Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2018, 5(1):113-122

ISSN: 2394-2630
CODEN(USA): JSERBR

Research Article

Remote Sensing Determination of Variation in Adjacent Agricultural Fields in the Ergene River

Selcuk Albut[1]*, M. Cuneyt Bagdatli[2], Omer Dumanli[3]

[1]Namik Kemal University, Agricultural Faculty, Dept. Of Biosystem Eng., Tekirdag, Turkey
[2]Nevsehir Haci Bektas Veli University, Faculty of Engineering and Architecture, Dept. of Biosystem Eng., Nevsehir, Turkey
[3]MSc. Agricultural Engineer, Bursa, Turkey

Abstract This study Ergene River on the right and left 10 kilometers of the former in terms of monitoring of the year the situation changes in some of the remaining agricultural lands in the 2003, 2008 and 2012 satellite images. In order to determine the temporal changes in land use, primarily the ASTER satellite images in 2003 and 2008 unsupervised and the 2012 dated satellite images taken supervised classification techniques are applied. Geodetic measurements in order to determine the land use change were made in 2012. Different crops and locations for land use control points in May 2012. DGPS (Differential Global Positioning System) was performed with the device. The results in making the land cover classification for each year are disclosed in the course of change. Classification way through the layers 9, grain fields, shrubs, sunflower + canola fields, vineyards + orchard areas, water surfaces, artificial surfaces, were made under the classification of layers such as rice and pasture. Supervised classification and unsupervised classification techniques are used.

Research in the area of 279 409 ha is subject to a classification analysis was divided into 9 classes studied area. The highest area of the spatial distribution of the classification results in 2003 99791.6 ha and 99789.2 ha get it why pastures creating 'take it like it was observed that followed the grain field. Canola and sunflower farming areas do conclude that create 13.17% of the total area of the zone. When we look at the year in 2008, still a large proportion of the total area while the slice grain pastures percentage 34.76%, while canola and sunflower seem to be a percentile 13.75%. In 2012, while having a field of grain fields 91300.2 ha and 40895.4 ha were identified where the area of agriculture canola and sunflower. When the construction field in 2003 in an area of 1615.6 ha construction, while this ratio in 2012 reached an area of 1979.2 hectares, an increase of 0.06% in 2008 compared to 2003. The amount of this field is 0.39% hood has seen an increase of 2719.4 ha area reaching health. Share in the total surveyed area of tree and shrub areas, this rate is 9.06%, while in 2012 and 9.47% in 2008, reached a share 9.87%.

Keywords Watershed, Geoprocessing, ArcGIS Model Builder, ArcHydro, GIS

1. Introduction

The Ergene River, which is the most important water source in the Thrace region, and the land changes of the region will have the opportunity to be examined. The drainage is of the Ergene River: 10,730 km^2, its average yearly flow: 27.27 cm^3/water. The presence of irrigation and use ponds on top of the tributaries that feed the Ergene River reduces flow and decreases natural regeneration. Ergene starts in Tekirdag's Saray district and divides the region in two throughout. It meets with the Meric River, passing through the Cerkezkoy, Corlu, Muratli, Pehlivankoy, and Uzunkopru districts.

In the context of research with this study, the 10 kilometer sections of the river from the right and left banks of the Ergene River and the satellite images from 2003, 2008, and 2012 of a total space of 279,409.00 hectares were comparatively analyzed. Pooling together spatially and by percentage, the status of land use and change in the results of the analysis acquired in this regard, the yearly course of differences was clearly identified.

2. Material and Methods

The Ergene Basin, one of the 26 rain basis in Turkey, is one of the basin areas that formed the Ergene River. The most important tributaries of the Ergene River are the Çorlu Brook, the Sulacak Stream, the Lüleburgaz Stream, the Şeytan Stream, the Teke Stream, the Ana Stream and the Hayrabolu Stream. The total length of the river is 282 km and the total basin area is 12,438 km^2. The average rainfall of the basin is 621 mm and is less than the average rainfall of Turkey (643 mm). The subject of the research, the Ergene River and the place and location of the examination field were given in Figure 1.

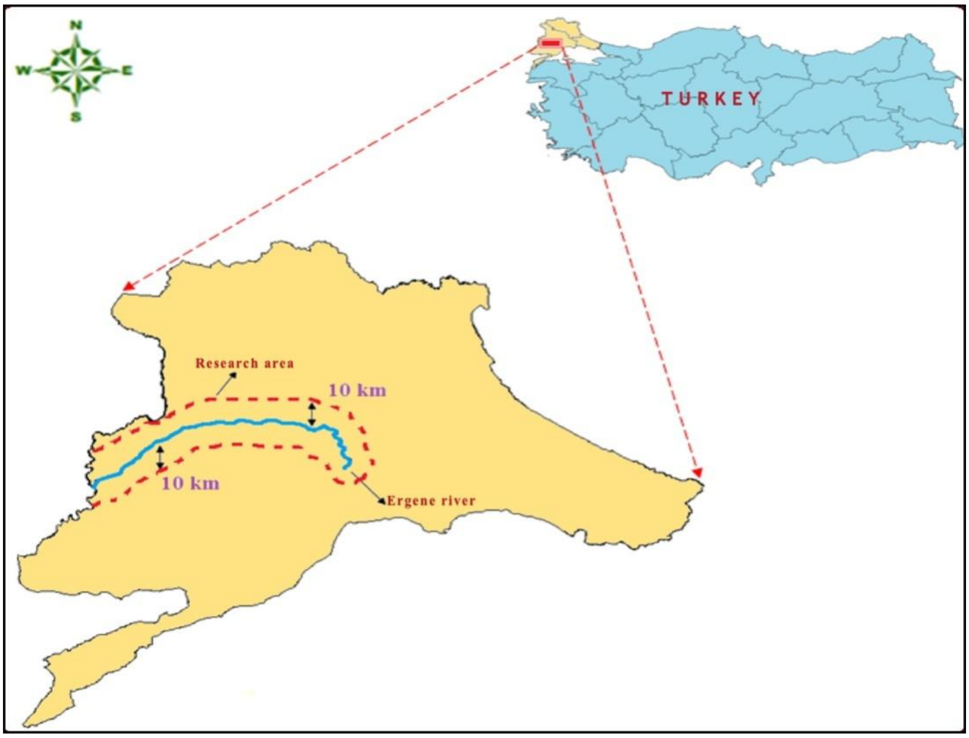

Figure 1: The Research Area

It was seen in research in the agricultural fields and in the region in which production activities were done intensively that fields close to the Ergene River were directly affected by problems originating from pollutants in the river bed. It has been thought that the yearly observation of the differences in the land use and in the changes occurring in the range of products in the agricultural fields adjacent to the Ergene River in the region and the pooling together of these differences has formed a base in other studies.

In the scope of the study, the ASTER satellite images from past dated years 2003 and 2008 were procured as an archive, and the images from the year 2012 were procured in the context of the project by being captured as newly dated images.

DGPS-supported point-taking studies were carried out in the months of May and June in the field of study from the perspective of the status of land uses and the identification of the dispersal of the species and characteristics of plants. Being processed through the RS software, the acquired coordinate points and satellite images were categorized and the land use capabilities of the basin area and the changes in vegetation were identified in the results.

Methodology

Identification of Land Change

Point-taking studies were carried out with DGPS in the months of May and June in the field of study from the perspective of the status of land uses and the identification of the dispersal of the species and characteristics of plants. Being processed with the RS software, the acquired coordinate points and satellite images were categorized and the land use capabilities of the basin area and the changes in vegetation were identified in the results.

The imaging operation was carried out in two stages in the form of image enhancement and image classification in the study. Increasing the discernibility between features in the digital images through the use of various algorithms and bringing it to a more interpretable form is called image enhancement [1]. The image enhancement technique was used in the transformation of the main components for the purpose of the identification of the changes in land use. There are two methods known as supervised and unsupervised classification which are commonly used for classification [2, 3].

Using preliminary information about the land cover, it was identified how many categories were necessary to divide the working area and what these categories were. The dispersal of the vegetation in the basin area was pooled together with the Normalized Difference Vegetation Index (NDVI) classification process. NDVI is one of the plant indices that specifies the amount of green space of vegetation [3, 4, 5, 6].

It also significantly removes the different illumination features and effects of shade originating in terms of sun and perspective [7, 8, 9].

Using the reflection values that the plants generated on the band, the red band (R) and near-infrared (NIR) (0.7-1.5µm) between the values of 0.62µm -7µm were determined to be the values in the results of the NDVI calculations. The red band is insusceptible to the chlorophyll inside the plant tissue, the infrared band is susceptible to the chlorophyll and therefore is the band in which the reflecting values are high [10, 11].

When NDVI is being done, the red band is going to be removed from the infrared band and the value to be found will be divided into the data acquired from the total of the infrared and red bands.

$$NDVI = (NIR - R) / (NIR + R)$$

In the equation, the values NDVI = Normalized Difference Vegetation Index, NIR = Near Infrared band (0.76-0.86 µm), R = Red band (0.63-0.69 µm) are shown.

Location and geo-referencing of spatial data

DGPS was used in the processes of determination and geo-referencing of the spatial data in the study, and points were taken through sample relating to the different land uses in the basin areas from the 10 km strips to the right and left of the Ergene River that is subject to the research in the month of June.

The satellite images used in the study were raw data and were transmitted directly to us by way of the relevant vending firm without the geometric corrections and geo-referencing processed having been implemented. The geographic referencing process of the images was primarily done in this context. The ERDAS Imagine Professional software which has the image processing feature was actively used in the fulfillment of these processes. This process was carried out based on the roads, stream beds, and buildings which were clearly visible in the bilinear and satellite images when geometric corrections were being done on the satellite images.

Geometric correction operations in the satellite image

The raw ASTER satellite images used and procured in this study were primarily subjected to geometric correction procedures without being subjected to supervised classification. This kind of sensitive geometric correction procedures carried out in this study had a direct effect on the accuracy of the study. In this sense, the ground control points identified with DGPS which were procured in the land conditions in the geometric correction process were beneficial. In these processes, the geographic transformation matrix was performed with the correction process [12]. The relevant matrix: Here: x_0 and y_0 are point coordinates after transformation, x and y are point coordinates before transformation, a_0, a_1, a_2 and b_0, b_1, b_2 are indicators of the transformation matrix.

$$X_0 = a_0 + a_1x + a_2y$$

$$Y_0 = b_0 + b_1x + b_2y$$

$$RMS = \sqrt{(x_0 - xorj)^2 + (y_0 - yorj)^2}$$

The transformation error between reference data from after transformation with coordinates of corrected images is identified with the average quadratic error of each control point [13].
The pixel values on the satellite images were subjected to recalculation after carrying out the relevant geometric corrections. The closest neighborhood administration suggested by Campbell [14], 1996 was used in the verification of the geometric correction processes of the images in this stage.

Accuracy analysis of produced data
It is known that the Remote Sensing data contains errors at certain rates for environmental or other reasons. However, as a result of such data analyses, it is important to subject the product to accuracy analysis in terms of holding the share of errors to a minimum level [11, 12]. Accuracy analyses were performed on the products that came to light in the image classification done using supervised classification techniques in the context of the study.
In this process, reference data whose accuracy is known to be definite were given with products obtained by image classification. The results acquired in this study were subjected to comparison in a manner in which reference data and the error matrix formed, carrying out the accuracy analyses of the data [5, 6, 10].

3. Results and Discussion
The 10-kilometer sections of the right and left banks of the Ergene River were subjected to examination in terms of land use in the study. In this context, the total area of examined land was 5,660 km^2, and the course of temporal change in the use of land in these boundaries was identified with the analysis of detailed satellite images.

Digitization of Layers and Reference Points
The polygonization related to some of the levels dependent on the classification in the 10 km band width of the right and left banks of the Ergene River in the context of the research was carried out. For this purpose, while the classification was being done by the polygonization of specified areas like housing areas, water surfaces, and roads and by creating levels on a spatial basis, some reference areas were acquired. In the study, a total of 48 reference data points was obtained from the land studies supported by DGPS (Figure 2).

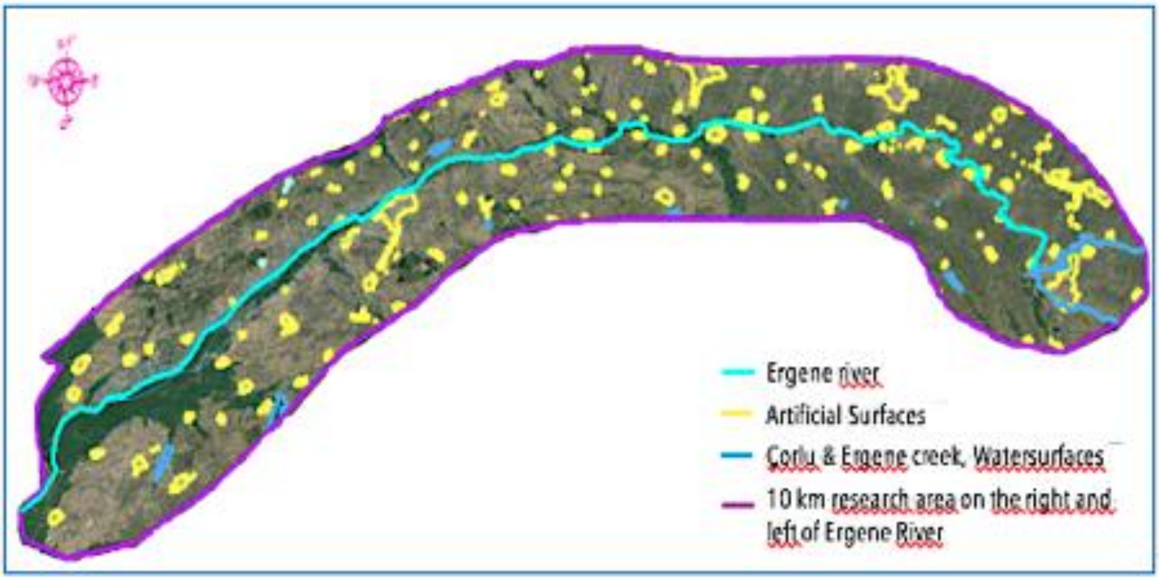

Figure 2: Digitization of layers and reference points.

The Classification of Temporal Changes in the Land Cover
Land use changes in the working area in 2003 and of changes in vegetation were categorized as unsupervised in the shape of 9 levels: water surfaces, housing, vineyard + orchard fields, meadows, rice fields, forestry+shrubbery fields, sunflower and canola fields, roads, and grain fields (Figure 3).

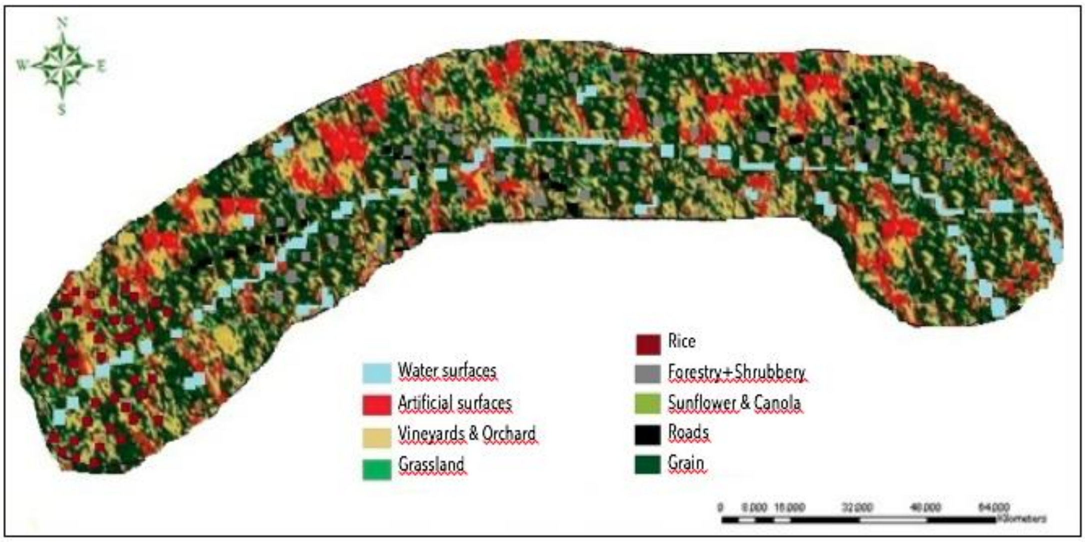

Figure 3: Land use changes in 2003

The results of the unsupervised classification of the accuracy of the distribution rate of the rate of accuracy whose result formed in the classification on the housing, agriculture, and grassland areas were approximately 75%. In the classification, forestry+shrubbery areas like vineyard+ orchard fields were categorized together on the same level as sunflower + canola fields. The output map that formed as a result of the unsupervised classification applied to the 2008 satellite images is provided in Figure 4.

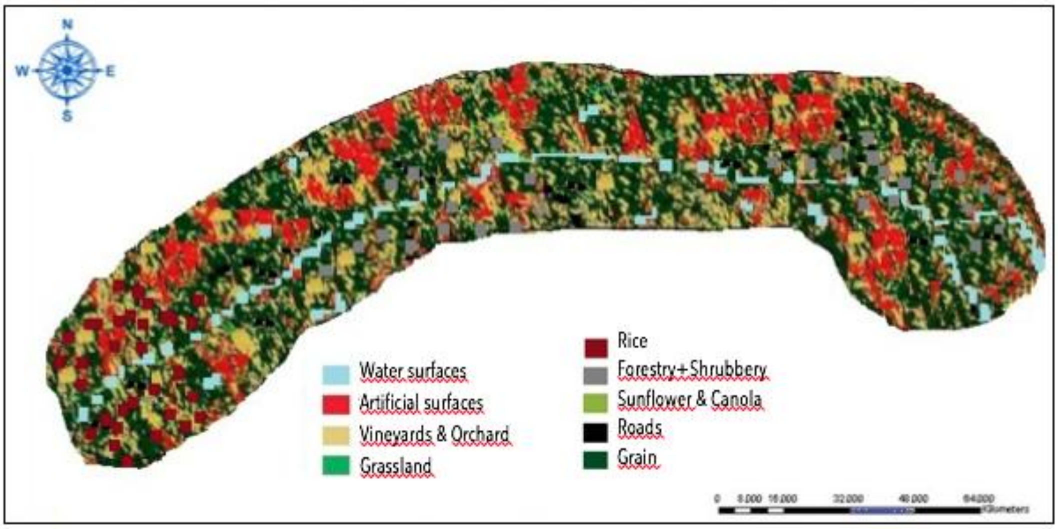

Figure 4: Land use changes in 2008

Again, the 2008 satellite images with which the unsupervised classification technique was used were categorized into 9 levels. Differences showed up in the classification in the rice, sunflower+canola, and grain fields along within the housing areas, and the distribution of the production in these fields was categorized with a different ratio than compared to 2003. The five-year course of change that occasionally intervened compared to 2003 is clearly able to be seen here. When it is taken into consideration that production is being done and the rotation of crops is done according to the initiative of the farmer in agricultural production, the presence of changes in the production fields is normally seen. The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change.

Another attention-grabbing layer of land changes is housing areas. Settlement areas, industrial facilities and agricultural production and storage structures within the artificial areas are considered together with other infrastructural studies. Showing the increasing industrialization and the triggered population spike, a situation showing itself in 2008 compared to 2003 had reached its position. An accuracy in the amount of 74% was obtained in the classification done for 2008.

The 2012 satellite images that were done using the supervised classification technique in the study and that were supported with land control points so that a high level of accuracy could be acquired with the reference data were analyzed and the output map is presented in Figure 5.

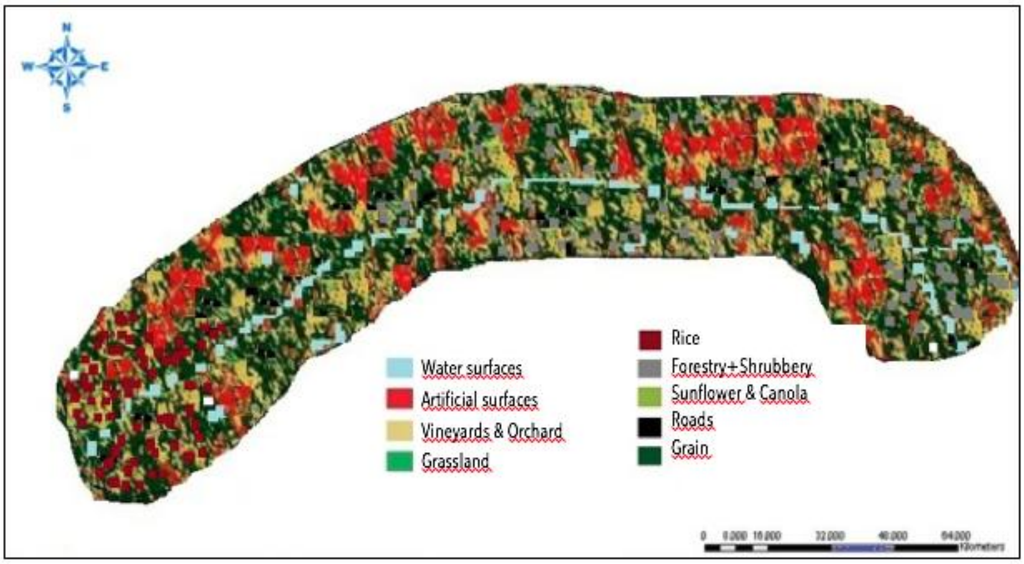

Figure 5: Land use changes in 2012

As a result of the supervised classification, a ratio of 92.6% was acquired as a percentage of the accuracy, and it was seen that this reference data had a big effect on the capturing this accuracy. It was seen that there was no significant increase in the pasture areas relative to the years 2003 and 2008. This is due to the fact that it is subject to a situation in the form of concordantly observing agricultural production and livestock raising of the fields that were opened as pastures.

The observation of the increases especially in the forestry+shrubbery fields in this region compared to other years can be interpreted as the course of the increase in the studies which were done in the frame of the Ergene Action Plan of the Ministry of Forestry and Water Affairs. The course by year of the changes in the vineyard and orchard fields can be interpreted by showing the parallels with the support of bush and incentive given to relevant fields.

Comparison of Temporal Change in Land Use by Year

The share within the hectare and total research area of the amount of spatial change in the use of land in between the years 2003, 2008, and 2012 are identified in the study as a percentage. The differences by year of the spatial changes in the use of the land are presented in Table 2.

Table 2: Amounts of spatial changes due to time of land use

	2003		**2008**		**2012**	
Land Cover	**Area (ha)**	**%**	**Area(ha)**	**%**	**Area (ha)**	**%**
Grain	**99,789.20**	**35.71**	**97,108.30**	**34.76**	**91,300.20**	**32.68**
Canola + Sunflower	**36,789.40**	**13.17**	**38,430.20**	**13.75**	**40,895.40**	**14.64**
Rice	**12,589.63**	**4.51**	**12,229.00**	**4.38**	**13,455.20**	**4.82**
Vineyard + Orchard	**1,689.40**	**0.60**	**1,789.40**	**0.64**	**1,948.30**	**0.70**
Roads	129.50	0.05	139.70	0.05	161.60	0.06
Watersurface	**1,689.40**	**0.60**	**1,481.70**	**0.53**	**1,471.90**	**0.53**
Artificialsurfaces	1,615.60	0.58	1,979.20	0.71	2,719.40	0.97
Grassland	**99,791.60**	**35.72**	**99,792.50**	**35.72**	**99,879.50**	**35.75**
Forestry+Shrubbery	25,325.27	9.06	26,459.00	9.47	27,577.50	9.87
Total	**279,409.00**	**100.00**	**279,409.00**	**100.00**	**279,409.00**	**100.00**

As seen in Table 2, the total area subject to research is 279,409.00 hectares. The examined areas were examined, categorized into 9 classes, and when it was looked at by year, it was seen that while the pasture fields were forming with the 99,791.60 hectare space in the spatial distribution in 2003, the grain areas followed this with a 99,789.2 hectare space. The fields in which canola and sunflower are farmed constituted 13.17% of the total area.

In Table 2, when 2008 is looked at, it is seen that while the pasture fields again had a large ratio as a percentile, grain had a 34.76% percentile and canola+sunflower had a 13.75% percentile within the total area. While in 2012 the grain fields had a 91,300.20 hectare area, it was determined that canola+sunflower agriculture was done over a 40,895.40 hectare area.

When artificial areas are looked at, while there was housing in 2003 on a 1,615.60 hectare area of land, this ratio reached a space of 1,979.20 hectares in 2008 with a 0.06% increase, and it was seen that this area in 2012 reached an area of 2,719.40 hectares with an increase of 0.39% compared to 2003. While the total share of forestry and shrubbery in the surveyed area was 9.06%, this ratio reached 9.47% in 2008 and reached a share of 9.87% in 2012.

Comparative graphs based on the level of the temporal changes in the status of land use in the context of this research are presented in detail in Figure 6.

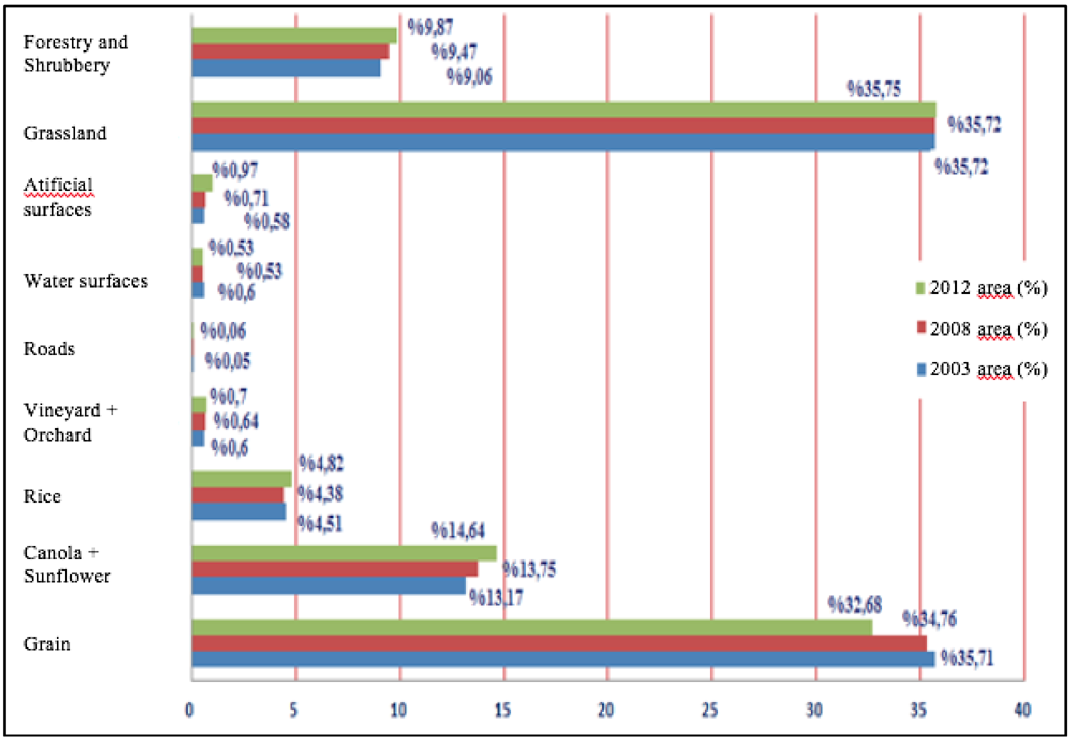

Figure 6: The proportional distribution of temporal changes in land use

As the course of change within years based on proportionality is seen above, it has been presented graphically in Figure 6 and the course of change in the land use has been pooled below. Looking at the changes in the grain fields by year, while the ratio within the total surveyed area in 2003 is 35.71%, this ratio comes down to 32.68% in 2012 with a drop of 3.03%. A drop of 1.47% was observed between 2003 and 2012 in the Canola+Sunflower fields. Although the rice fields are not with the subject to a significant change, while the ratio in 2003 is 4.51%, this ratio comes down to 4.38% in 2008 and rises to 4.82% in 2012. In vineyard+orchardfields, an increase has been shown of 0.1% in 2012 compared to 2003. In water surface areas, a decrease was seen in the percentage of space in 2012 compared to 2003 in congruence with the decrease in water sources as it relates to global climate change.

While a course of the increase in artificial areas showed itself as 0.53% in 2003, this situation rose to 0.71% in 2012 corresponding to increases in industrialization and population. Because generally rather than foraging a free-fledged or bounded form of production was assumed in the stages of production relating to livestock breeding in the region, and taking into consideration that the pasture areas were not within specific limits and were generally not able to continuously change, the course of change in the relevant areas generally retained the same ratios by years. When looking at the forestry and shrubbery areas, the results of this situation in which an increase was observed in 2012 compared to 2003 can be interpreted as being dependent on the situation that the rehabilitation studies that were being carried out in the region triggered.

Accuracy Analyses

Error matrices and accuracy analyses were carried out for the purpose of testing the reliability and accuracy of the classification acquired within the study. In this context, the values of the accuracy and error matrix acquired over the classification data set which was performed as a result of the classification of 2003 have been calculated and given in detail in Table 3.

Table 3: Land classification error matrix and accuracy analysis (2003)

Layer name	1	2	3	4	5	6	7	8	9	Total	User Accuracy
Grain (1)	44	0	12	3	4	0	4	23	0	90	85.00
Canola+ Sunflower (2)	0	30	20	6	20	0	14	0	0	90	78.00
Rice (3)	0	25	0	11	10	10	15	0	19	90	86.00
Vineyard+Orchard (4)	0	28	0	9	14	12	8	0	19	90	79.00
Roads (5)	0	12	18	3	10	28	12	4	3	90	74.00
Watersurface (6)	0	9	19	31	0	14	5	10	2	90	73.00
Artificialsurfaces (7)	0	15	48	12	10	0	1	4	0	90	69.00
Grassland (8)	0	10	40	10	3	0	0	6	21	90	73.00
Forestry+ Shrubbery (9)	0	8	23	0	32	4	4	0	19	90	81.00
Total	44	137	180	85	103	68	63	47	83	810	
Overall Accuracy	100	71.14	76.84	74.59	82.19	75.20	81.13	79.43	73.12		**78.45**
Kappacofficient	0.9141	0.7482	0.5279	0.7641	0.8412	0.6948	0.8315	0.8219	0.6871		**0.7590**

For the 2003 images in the land classification, while the percentage of general accuracy is 78.45%, the kappa coefficient was 0.7590. Accuracy analyses and the error matrix for the year 2008 were calculated and given in Table 4.

Table 4: Land classification error matrix and accuracy analysis (2008)

Layer name	1	2	3	4	5	6	7	8	9	Total	User Accuracy
Grain (1)	41	0	0	3	0	28	0	17	1	90	74.00
Canola+ Sunflower (2)	1	0	14	0	52	0	6	17	0	90	61.00
Rice (3)	5	45	1	0	12	0	14	13	0	90	73.00
Vineyard+Orchard (4)	16	18	3	31	6	0	9	7	0	90	78.00
Roads (5)	0	23	32	0	14	1	16	0	4	90	69.00
Watersurface (6)	6	2	12	19	19	5	19	0	8	90	72.00
Artificialsurfaces (7)	0	0	23	10	21	14	1	21	0	90	79.00
Grassland (8)	0	18	34	2	8	0	5	0	23	90	81.00
Forestry+ Shrubbery (9)	3	9	2	8	0	42	10	6	10	90	71.00
Total	72	115	121	73	132	90	80	81	46	810	
Overall Accuracy	76.12	78.64	69.41	68.43	79.27	74.23	81.13	60.13	73.12		**74.13**
Kappa cofficient	0.8115	0.7327	0.5963	0.7513	0.8079	0.6743	0.8014	0.6941	0.7120		**0.7079**

As it is seen in Table 4, while the general accuracy percentage in the results of the unsupervised classification done over the satellite images for 2008 is 74.13%, the kappa coefficient was identified as 0.7079. The results of the supervised classification done for 2012 and the error matrix table are presented in detail in Table 5.

Using the supervised classification technique, when the distributions of the classification acquired from the 2012 images are looked at, while the general accuracy percentage is found in the band of 92.6%, the kappa coefficient is found to be 0.8998.

Table 5: Land classification error matrix and accuracy analysis (2012)

Layer name	1	2	3	4	5	6	7	8	9	Total	User Accuracy
Grain (1)	39	0	0	3	18	10	0	19	1	90	93.00
Canola+ Sunflower (2)	0	38	9	0	26	0	0	17	0	90	89.00
Rice (3)	1	3	45	1	3	9	15	13	0	90	91.00
Vineyard+Orchard (4)	0	1	43	31	6	0	9	0	0	90	89.00
Roads (5)	0	3	23	4	14	19	16	7	4	90	94.00
Watersurface (6)	0	4	10	19	19	5	19	6	8	90	98.00
Artificialsurfaces (7)	0	0	23	14	5	14	17	14	3	90	88.00
Grassland (8)	0	0	40	0	13	19	5	0	13	90	97.00
Forestry+ Shrubbery (9)	29	8	2	2	13	16	10	6	4	90	94.00
Total	69	57	195	74	117	92	91	82	33	810	
Overall Accuracy	96.83	89.10	84.41	91.19	88.41	83.26	89.42	94.49	98.44		**92.60**
Kappacofficient	0.9819	0.9114	0.8841	0.8913	0.9179	0.9077	0.9114	0.9500	0.8952		**0.8998**

4. Conclusion

The use in recent years of Remote Sensing in this kind of studies provides important contributions particularly to the enabling of the planning of land use and the management of watersheds. When the size of the working area is taken into consideration, it is difficult for changes in this big of an area to be consistently measured. However, the active use of Remote Sensing in this kind of studies is able to prepare the possibility and groundwork for the performance of investments and activities for the necessary points, providing positive contributions in decision-making processes.

To produce an observation of the changes in areas parallel to this river bed which is the lifeblood of Thrace, like the Ergene River, provides the infrastructural support for studies in the region. The increase of water quality in studies carried out in the riverbed by relevant organizations and reclamation studies in the riverbed positively affect the course of change of products in agricultural fields close to the riverbed. Organizations' following of the course of change over specific periods of time, watching with satellite images the river bed and areas near to it with the support of Remote Sensing provides positive contributions to improvement activities being carried out.

In light of all of these classifications especially in the region, significant changes have come into question in agricultural fields with the implementation of the Ergene Action Plan. As a result of the water pollution which has been enabled by the Ergene River, which is rich especially in terms of the heavy metal pollution of the soil, it has been seen in other studies that product designs are being limited and there is a decrease in yield. However, improvements in agricultural product design together with improvement studies being maintained in the region could be observed. Ensuring the more effective use of technologies in these kinds of studies like Remote Sensing, help studies that are being carried out continuously in a positive environment, making it possible to intervene against any negative outcomes that may arise possibly.

Acknowledgments

This research was supported by Namik Kemal University Scientific Research Projects Unit under the project no of NKUBAP.00.24.AR.12.14.

References

[1]. Alparslan, E., Dönertaş, A.S., ve Yüce, H., 2004. "Yalova İli Kıyı Yerleşimindeki Değişimin Uydu Görüntülerinden İzlenmesi". 3. Coğrafi Bilgi Sistemleri Bilişim Günleri Bildiriler Kitabı, 53-62, Fatih Üniversitesi, İstanbul.

[2]. Anonymous, 2003. ErdasField Guide, ERDAS, Inc., Atlanta, Georgia, USA.

[3]. Sener M., 2012. Assessment of Irrigation Management Transfer: A Case Study of Meric-Ergene Basin in Turkey, Journal of Food Agriculture & Environment, vol. 10, pp. 1060-1064.

[4]. Sellers, P.J., 1985. “CanopyReflectance, Photosynthesis and Transpiration”, Int. J. Remote Sensing, 6, 1335-1372. (1985).

[5]. Melesse, A.M. and Jordan, J.M., 2003. “Spatially Distributed Watershed Mapping and Modelling: Thermal Maps and Vegetation Indices to Enhance Land Cover and Surface Microclimate Mapping: Part 1”, Journal of Spatial Hydrology, Vol.3, No.2,

[6]. Wang, Q., and Tenhunen, J.D., 2004. “Vegetation Mapping with Multitemporal NDVI in North Eastern China Transect (NECT)”, International Journal of Applied Earth Observation and Geoinformation, V.6, p.17-31.

[7]. Holben, B.N., and Fraser, R.S., 1984. “Red and Near Infrared Response to Off Nadir Viewing”, International Journal of Remote Sensing, 5, 145-160.

[8]. Schultz, G.A., Engman, E.T., 2000. Remote Sensing in Hydrology and Water Management, Springers. 230, Germany.

[9]. Sotomayor, A. I., 2002. A Spatial Analysis of Different Forest Cover Types Using GIS and Remote Sensing Techniques; A Casestudy in Shivapuri Area, Nepal, Master of Science Thesis, ITC, Netherland, (2002).

[10]. Albut, S., Uysal, T.,Tekirdağ İlinde Bağ Alanlarının Değişiminin Yıllar Bazında İncelenmesi ve Tekirdağ - Şarköy İlçesinde Topoğrafik Açıdan Uygun Yeni Bağ Alanlarının Coğrafi Bilgi Sistemleri (CBS) İle Belirlenmesi. Türkiye Bağcılık ve Teknolojileri Sempozyumu. Manisa, (2009).

[11]. Sener M., 2016. Change Detection in Rice Area Using Remote Sensing Data, International Journal of Current Research, vol. 8, pp. 36675-36679.

[12]. Süslü, A. 2007. Şereflikoçhisar Bölgesindeki Tarım Arazilerinde Uzaktan Algılama Yöntemiyle Ekili Alanların Tespiti ve Rekolte Tahmini. Gebze İleri Teknoloji Enstitüsü Mühendislik ve Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

[13]. Anonymous, 2004. Erdas Field Guide. 6th Edition. ERDAS, Inc., Atlanta, Georgia, USA.

[14]. Campbell, J.B., 1996. Introductionto Remote Sensing, Taylor and Francis, p. 146. London.