Universe Scientific Publishing

ORIGINAL ARTICLE

Examining Temporal Changes in Relations Between Land Uses and Land Use Capabilities in South of Sanliurfa lains

Mehmet Çelik [1], Ali Gülersoy [2]

[1] Kilis 7 Aralik Univercity

[2] Dokuz Eylül University

Abstract: Today, the Earth's land pattern can be examined by the detectors on satellite sensors periodically and the variations on these patterns can be detected in a short while. Monitoring of land cover changes and planning these lands effectively are the important issues for economic and ecological sustainability. In this study, the land cover changes of Suruç, Akcakale, Ceylanpinar and Harran plains have been investigated between 1985 and 2016. Accordingly, we utilized Landsat satellite images for three different dates of their summer recordings. Satellite images were classified by the segmentation process and supervised classification through Maximum Likelihood technique. The land use maps obtained from the analysis consist of four classes: dry farming, irrigated farming, grassland and settlement. In addition, accuracy assessment has been implemented on each classified map in order to assess the degree of robustness of our analysis. According to our results, we obtain 85% of overall accuracy where the Kappa value is about 80%. Our results show that significant changes occurred in the land cover of southern plains of Sanliurfa. These changes occurred in the form of transforming dry farming areas to irrigated farming areas in Akcakale and Ceylanpinar whereas irrigated farming were transforming to dry farming in Suruc, during the period of 1985 to 2016.

Keywords: Land use; land use Capability; temporal change; southern plains of sanliurfa; landsat

1. Introduction

1.1 test

The use of water is an important factor in terms of increasing and securing agricultural production in arid and semi-arid regions (Ahmadi and Sedghamiz, 2007: 277). In spite of having large and fertile agricultural lands, the Southeastern Anatolia Region of Turkey has faced various problems related to irrigation for years. The Southeastern Anatolia Project (GAP) has aimed to eliminate the irrigation problem in fertile agricultural lands. The provinces included in the GAP have a semi-arid climate, which leads to excessive water insufficiencies for agricultural purposes. Hence, large dams have been built within the scope of GAP to meet the irrigation needs of the region. Started in 1983, the Ataturk Dam was built within the scope of GAP. The reservoir behind the dam, called Lake Ataturk Dam, is the third largest lake in Turkey with a volume of 48.7 km^3 and an area of 817 km^2 (Gürbüz *et al*., 2013: 854-855).

One of the biggest investments in the history of Turkish Republic, the primary objective of GAP is to increase agricultural yield through irrigation and enable agriculture-based industrial production (Göçer, 2004). Other objectives of GAP include ensuring regional development, eliminating differences between regions, improving economic and social conditions in the region, and improving the well-being and life standard of the region's population (Yıldız, 2008).

Copyright © 2018 Mehmet Çelik *et al*.
doi: 10.18686/ag.v2i1.1114
This is an open-access article distributed under the terms of the Creative Commons Attribution Unported License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Southern Plains of Sanliurfa are the largest agricultural lands and have the best irrigation system within the scope of GAP. Extending over an area of 427,000 ha, the study area has one of the densest irrigation systems in Turkey.

Remote sensing provides significant conveniences and advantages in terms of monitoring and recording changes in land cover, water resources, and agricultural product patterns over large areas. This study examines the change in land cover in Suruc, Harran, Akcakale, and Ceylanpinar plains between 1985-2016 using advantages offered by remote sensing. In this context, the study seeks to answer the question, "How did the land cover change in southern plains of Sanliurfa?"

Suruc, Harran, Akcakale, and Ceylanpinar plains are southern region of Turkey. In border of Syria. Study area is south of Sanliurfa City. Study area is west of the Mardin Province. North and Northwest of study area mountainous (**Figure 1**).

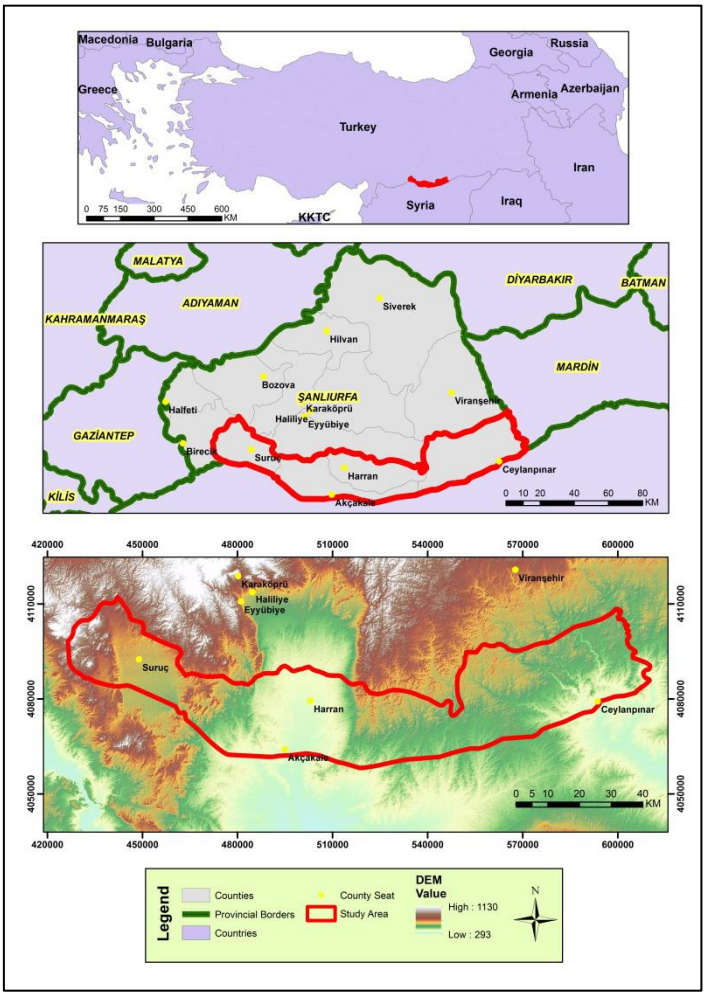


Figure 1. Location map of the study area.

2. Data and method

Landsat satellite images, which provide constant retrospective data, were used in our study to determine temporal and spatial change. Landsat satellite data is commonly used in many fields related to soil, agriculture, landscape, and earth sciences (Barsi *et al*., 2003; Çelik, 2012; Gülersoy, 2013; Çelik and Gülersoy, 2013a). 8 satellite images for 1985, 2001, and 2016 were obtained from USGS (United States Geological Survey) (Table 1).

	Date	Satellite Sensor	Location in The Study Area
1985	01.08.1985	L1-5 MSS	West
	10.08.1985	L1-5 MSS	East
	10.08.1985	L1-5 MSS	South
2001	28.07.2001	L4-5 TM	West
	29.07.2001	L7 ETM+	Northeast
	29.07.2001	L7 ETM+	Southeast
2016	22.08.2016	L8 OLI/TIRS	West
	31.08.2016	L8 OLI/TIRS	East

Table 1. Properties of satellite images.

Since the study area consists of four districts extending east to west, multiple satellite images were combined for a single year (**Figure 2**). Satellite images with closer dates were preferred to ensure objectivity and consistency.

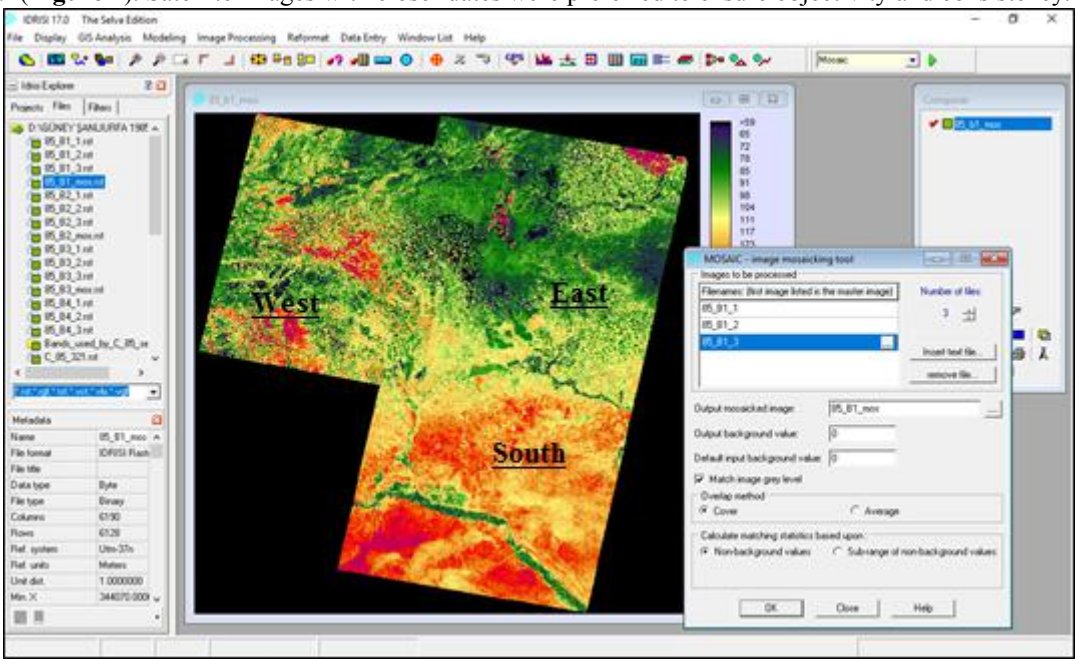


Figure 2. Combining satellite image bands.

Preparation, classification, and accuracy analysis of the satellite images were performed using the IDRISI Selva 16.0 software. First of all, each band of the satellite images was converted from 'tif' format to 'rst' format for compatibility with remote sensing softwares. Then, all bands of multiple satellite images for the same year were combined together and cut from the study area. A composite process was carried out by using bands with the same wavelength. Thus, RGB values were 3,2,1 for 1985; 4,3,2 for 2001; and 5,4,3 for 2016.

Segmentation module, controlled classification, and accuracy analysis methods were essentially used in the study. The segmentation process, which involves grouping pixels with spectral similarities together (Eastman, 2012: 202), was applied to each satellite image. Sample areas were determined according to 4 land cover classes (settlement, irrigated farming, dry farming, and grassland). Training data sets were defined as 386 for 1985, 397 for 2001, and 293 for 2016 (**Figure 3**).

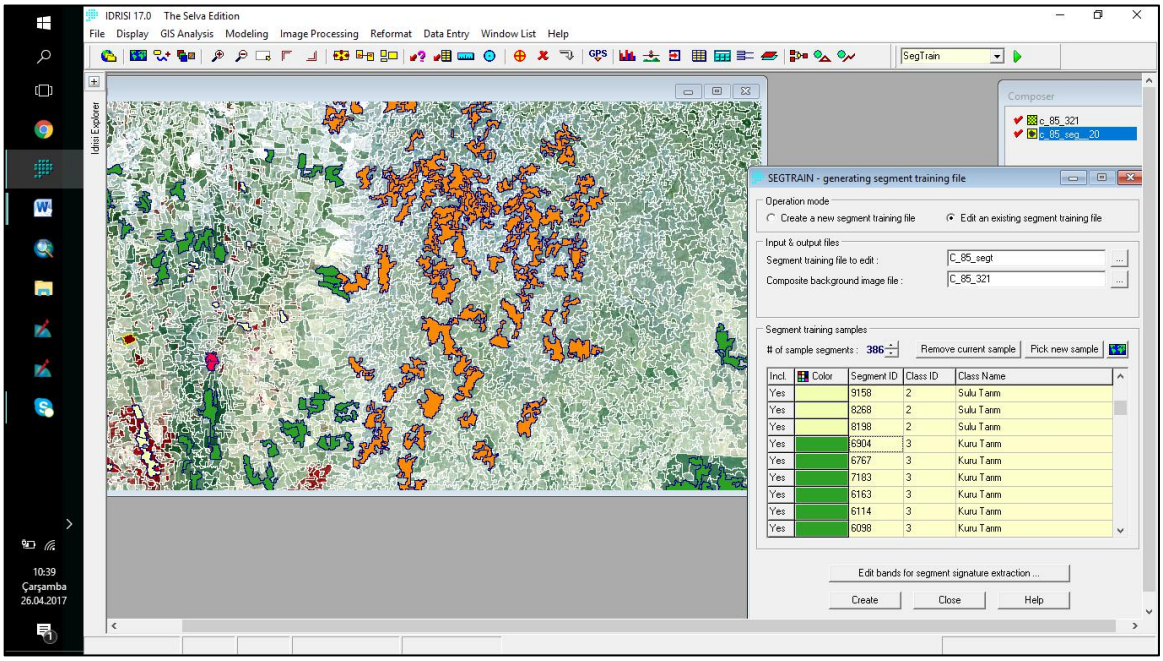


Figure 3. Segmentation process and defining training data sets.

The controlled classification process, which involves classification of unknown similar pixels using known similar areas (Campbell and Wynne, 2011: 349), was applied to satellite images for classification based on the Maximum Likelihood technique.

	Settlement	Irrigated Farming	Dry Farming	Grassland	No Information	Total	User Error (%)
Settlement	**2**	0	2	0	0	4	0.50
Irrigated Farming	0	**3**	0	0	0	3	0.00
Dry Farming	0	1	**51**	3	0	55	0.07
Grassland	0	0	5	**31**	0	36	0.13
No Information	0	0	0	0	**2**	2	0.00
Total	2	4	58	34	2	**100**	
Producer Error (%)	0.00	0.25	0.12	0.08	0.00		**0.11**
1985 Error Matrix, Overall Accuracy 89%, Kappa 80%							

Table 2. Results of the accuracy analysis for 2011 land use map.

The accuracy analysis was performed to determine the proximity of classified maps to reality. To this end, the Stratified Random Point method, which is based on spatial distribution of the rectangular area according to its systematic distinction, was used. Accordingly, 100 sample points were distributed randomly on the land cover map.

	Settlement	Irrigated Farming	Dry Farming	Grassland	No Information	Total	User Error (%)
Settlement	1	0	0	0	0	1	0.00
Irrigated Farming	0	18	0	0	0	18	0.00
Dry Farming	0	1	33	6	0	40	0.17
Grassland	0	0	3	38	0	41	0.07
No Information	0	0	0	0	0	0	0.00
Total	1	19	36	44	0	100	
Producer Error (%)	0.00	0.05	0.08	0.13	0.00		0.10
2001 Error Matrix, Overall Accuracy 90%, Kappa 84%							

Table 3. Results of the accuracy analysis for 2011 land use map

Error matrices were produced by defining actual class values corresponding to each sample point. Thus, the overall accuracy was found to be 89% for 1985, 90% for 2001, and 92% for 2016. Also, the Kappa value was 80%, 84%, and 88%, respectively which indicates the classification was close to reality (Table 2, 3 and 4)

.	Settlement	Irrigated Farming	Dry Farming	Grassland	No Information	Total	User Error (%)
Settlement	5	2	1	1	0	9	0.44
Irrigated Farming	0	25	0	0	0	25	0.00
Dry Farming	0	0	29	3	0	32	0.09
Grassland	0	0	1	33	0	34	0.02
No Information	0	0	0	0	0	0	0.00
Total	5	27	31	37	0	100	
Producer Error (%)	0.00	0.07	0.06	0.10	0.00		0.08
2016 Error Matrix, Overall Accuracy 92%, Kappa 88%							

Table 4. Results of the accuracy analysis for 2016 land use map.

3. Findings

About 90% of the Southern Plains of Sanliurfa consisting of Suruc, Harran, Akcakale, and Ceylanpinar Plains are flat terrains suitable for agriculture. Considering the land use capability classification maps of the Southern Plains of Sanliurfa, it seems that the majority of the area is valuable in terms of agriculture. More than the half of the study area is covered by class I agricultural lands. Irrigated farming is possible in these areas thanks to channels from the Ataturk Dam. Lands in land use capability class II and III are usually dry farming lands where grain farming is carried out. Lands in land use capability class IV, VI, and VII are areas where agricultural activity is limited.

Class I lands cover a large portion of the study area with 70%. Almost all of these lands are used for farming activities, whereas a small portion is used for settlement. Lands in land capability class I are mostly used for irrigated farming. The second largest land use capability class in the study area is class III. These lands are mostly used for dry farming. Most of the lands in class VI and VII are grasslands (**Figure 4** and Table 5).

Land Capability	%	ha
I	69,58	297107
II	3,21	13707
III	10,92	46628
IV	3,4	14518
VI	4,01	17123
VII	8,88	37918
Total	100	427000

Table 5. The ratio of land use capability classes in the survey area.

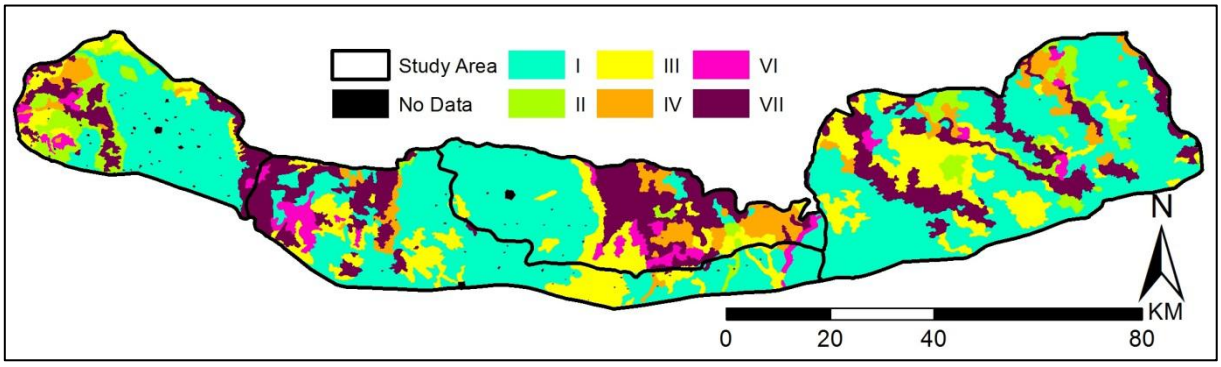


Figure 4. Land use capability map of the study area.

July and August are the months when irrigation activity is its highest level in the Southern Plains of Sanliurfa (Bereketoğlu and Bahçeci, 2005; Bahçeci and Bal, 2008). Satellite images of July and August were especially preferred since irrigation in The Harran Plain is performed in July and August, the driest months of the year. Plants with high biomass activity indicate irrigated farmlands in July and August. Considering the climate-plant product relationship in the study area, the vegetation must be almost non-existent or only plants with low photosynthesis needs must be seen in August, the driest period of the year (Çelik and Gülersoy, 2013b). However, satellite images show that almost the entire plain is covered with plants with high biomass activity in this dry period. These are irrigated farming products, cotton and corn in particular.

The spatial analysis of the Southern Plains of Sanliurfa show significant difference in terms of land use classes. The land use in the area included dry farming and grassland in 1985, which was maintained in 2001 as well. However, irrigated farming lands increased and overtook the above mentioned land uses by 2016. GAP has shaped the region's economy and spatial distribution, and played an important role in this change. Also, it is possible to say that settlement and irrigated farming areas usually expanded, while areas used for dry farming and as grassland decreased (**Figure 5**).

Rapid changes are observed in plant product patterns of Harran and Akcakale with improved irrigation facilities in connection with the construction of the dam in 1995. According to Landsat data, whilst irrigated farming was performed in the Suruc Plain, dry farming activities were more common in Harran, Akcakale, and Ceylanpinar. 2001 and 2006 Landsat data show that irrigated farming areas in Suruc turned into dry farming areas. On the other hand, dry farming was replaced by irrigated farming in Ceylanpinar, Harran, and Akcakale (**Figure 5**).

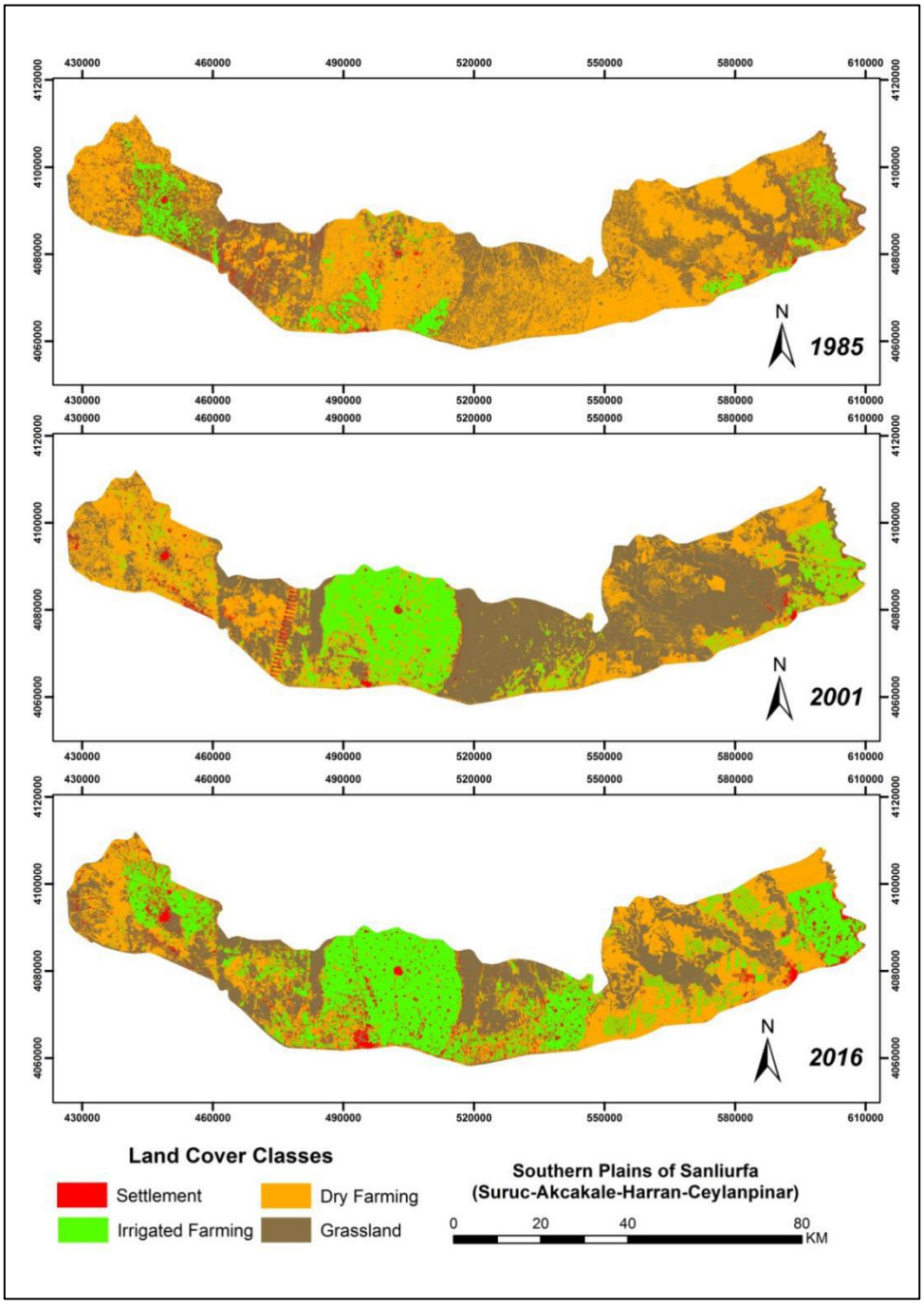


Figure 5. Land cover/use map of the southern plains of sanliurfa.

A considerable increase is observed in the grassland class in 2001. This change can be said to be a result of dry farming lands turning into irrigated farming lands with the introduction of irrigation in 1995, and some abandoned lands turning into grassland.

Considering approximately the last 30 years, whilst dry farming lands occupied the largest area with 57% in 1985, irrigated farming lands dominated the region by 2016 and today, about 34% of the region is occupied by irrigated farming lands (Table 5). In other words, about 131,000 ha dry farming land, 51,200 ha grassland, and 2,000 ha settlement area turned into irrigated farming land. Thus, about 71% of the total 1842,000 ha that turned into irrigated farming came from dry farming land, 27% came from grassland, and 1% came from settlement areas. Examining this change spatially, the density of irrigated farming lands is noteworthy in the northern part of Suruc, located in the far western point of the region, most of which derived from dry farming class. The most drastic change is observed in the Harran Plain and vicinity, the middle section of the region, where the entire change involves dry farming

lands turning into irrigated farming lands. The change in the Ceylanpinar Plain, the eastern part of the region, has a scattered spatial distribution and involves expansion of irrigated farming lands through transformation of dry farming lands (Figure 6).

Years	Settlement	2	Irrigated farming	2	Dry farming	2	Grassland	2	Total
1985	16934	4	35049	8	242777	57	132827	31	427587
2001	9100	2	78551	18	145748	34	194188	46	427587
2016	31925	7	144116	34	144071	34	107475	25	427587

Table 5. Land cover/use in the southern plains of sanliurfa between 1985-2016 (ha).

The application of sustainable agricultural plans with the advancing technology led to changes in the way agricultural activities are performed. Dry farming products, which used to represent the agricultural character of the Southeastern Anatolia Region in 1980s, are replaced by irrigated farming products today, thanks to improvements introduced by the Southeastern Anatolia Project. The region has become one of the prominent cotton and corn producers of Turkey. Improved irrigation systems, awareness raising efforts for farmers in the region through education and training, and support provided to the region via investments have played significant roles in this change.

The increase in irrigated farming lands in the region is believed to continue in future and it is projected that this change will be in the form of transforming dry farming lands and grasslands into irrigated farming lands. This goes to show that planned and correct use of space leads to improvements in terms of temporal change.

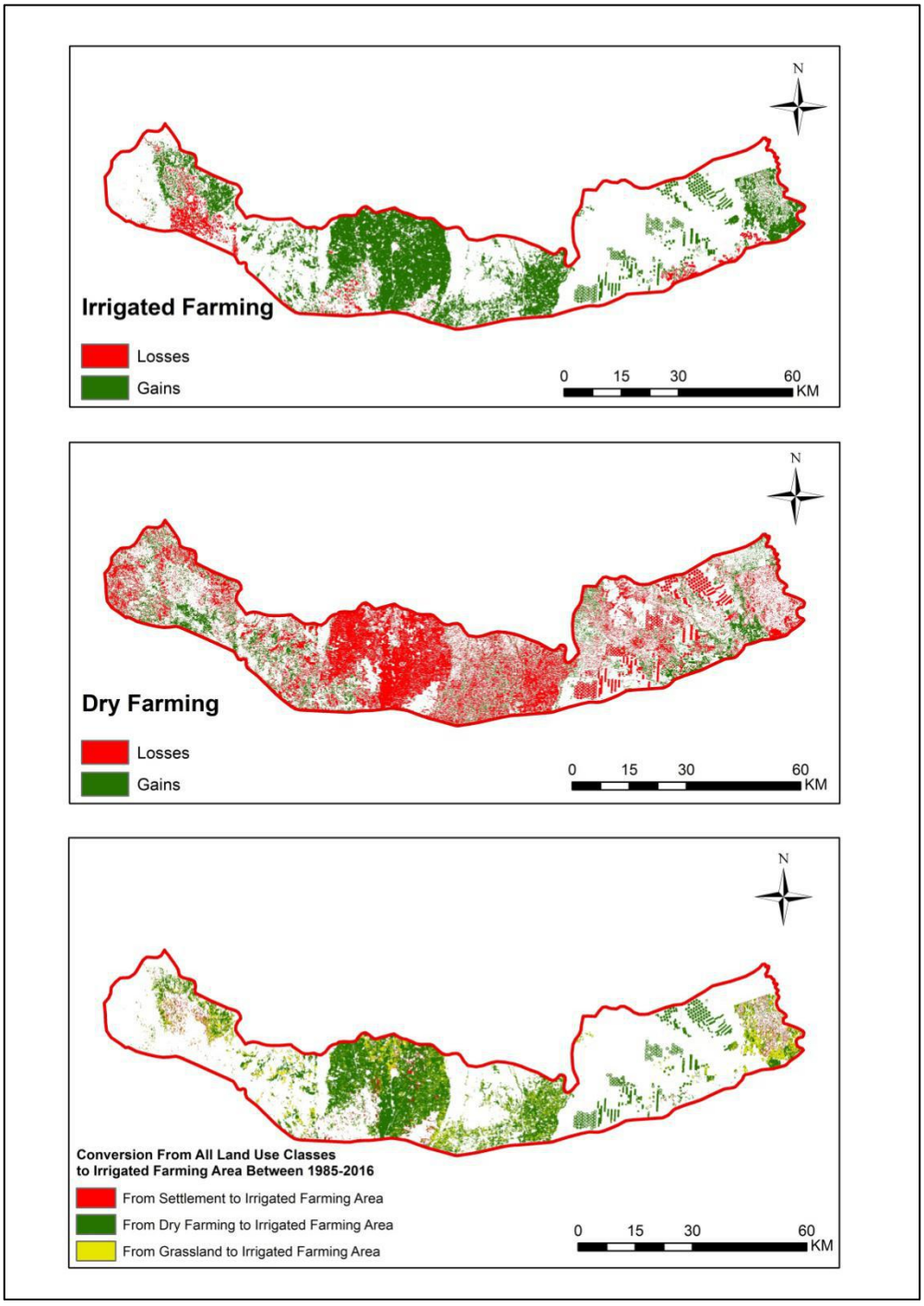


Figure 6. Transformation of land cover into irrigated farming lands between 1985-2016.

Considering the findings in general, it is safe to say that the ratio of irrigated farming lands is quite high in Suruc, Akcakale, and Ceylanpinar. The ground water level (GWL) is quite high in Akcakale. High groundwater level leads to salinization issues, which reduces agricultural yield. In Suruc, groundwater was used for irrigation intensively without a proper plan until 2000s. The extreme decrease in groundwater level led the locals to perform dry farming after 2000s. The groundwater level is rapidly decreasing in Ceylanpinar. The locals in Ceylanpinar continue irrigated farming activities intensively due to high economic return. Even products that do not need much water such as wheat, barley, and red lentil are irrigated for higher yield. This will dry groundwater level in a very near future. A similar event in Suruc led to a transition from irrigated farming to dry farming in terms of agricultural products. It is highly likely that the Ceylanpinar Plain will experience a situation similar to that of Suruc. There are two ways to stop the dramatic

decrease in groundwater level in Ceylanpinar. The first is to introduce water to the plain via channels. The second is the government's encouraging farmings to dry farming through effective agricultural policies. Otherwise, the locals will take up dry farming as in the case in Suruc.

4. Conclusion

This study examined the temporal change in relationships between land use and land use capability classes in the Southern Plains of Sanliurfa. About 70% of the lands in the study area are very fertile lands. Agricultural activities are performed on almost all of these lands. A great increase has been observed in irrigated farming lands as a result of irrigation via channels from the Ataturk Dam in particular. The results obtained from satellite data show that there has been a significant increase in irrigated farming lands especially after 2000s. Irrigated farming activities are carried out in two ways. The first is irrigation via channels from the Ataturk Dam. The second is the use of groundwater. While irrigation needs are met using groundwater in Ceylanpinar, Harran and Akcakale use channels from the Ataturk Dam. The groundwater level in Ceylanpinar dropped to -125 m due to irrigation activities. This is not ecologically or economically sustainable. Similarly, Suruc suffered from lack of awareness regarding groundwater use and irrigated farming could not be performed in Suruc for years. Irrigated farming became widespread in Ceylanpinar in 1995 and the following period. Agricultural products with high return such as cotton and corn stood out. Farmers began using more groundwater with increasing plantation areas and groundwater level dropped as a result. As in Suruc, there is an increase in the number of drill holes due to decreased groundwater level. Dry farming must be encouraged and irrigation facilities from dams must be provided in Ceylanpinar to prevent further decrease in groundwater. Otherwise, Ceylanpinar will inevitably suffer the same fate as Suruc.

Products with higher return have been preferred in the study area with increasing irrigation opportunities. The study area is among the most prominent cotton producers of Turkey. Irrigation, sunlight, and increased farmer awareness are necessary to increase agricultural yield in these fertile lands. The study area receives sufficient sunlight. It is also irrigated via channels from the Ataturk Dam and groundwater in the area. Relevant bodies and experts must raise awareness in the region through education and training in order to increase yield and prevent desertification. In this context, farmers in this region with arid to semi-arid ecosystem must be informed and "land use plans" prepared with an interdisciplinary approach must be implemented as soon as possible to prevent soil erosion and salinization.

References

1. Ahmadi, AH, Sedghamiz, A. (2007). Geostatistical Analysis of Spatial and Temporal Variations of Groundwater Level. Environmental Monitoring and Assessment 129(1): 277-294.
2. Barsi, JA, Schott, JR, Palluconi, FD, *et al*.(2003). Landsat TM and ETM+ thermal band calibration. Canadian Journal Remote Sensing 29: 141–153.
3. Campbell, JB & Wynne, R H (2011). Introduction to Remote Sensing. New York: Guilford Press.
4. Çelik, M A (2012). İslâhiye İlçesi Arazi Kullanımı Üzerinde Yükselti, Eğim ve Toprak Faktörlerinin Etkisi. Kilis 7 Aralık Üniversitesi Sosyal Bilimler Enstitüsü Dergisi. Sayı: 4 (2): 173-186
5. Çelik,MA, Gülersoy,AE (2013a). Kilis Merkez İlçede Marnlı Çıplak Yüzeylerin Zamansal Değişiminin Uzaktan Algılama ile Analizi (1984-2010) ve Bu Yüzeylerin Rehabilitasyonu İçin Öneriler. Marmara Coğrafya Dergisi 28. ss: 487-500.
6. Çelik, M. A., Gülersoy, A. E. (2013b). Güneydoğu Anadolu Projesi'nin (GAP) Harran Ovası Tarımsal Yapısında Meydana Getirdiği Değişimlerin Uzaktan Algılama ile İncelenmesi. Uluslararası Sosyal Araştırmalar Dergisi 28 (6) ss: 46-54.
7. Eastman, JR (2012). IDRISI Selva Manual. Clark University. Worcester. Massachusetts. USA.
8. Göçer, K(2004). İllerin Sosyo-Ekonomik Gelişme Endekslerine Göre Sıralanması ve Belirleyici Faktörler. Kentsel Ekonomik Araştırmalar Sempozyumu bildiriler kitabı içinde (ss: 176-188). Denizli: Pamukkale Üniversitesi.
9. Gülersoy, AE (2013). Marmara Gölü Yakın Çevresindeki Arazi Kullanım Faaliyetlerinin Zamansal Değişimi (1975-2011) ve Göl Ekosistemine Etkileri. Türk Coğrafya Dergisi.
10. Gürbüz, M, Çelik, M A, Gülersoy, A E (2013). Atatürk Baraj Gölü'nün Bozova İlçesi Tarımsal Ürün Deseni Üzerine Etkisinin İncelenmesi (1984-2011), Gaziantep University Journal of Social Sciences 12(4). ss: 853-866.
11. Yıldız, Ö (2008). GAP İllerinde Sosyal ve Ekonomik Dönüşüm. Ege Akademik Bakış 8 (1)., ss: 287- 300.