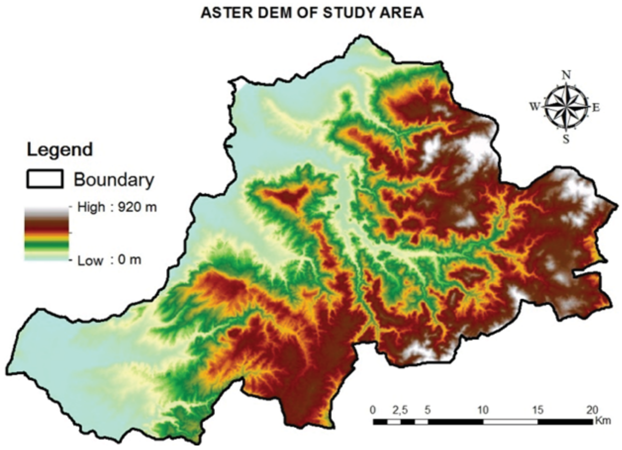

Fig. 9 Aster DEM map of the study area

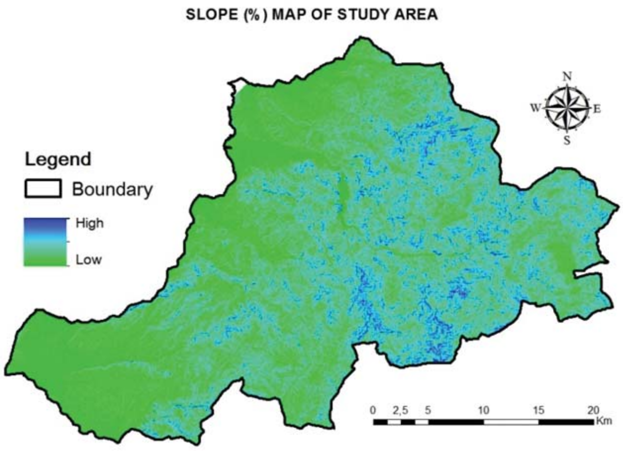

Fig. 10 Slope (%) map of the study area

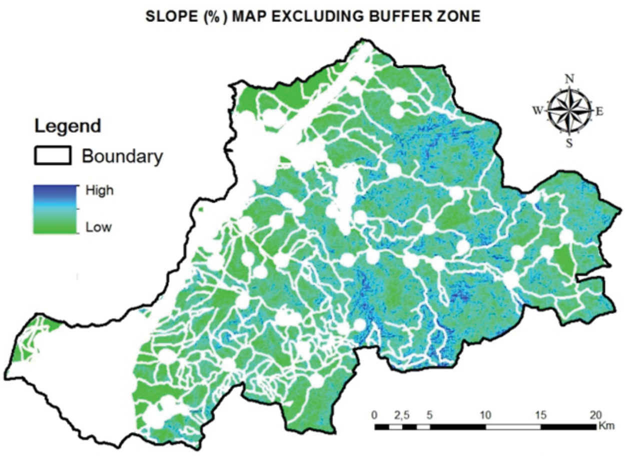

Fig. 11 Slope (%) map with an exclusion of buffer zones

Another important parameter in suitability analysis is slope status of the lands [3]. Slope (%) map was derived from Aster DEM which was downloaded from USGS website, and derivation process was conducted using 3D analysis tools of ArcGIS (10.3) software. It should be noticed that Aster (GDEM) is a product of METI, NASA [6].

According to DEM data, the elevation of study area was changing between 0 m (sea level) and 920 m (Fig. 9). Aster-derived slope (%) map and exclusion of buffer zones can be seen on Figs. 10 and 11, respectively.

G. Determination of Suitable (S) Lands

Determination of S and NS lands requires principally LULC, LUCC, and slope status to be assessed. The related data were developed using above mentioned procedures.

In the study, S lands were considered to be a function of LULC, LUCC and slope values (1). It was assumed that along with many LULC types, these structures can be constructed preferably on GL and AL lands. On the other hand, LUCC values under IV were absolute agricultural lands. Therefore, since they have high crop yield potential they may not be used for any other practices other than agriculture. Finally, it was reported that slope values over 6 % are not appropriate for livestock production [8]. Hence, the lands within GL and AG classes of LULC map, slope values ranging between 0-6 (%), and LUCC values ranging between IV-VII were named as Suitable (S) lands, and the rests as Non-Suitable (NS). Suitability analysis was carried out using ArcGIS (10.3) software.

$$S = (LULC_{GL,AL}, LUCC_{IV-VII}, Slope_{0-6\,\%}) \quad (1)$$

Finally, the results of suitability analysis were integrated into GIS database, and compared with the village-based inventory records including number of animals (NOA) (cattle, sheep, and goat) per village. Fig. 12 represents the village boundaries within the study area.

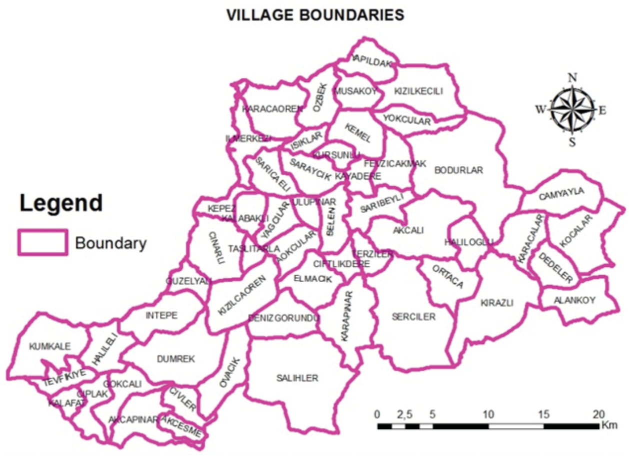

Fig. 12 Village boundaries within the study area

III. Results and Discussions

A. Results of LULC Classification

The accuracy of LULC map was found to be 86.20%. The results obtained from LULC map indicated that major part of the study area was covered with forests (F) (16464 ha) followed by agricultural lands (AL) (19053 ha). It was found that residential area – bare soil class (RB) was covering an area of 6178 ha. The area of grazing land (GL) class was found to be 6000 ha, while other fruit tree (OFT), olive tree (OT) and water surface (WS) classes were covering 4651 ha, 2230 ha, and 505 ha areas, respectively.

The LULC map pointed out that 25053 ha area may be suitable for livestock production (GL, and AL) if there is no limitation factor such as; roads, national park borders. The areas in hectares (ha) and percentages (%) are given in Table I. Additionally; Fig. 13 illustrates the LULC map of the study area.

TABLE I
PROPORTIONS OF LULC CLASSES

LULC Class	Area	
	Area (ha)	Area (%)
F	64171	62.5
GL	6000	5.8
AL	19053	18.5
WS	505	0.5
RB	6178	6.0
OT	2230	2.2
OFT	4651	4.5
Total	102788	100

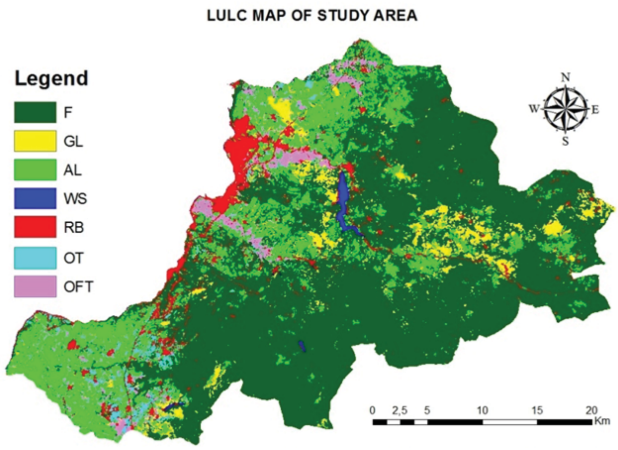

Fig. 13 GIS illustration of village-based NOA records

B. Suitability Results of GIS Analysis

According to GIS analysis results, the extent of suitable lands for livestock production is found to be 1330 ha within GL and AL classes of LULC map. Village-based distribution map of S lands can be seen on Fig. 14. In addition, areas of S lands in hectares (ha) for each village are shown in Fig. 15.

The results also showed that village-based suitable lands were varying between 0-146 ha. Since Halileli, Tevfikiye, Ciplak, and Kalafat villages are located within Troy National Park; there are no S lands within these villages. Similarly, district center consisted of settlement areas was not suitable for livestock production (0 ha). In Alankoy, Camyayla, Dedeler, Karapinar, Kirazlı, and Kocalar villages (0 ha), the restriction factors were seemed to be the LULC and slope level, since the LUCC was appropriate (VI and VII). In comparison, Karacaoren village was found to have the largest area of S lands (146 ha). This result was not only sourced from the broad grazing land located within this village, but also from the propriety of LULC, LUCC, and slope conditions. Status of the rest of the villages is given in Table II.

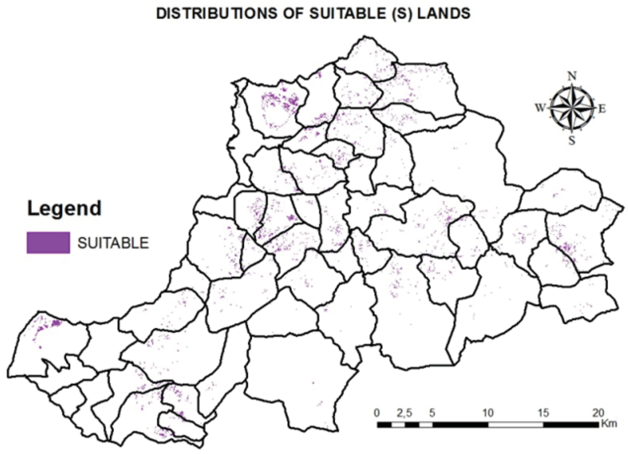

Fig. 14 Locations of suitable lands according to villages

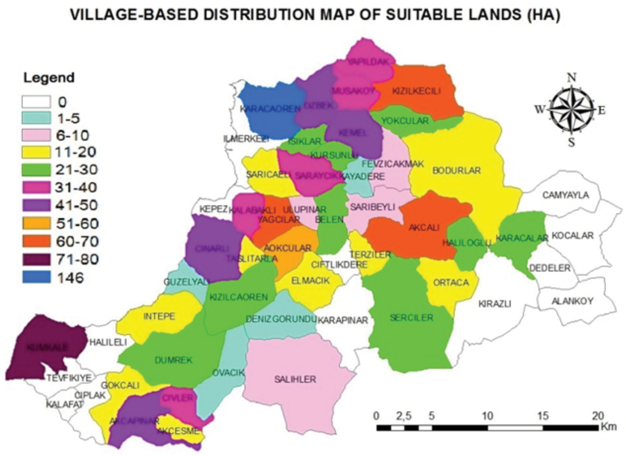

Fig. 15 Grouped extents of suitable lands (ha)

TABLE II
VILLAGE-BASED SUITABLE LANDS IN HECTARES

Village	ha	Village	ha	Village	ha	Village	ha
Kayadere	3	Terziler	13	Y.okcular	23	Yapildak	40
D.gorundu	4	Akcesme	17	Belen	26	Ozbek	43
Ovacik	4	T.Tarla	17	Kizilcaoren	26	Cinarlı	45
Guzelyali	5	Ortaca	18	Dumrek	28	Kemel	45
Ulupinar	6	Saricaeli	18	Isiklar	29	Akcapinar	46
Salihler	7	Intepe	19	Serciler	30	A.okcular	51
F.cakmak	8	Gokcali	20	Musakoy	34	Akcali	61
S.beyli	8	Haliloglu	21	Kalabakli	35	Yagcilar	64
Bodurlar	12	Karacalar	21	Saraycik	35	K.kecili	69
Elmacik	13	Kursunlu	23	Civler	38	Kumkale	71

C. Comparison of NOA Inventory Records and S Lands

The village inventory records of 2012 were consisting of various agricultural statistics such as; cultivation areas, irrigable areas, number of animals per age groups and per species, and numbers of tractors. In this study, only the number of animals (NOA) as a total number of cattle (NOC), and sheep/goat (NOSG), was considered (Fig. 16).

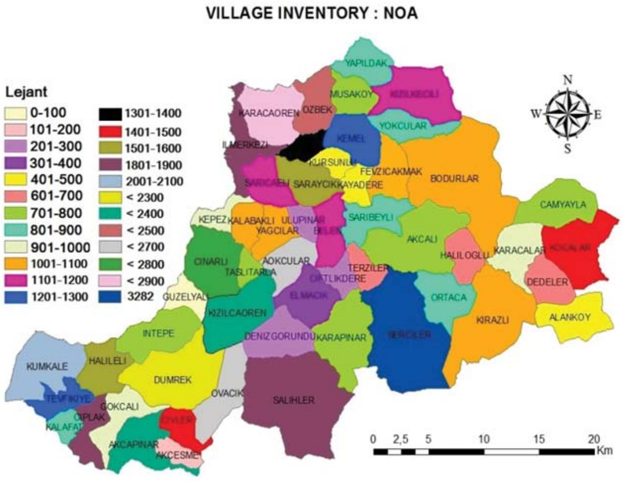

Fig. 16 GIS illustration of grouped village-based NOA records

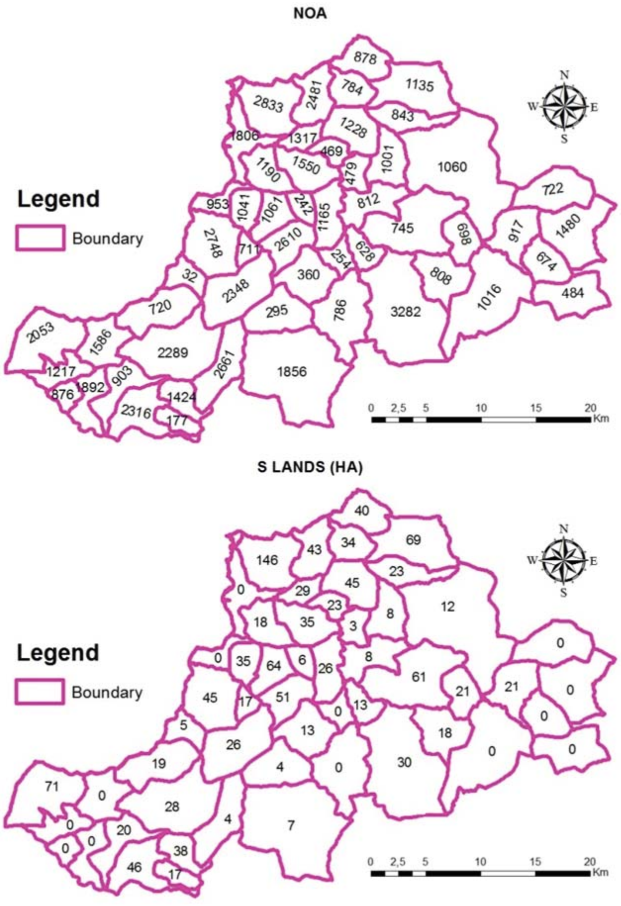

Fig. 17 Number of cattle against S lands (ha)

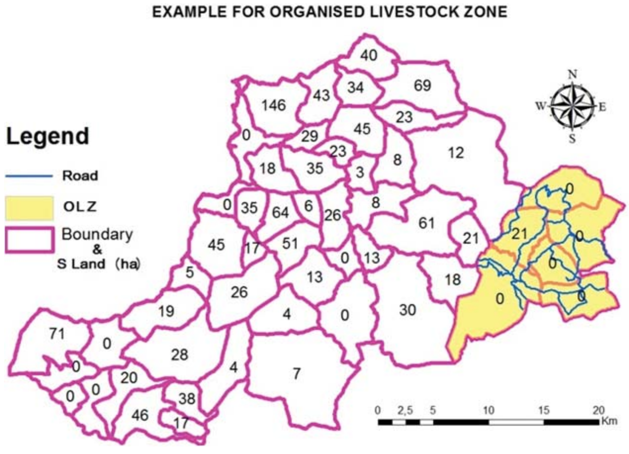

Fig. 18 Number of cattle against S lands (ha)

Evaluation of inventory showed that, the total NOA was 65896 according to 2012 records. The NOSG was recorded as 56708 while the NOC was 9188. The maximum NOA was noticed in Serciler village with a number of 3282 while the minimum was in Guzelyali with 32 animals (Fig. 16). The ungrouped values for NOA and S land of each village can be seen on Fig. 17.

Fig. 17 showed that in some villages there are livestock operations on inappropriate areas since there are no S lands in terms of LULC, LUCC, and slope or distance limitations. Therefore, the livestock structures should be move to villages where appropriate land is available. On the other hand, even though there are S lands available in central villages such as; Kalabakli, Karacaoren, and Guzelyali, it will be an unrealistic attempt to build such operations within these villages since it is known that transition process is already started.

Political decisions shape the conditions of a specific area as it is well known. A politics-related decision in study area is the bridge project on Canakkale strait, which will combine 7 cities including Canakkale with new highway network, is foreseen to be finished in 2023. Project may affect land-use preferences of the study area, especially shoreline and its environment, and unsurprisingly, the mentioned area is expected to be reserved for new settlements and alternative transportation networks. Considering these, Ozbek, Musakoy, and Yapildak villages may not be appropriate for livestock production as well as Karacaoren. New locations may be required for conducting livestock production.

As a suggestion, organized livestock zones may be constructed to serve more than one village. This kind of production approaches started to be implemented in some cities of Turkey. It can be an alternative way of moving livestock operations out of villages. Fig. 18 shows a potential example which depends only on S land (ha) with an area of 21 ha in Karacalar village which may serve to surrounding villages (Alankoy, Camyayla, Dedeler, Kirazli, and Kocalar). However, this is only an example and it is highly important to evaluate political approaches, the opinions of local people, detailed ground data, transportation possibilities, animal population, market access, as well as the parameters investigated in this study. Finally, using RS data with higher spatial and spectral resolution is also advantageous not only for improving the classification accuracy, but also for determining the locations of the inconvenient livestock operations.

IV. Conclusion

In brief, it was concluded that distance limitations result in 44230 ha area to be excluded out of study area. Furthermore, forests, olive and other fruit orchards were considered as preferably unchangeable LULC classes for livestock purposes (71052 ha), thus, also excluded. In comparison, a total of 1228 ha area found to have potential to be S lands.

Village-based inventory records showed that livestock production continues in some villages even though there are no S lands, which indicated that they should be moved out. However, it is essential to state locations of livestock operations even in villages containing S lands to evaluate the actual status. Finally, use of RS data with higher resolution together with detailed ground data is recommended not only for due diligence, but also for identification of suitable lands for organized or individual livestock production zones.

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