AGRARIAN AND WETLAND AREAS UNDER METROPOLITAN THREATS: LEARNING FROM THE CASE OF INCIRALTI, IZMIR (TURKEY)

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Abstract. The aim of the study is to determine the Land use/land cover (LULC) changes and conversions in Inciralti İzmir (Turkey), and the fragmentation of these land uses between 1996 and 2018. Aerial photographs and Quickbird satellite imagery were used to obtain data. Aerial photographs were georectified using 1: 25,000 scaled topographic maps. The feature (vector) boundary of the study area was used to subset aerial photographs and Quickbird satellite image. LULC classes were defined according to Coordination of Information on the Environment (CORINE) LULC classes. The defined LULCs were digitized. Between 1996 and 2018, the highest conversion rate among agricultural areas occurred in permanently irrigated land with 41.43%, and the highest conversion among wetlands were in inland marshes with 65.19%. Between 1996 and 2018, the LULC with the highest increase in the number of patches was coastal lagoons with 300%. Research data shows that there has been a great change, conversion and fragmentation process in construction sites, wetlands and agricultural areas in Inciralti between 1996 and 2018. Change, conversion, and fragmentation of LULCs have damaged the natural and cultural structure of Inciralti. In order to stop this damage, filling of wetlands and the construction on agricultural areas in Inciralti should be prevented.
Keywords: *agricultural and wetland loss, Cakalburnu Lagoon, CORINE, LULC (land use/land cover) change, landscape fragmentation*

Introduction

Human activities all over the world have been the dominant factor shaping most of the agricultural landscapes (Goudie and Viles, 1997) and wetlands (Moulton and Jacob, 2000). The most important reasons for the loss of agricultural areas and wetlands are population growth (Turner II, 1989; Hobbs et al., 1991) and rapid and unplanned urbanization (Lopez et al., 2001).

Urbanization directly affects fertile agricultural areas by transforming them into residential, commercial areas (Sanders, 2006), and it affects wetlands by transforming them into agricultural (Zhang et al., 2010), industrial and recreational areas and through filling works (Maynard and Wilcox, 1997). This conversion is called as Land use/land cover (LULC) change. One of the most important effects of rapid urbanization is fragmentation, which has a profound impact on urban ecosystems (Fan and Myint, 2014).

Land monitoring enables better using of land. It provides valuable information about the environment (Balado et al., 2018). Analyzing the change characteristics of LULC, revealing the evolution of different time scales are helpful to reveal the process under the influence of human society (Li et al., 2019). There are many ways to monitor or detect LULC change over time (Fonji and Taff, 2014). One of them is LULC mapping. Mapping LULC of large cities is a main component of detecting rapid changes (Rujoiu-Mare and Mihai, 2016; Nuthammachot and Stratoulias, 2019).

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Coordination of Information on the Environment (CORINE) is widely used in LULC mapping. CORINE is the longest available land cover and land cover change database with a consistent class labeling system (Cole et al., 2018). CORINE data sets are useful for describing long term structural changes of ecological complexes (Petrişor et al., 2014). CORINE database is a key for integrated environmental assessment (Dzieszko, 2014).

Urbanization, which has been encouraged by remarkable economic development, has progressed increasingly rapidly in Turkey in the last fifty years. In the industrialization and urbanization processes, it is clearly documented that large agricultural areas have been lost due to non-agricultural uses (Esbah, 2004). Metropolitan areas now cover an important part of Turkey's agriculture. Wetlands are among the most threatened ecosystems of Turkey.

Several studies using Remote Sensing (RS) and Geographical Information Systems (GIS) techniques in Turkey have been conducted to examine the intense pressure of the urbanization on agricultural lands and wetlands and to determine LULC changes.

In a study conducted in Antakya, the Amik plain, one of the most fertile plains of Turkey, was determined to be under the intense pressure of the expansion of urban and industrial areas (Kilic et al., 2005).

LULC changes in the coastal region of the Çandarlı Bay between 1990 and 2005 were examined in terms of the conversion of agricultural areas, olive groves and coastal wetlands into urban areas (Kesgin and Nurlu, 2009).

In the study on the LULC changes in the urban settlement of Kuşadası district between the years 1993 and 2006, it was determined that agricultural areas decreased and were converted into industrial, commercial and residential areas (Kara et al., 2013).

The study area is Inciralti located in the metropolitan area of Izmir, the third largest city of Turkey. The reason for choosing Inciralti as the study area is that it is home to two important ecosystems such as fertile agricultural land and wetlands at the same time in the center of the metropolitan area of Izmir.

The aim of a study is to monitor the changes/conversions and fragmentations in agricultural areas and wetlands in Inciralti in the period of 22 years between 1996 and 2018 by using aerial photographs, satellite image, RS and GIS techniques.

Materials and methods

Study area

Inciralti, which is the study area, is located on the west coast of Turkey, in the Aegean region, in the south of the Izmir bay, and in the metropolitan area of Izmir, the third largest city, within the boundaries of Balcova district (*Fig. 1*). Coordinates of Inciralti are 38°24'42.28"N 27°1'58.47"E and 38°23'55.76"N 27°3'46.64"E. Its surface area is 378.04 ha. Within the boundaries of the study area, there are the Balcova plain and Cakalburnu lagoon, which are among the most fertile agricultural areas and wetlands of the city (*Fig. 2*).

Inciralti is the only area that has been able to maintain its agricultural character despite the intensive urbanization in the metropolitan area of Izmir. In the Balcova plain, there is a very intensive production in greenhouses, open fields, flower, vegetable, citrus gardens and various orchards.

Cakalburnu lagoon, which is one of the most important natural areas of Izmir, is a wetland area integrated with the city, unlike other wetlands. Cakalburnu lagoon is one

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of the important wetlands in Izmir with 103 bird species (Sevil, 2010). The world-wide endangered *Pelecanus crispus* (Dalmatian Pelican) and *Hoplopterus spinosus* (Spur-winged Lapwing) that breeds only in Greece also breed only in Cakalburnu lagoon in Turkey. Cakalburnu lagoon is one of the areas where *Tapes decussatus* (Grooved carpet Shell), a mussel species of economic value, is commercially collected in Turkey (Serdar et al., 2010). The predominant vegetation of Cakalburnu lagoon is composed of *Salicornia europaea* L. (Common glasswort).

In addition to its agricultural potential and ecological value, Inciralti is the only green area in Izmir as the “last coast with accessible recreational potential for all.

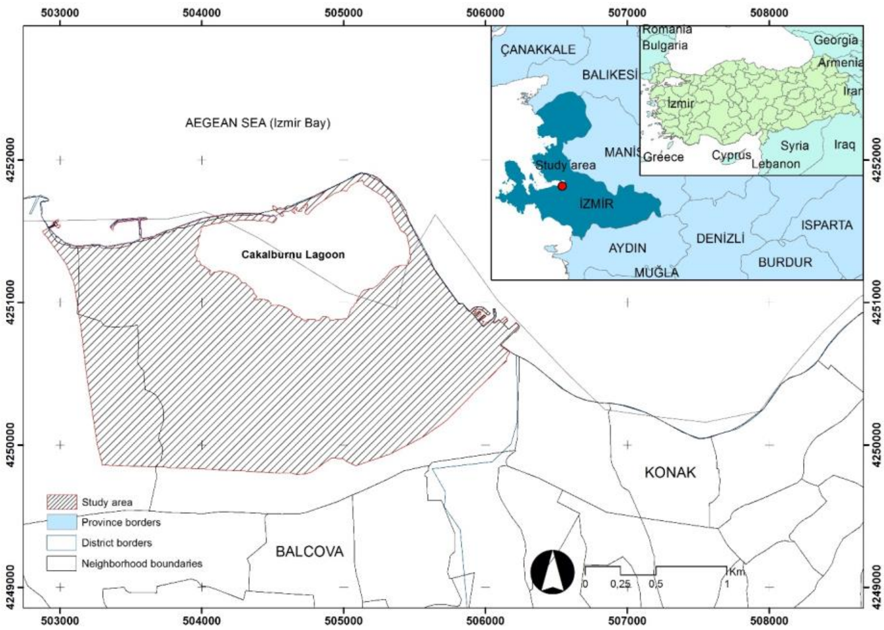

Figure 1. *Location of the study area*

Figure 2. *Inciralti with fertile agricultural areas and wetland lies on the north of Balcova urban area*

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Data collection

The main material of the study consists of aerial photographs and satellite image. Aerial photographs and QuickBird satellite image were used to obtain LULC data for the previous years in the study area. The aerial photographs are monochrome monoscopic/stereoscopic with a 1/35.000 scale belonging to the year 1996. High-resolution QuicBird satellite image has a spatial resolution of 0.6-m dated June 25, 2018. ERDAS IMAGINE® 9.2 and Esri® ArcMap 9.3 software were used to process digital data. RS and GIS techniques were used to detect the LULC changes and conversions.

Image pre-processing

The geometric rectification of the aerial photographs was made according to the topographic map with a 1:25,000 scale. Satellite image and digitized aerial photographs were georectified in the Universal Transverse Mercator (UTM) (Zone 35) coordinate system using first-order polynomial transformation and subsetted according to the feature (vector) boundary of the study area.

Interpretation of aerial photographs and satellite image

Visual interpretation and on-screen digitizing method were used to detect the LULC changes and conversions between 1996 and 2018. Aerial photographs and satellite image were visually interpreted on the screen using direct (tone, texture, shape, and pattern) and indirect (location and relationship) identification elements.

Image classification

LULC changes and conversions were detected by using remotely sensed data. The bi-temporal change detection technique (Royer and Charbonneau, 1988) was used to determine LULC changes and conversions from 1996 to 2018. CORINE Land Cover nomenclature was used in change detection.

The cross-tabulation method was used to determine LULC changes. In this way, a change matrix was produced (Wang et al., 2006).

In the study area, 16 CORINE LULC classes were determined at Level 3 (*Table 1*).

Data processing

A comparison between 1996 and 2018 of the field data were generated. Then, the quantitative data of changes, increases, and losses in the LULC of each category were compiled. Thus, the expansion of urban sprawl on agricultural areas and wetlands was determined.

The digitization process not only provided an analysis of the changes in the total area of LULCs but also produced quantitative information on the rate of fragmentation of the parcels and changes in the average parcel size.

Results

Between 1996 and 2018, there were serious changes in LULC in Inciralti (*Figs. 3* and *4; Table 2*). In 1996, coastal lagoons, covering the 19.04% of the area, constituted the largest LULC of Inciralti. In 2018, coastal lagoons became the third largest LULC with a ratio of 13.32%.

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***Table 1.** CORINE LULC classes used in the study*

No.	CORINE classes	LULC	Description
1	112	Discontinuous urban fabric	Urban fabric
2	121	Industrial or commercial units	Industrial, commercial and transport units
3	122	Road and rail networks and associated land	
4	123	Port areas	
5	132	Dump sites	Mine, dump and construction sites
6	133	Construction sites	
7	141	Green urban areas	Artificial, non-agricultural vegetated areas
8	142	Sport and leisure facilities	
9	211	Non-irrigated arable land	Arable land
10	212	Permanently irrigated land	
11	222	Fruit trees and berry plantations	Permanent crops
12	323	Sclerophyllous vegetation	Scrub and/or herbaceous vegetation associations
13	333	Sparsely vegetated areas	Open spaces with little or no vegetation
14	411	Inland marshes	Inland wetlands
15	511	Water courses	Inland waters
16	521	Coastal lagoons	Marine waters

CORINE = coordination of information on the environment, LULC = land use and land cove

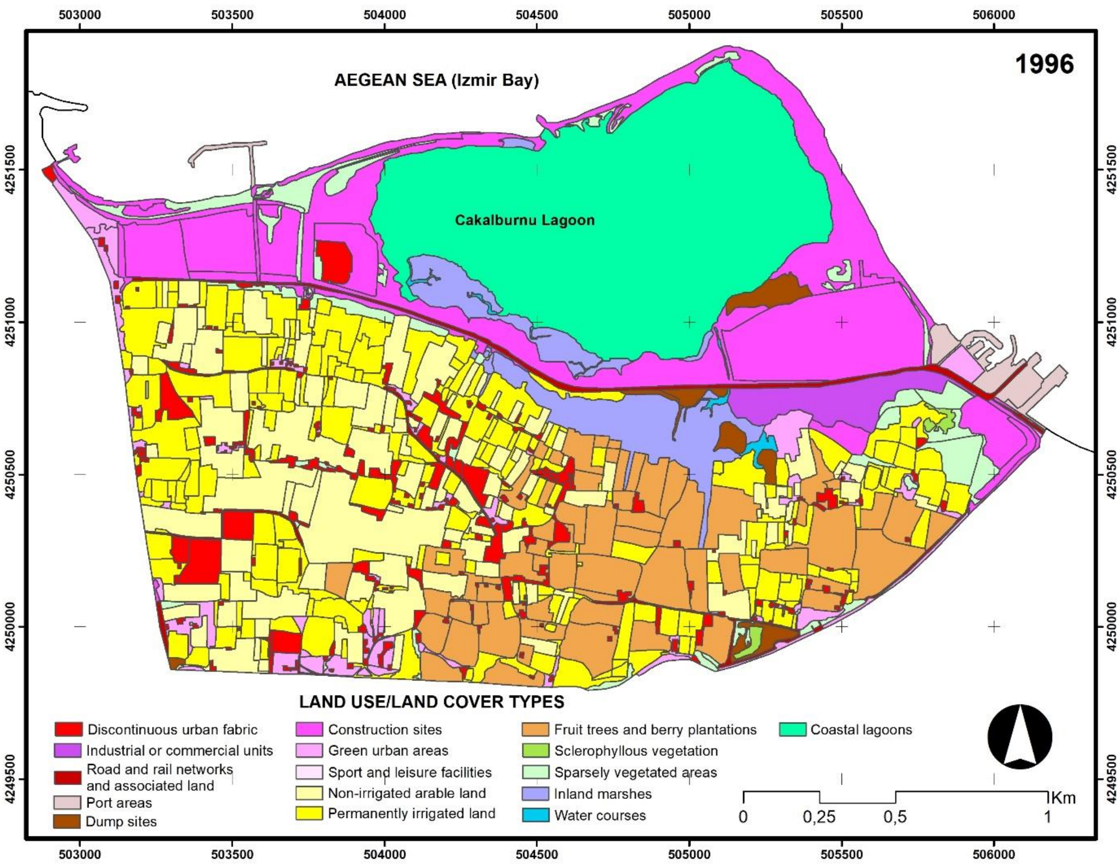

***Figure 3.** LULC sizes in 1996*

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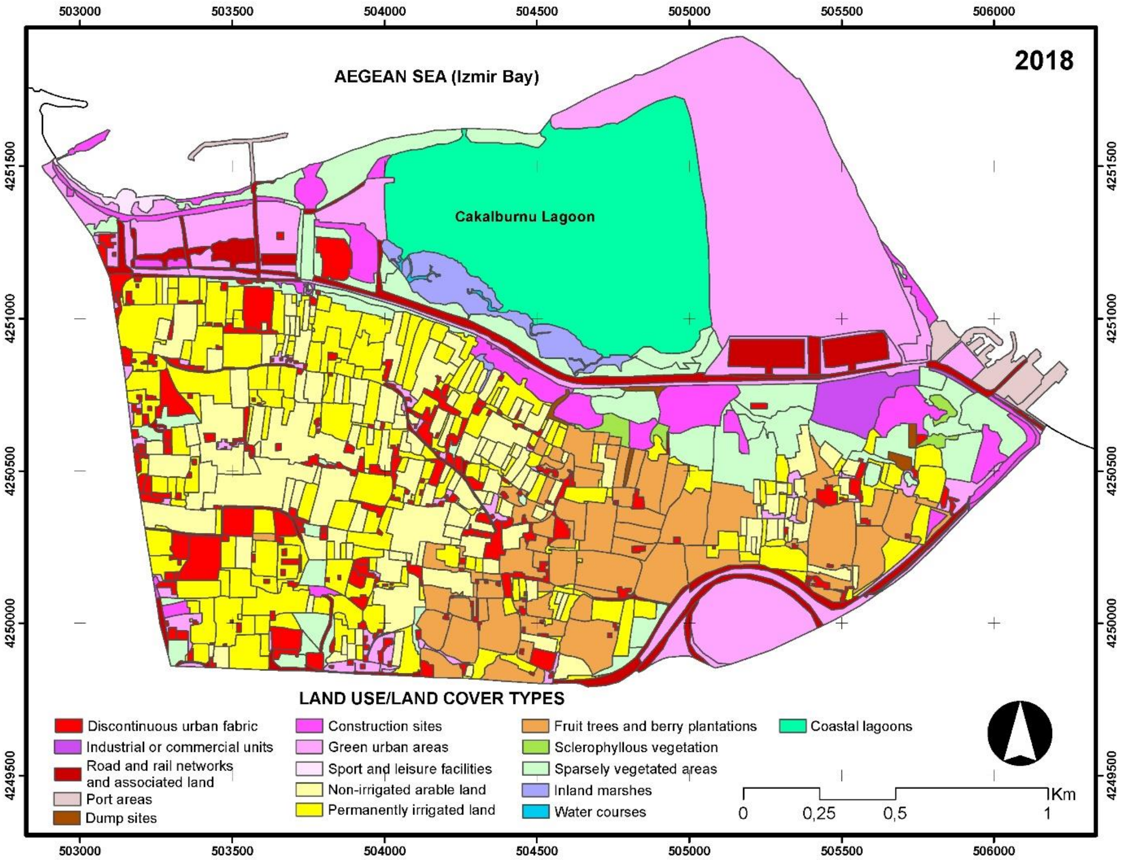

Figure 4. *LULC sizes in 2018*

Table 2. *LULC Changes in Inciralti between 1996 and 2018*

No.	Area					
	1996		2018		Image difference	
	ha	%	ha	%	ha	%
1	19.30	4.13	25.78	5.52	6.47	25.11
2	7.39	1.58	4.55	0.97	-2.83	-62.25
3	6.29	1.35	21.38	4.57	15.09	70.58
4	5.23	1.12	5.23	1.12	0.00	0.00
5	5.24	1.12	1.12	0.24	-4.13	-369.01
6	72.13	15.44	19.20	4.11	-52.93	-275.67
7	14.45	3.09	89.88	19.24	75.43	83.92
8	0.00	0.00	0.87	0.19	0.87	100.00
9	68.58	14.68	58.70	12.56	-9.88	-16.84
10	82.61	17.68	73.63	15.76	-8.98	-12.19
11	58.25	12.47	50.75	10.86	-7.50	-14.78
12	0.87	0.19	1.82	0.39	0.95	52.26
13	16.48	3.53	44.07	9.43	27.59	62.61
14	20.15	4.31	7.54	1.61	-12.62	-167.41
15	1.31	0.28	0.52	0.11	-0.79	-151.45
16	88.97	19.04	62.22	13.32	-26.75	-42.99
Total	467.25	100.00	467.25	100.00		

The second largest area among LULCs in 1996 (17.68% of the total) was the permanently irrigated land, which is the western part of the study area. The majority of permanently irrigated land consists of the areas where vegetables are cultivated. In 2018, the permanently irrigated land occupied less area compared to 1996 but was the second largest area (15.76% of the total).

The LULC with the third largest area in 1996 (15.44%) was the construction sites. A large part of the construction sites consists of fillings (rubble dumping) made in the northern part of the area on Izmir Bay coast and Cakalburnu lagoon. In 2018, the construction sites accounted for 4.11% of the total area and ranked ninth in terms of area size.

The discontinuous urban fabric ranked seventh in terms of area size among LULCs (4.13%) in 1996. The discontinuous urban fabric consists of agricultural enterprises and luxury villas in the central and western part of the area. The area covered by the discontinuous urban fabric increased to 5.52% but remained in the seventh place in 2018.

Between 1996 and 2018, the most significant increase in the LULC in terms of area size was in sport and leisure facilities (100%), green urban areas (83.92%), road and rail networks and associated land (70.58%). The most significant decrease was in dump sites (369.01%), construction sites (275.67%), and inland marshes (167.41%).

Tables 3 and *4* show the changes and conversions between LULCs. The discontinuous urban fabric increased by 25.11% (6.47 ha). Between 1996 and 2018, the city developed on the 8.22% (1.19 ha) of green urban areas, 5.99% (4.95 ha) of permanently irrigated land, 3.16% (2.17 ha) of non-irrigated arable land and 1.07% (0.62 ha) of fruit trees and berry plantations (*Fig. 5*).

Figure 5. *The spread of the discontinuous urban fabric to the non-irrigated arable land and permanently irrigated land*

Green urban areas increased by 83.92% (75.43 ha). The most important reason for the increase in green urban areas is the conversion of 54.32% (2.85 ha) of the dump sites, 50.69% (36.56 ha) of construction sites and 29.14% (25.92 ha) of coastal lagoons into green urban areas.

The non-irrigated arable land (greenhouse cultivation) showed a decrease of -16.84% (9.88 ha). 26.30% (18.04 ha) of the non-irrigated arable land was converted into permanently irrigated land, 3.16% (2.17 ha) into the discontinuous urban fabric, and 1.86% (1.28 ha) into green urban areas.

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Table 3. *The conversion matrix of LULC change from 1996 to 2018 (%)*

LULC in 2018	**LULC class changes (%)**															
	LULC in 1996															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	**85.49**	1.27	0.00	0.00	0.00	0.18	8.22	0.00	3.16	5.99	1.07	0.00	0.74	0.00	0.00	0.00
2	0.00	**54.64**	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1.36	0.00	**50.82**	0.00	0.00	17.72	3.29	0.00	0.25	2.79	2.82	0.00	3.03	0.25	0.00	0.00
4	0.00	0.00	0.00	**100.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	**3.75**	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	2.12	0.00	0.00
6	0.00	2.04	0.00	0.00	21.64	**9.86**	0.75	0.00	0.51	2.05	0.45	0.00	15.31	27.23	22.69	0.10
7	4.54	1.90	48.17	0.00	54.32	50.69	**60.11**	0.00	1.86	4.91	4.57	46.38	20.16	0.00	7.41	29.14
8	0.00	0.00	0.00	0.00	0.00	1.04	0.00	**0.00**	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.00
9	2.28	0.00	0.00	0.00	0.00	0.00	1.81	0.00	**66.39**	14.28	1.01	0.00	0.47	0.00	0.00	0.00
10	2.70	0.00	0.48	0.00	0.00	0.00	9.11	0.00	26.30	**58.57**	7.07	0.00	2.24	4.23	0.00	0.00
11	1.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	2.73	**81.77**	0.00	0.00	1.59	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**25.63**	3.19	5.34	0.00	0.00
13	1.65	40.15	0.53	0.00	20.29	19.37	16.70	0.00	1.30	8.08	1.24	27.99	**53.60**	24.43	35.44	0.62
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	**34.81**	0.00	0.53
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**34.46**	0.08
16	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	**69.53**
1996 total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Class changes	14.51	45.36	49.18	0.00	96.25	90.14	39.89	0.00	33.61	41.43	18.23	74.37	46.40	65.19	65.54	30.47
Image difference	25.11	-62.25	70.58	0.00	-369.01	-275.67	83.92	100.00	-16.84	-12.19	-14.78	52.26	62.61	-167.41	-151.45	-42.99

LULC = land use and land cover. 1. discontinuous urban fabric; 2. industrial or commercial units; 3. road and rail networks and associated land; 4. port areas; 5. dump sites; 6. construction sites; 7. green urban areas; 8. sport and leisure facilities; 9. non-irrigated arable land; 10. permanently irrigated land; 11. fruit trees and berry plantations; 12. sclerophyllous vegetation; 13. sparsely vegetated areas; 14. inland marshes; 15. water courses; 16. coastal lagoons

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Table 4. *The conversion matrix of LULC change from 1996 to 2018 (ha)*

LULC in 2018	LULC class changes (ha)																
	LULC in 1996																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**2018 total**
1	**16.50**	0.09	0.00	0.00	0.00	0.13	1.19	0.00	2.17	4.95	0.62	0.00	0.12	0.00	0.00	0.00	25.78
2	0.00	**4.04**	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55
3	0.26	0.00	**3.20**	0.00	0.00	12.78	0.48	0.00	0.17	2.30	1.64	0.00	0.50	0.05	0.00	0.00	21.38
4	0.00	0.00	0.00	**5.23**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.23
5	0.00	0.00	0.00	0.00	**0.20**	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.43	0.00	0.00	1.12
6	0.00	0.15	0.00	0.00	1.13	**7.11**	0.11	0.00	0.35	1.69	0.26	0.00	2.52	5.49	0.30	0.09	19.20
7	0.88	0.14	3.03	0.00	2.85	36.56	**8.69**	0.00	1.28	4.05	2.66	0.40	3.32	0.00	0.10	25.92	89.88
8	0.00	0.00	0.00	0.00	0.00	0.75	0.00	**0.00**	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.87
9	0.44	0.00	0.00	0.00	0.00	0.00	0.26	0.00	**45.53**	11.80	0.59	0.00	0.08	0.00	0.00	0.00	58.70
10	0.52	0.00	0.03	0.00	0.00	0.00	1.32	0.00	18.04	**48.38**	4.12	0.00	0.37	0.85	0.00	0.00	73.63
11	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	2.26	**47.63**	0.00	0.00	0.32	0.00	0.00	50.75
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.22**	0.52	1.08	0.00	0.00	1.82
13	0.32	2.97	0.03	0.00	1.06	13.97	2.41	0.00	0.89	6.67	0.72	0.24	**8.83**	4.92	0.46	0.55	44.07
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	**7.01**	0.00	0.47	7.54
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.45**	0.07	0.52
16	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	**61.86**	62.22
1996 total	19.30	7.39	6.29	5.23	5.24	72.13	14.45	0.00	68.58	82.61	58.25	0.87	16.48	20.15	1.31	88.97	**467.25**
Class changes	2.80	3.35	3.09	0.00	5.05	65.02	5.76	0.00	23.05	34.22	10.62	0.65	7.65	13.14	0.86	27.11	
Image difference	6.47	-2.83	15.09	0.00	-4.13	-52.93	75.43	0.87	-9.88	-8.98	-7.50	0.95	27.59	-12.62	-0.79	-26.75	

LULC = land use and land cover. 1. discontinuous urban fabric; 2. industrial or commercial units; 3. road and rail networks and associated land; 4. port areas; 5. dump sites; 6. construction sites; 7. green urban areas; 8. sport and leisure facilities; 9. non-irrigated arable land; 10. permanently irrigated land; 11. fruit trees and berry plantations; 12. sclerophyllous vegetation; 13. sparsely vegetated areas; 14. inland marshes; 15. water courses; 16. coastal lagoons

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Inland marshes showed a significant decrease of -167.41% (12.62 ha). Upon looking at the conversion matrix, the main reason for the change in these areas is the conversion of 27.23% (5.49 ha) into construction sites, 24.43% (4.92 ha) into sparsely vegetated areas and 5.34% (1.08 ha) into sclerophyllous vegetation.

Coastal lagoons showed a decrease of -42.99% (26.75 ha). 29.14% (25.92 ha) of coastal lagoons were converted into green urban areas (*Fig. 6*).

Between 1996 and 2018, there were significant changes in the patch numbers and patch areas of the LULC categories (*Table 5*). Between these years, the total patch number of the discontinuous urban fabric increased by 24.12% (from 199 to 247). The highest increase in the patch number was in the area with a 0-0.9 ha patch size (23.86%/from 197 to 244). There was no change in the average patch area size of the discontinuous urban fabric (0.1 ha).

The total patch number of green urban areas increased from 65 to 76 (an increase of 16.92%). The highest increase (300%/from 3 to 9) was observed in the patches of 1-4.9 ha. The average patch area increased by 536.36% from 0.22 ha 1.18 ha.

The total patch number of the non-irrigated arable land increased by 30.77% from 104 to 136. The highest increase in the patch number was in the patch group of 0-0.9 ha with 44.19% (from 86 to 124). The average patch area size of the non-irrigated arable land decreased by 34.85% (from 0.66 to 0.43 ha).

The total patch number of inland marshes decreased by 58.33% from 12 to 5. The highest decrease in the patch number was in the areas with a patch size of 0-0.9 ha (60%/from 10 to 4). The average patch area decreased by 10.12% from 1.68 ha to 1.51 ha.

The total patch number of coastal lagoons increased by 300% (from 1 to 3). The highest increase in the patch number was in the areas with a patch size of 0-0.9 (200%/from 0 to 2). The average patch area decreased by 76.69% (from 88.97 ha to 20.74 ha).

Discussion

The effects of urbanization in Inciralti are observed with the conversion of different LULCs into urban areas. The conversion of agricultural areas (permanently irrigated land, non-irrigated arable land, and fruit trees and berry plantations) into urban areas (discontinuous urban fabric) shows that urbanization in Inciralti creates great pressure on agricultural areas. This result is line with results of a previous survey in Nanping city, China, where the pressure of urban expansion on agricultural areas can be seen as decreases in cultivated land (Fan and Zhao, 2019). An indirect indicator of the continuation of a process leading to the construction of Inciralti is that agricultural areas were left unused. The decrease in the importance given to agriculture has led to the large abandonment of agricultural areas (Price et al., 2015).

Although the impact of human activities is for all natural ecosystems, it particularly affects coastal wetlands (Valdez et al., 2016). The reason for the conversion of wetlands into urban and agricultural areas in Inciralti is the filling of the area with rubble and garbage. As a result of filling Cakalburnu lagoon with rubble, Inciralti has been losing its wetlands characteristics. The reason for such losses in coastal wetlands is tremendous demand for land (Jiang et al., 2015; Kingsford et al., 2016). The major threat to coastal wetlands is the transformation of coastal ecosystems, which is the result of urbanization, which leads to significant loss and change of habitat (Gallant, 2015; Xu et al., 2016). Wetland loss is an important problem in local communities as well as for many wetland species that depend on wetlands (Orimoloye et al., 2018).

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Table 5. *Patch numbers of LULC categories according to patch area coverages*

		Years													
		1996							2018						
		Patch size category (ha)													
		0-0.9	**1-4.9**	**5-9.9**	**10-49.9**	**50 or more**	**No. of patch (total)**	**Av. patch area (ha)**	**0-0.9**	**1-4.9**	**5-9.9**	**10-49.9**	**50 or more**	**No. of patch (total)**	**Av. patch area (ha)**
1	No. of patch	197	2	-	-	-	199		244	3	-	-	-	247	
	Patch area (ha)	16.31	2.99	-	-	-		0.10	21.51	4.27	-	-	-		0.10
2	No. of patch	-	-	1	-	-	1		1	1	-	-	-	2	
	Patch area (ha)	-	-	7.39	-	-		7.39	0.18	4.37	-	-	-		2.28
3	No. of patch	15	1	-	-	-	16		27	8	-	-	-	35	
	Patch area (ha)	3.18	3.11	-	-	-		0.39	7.63	13.75	-	-	-		0.61
4	No. of patch	3	2	-	-	-	5		3	2	-	-	-	5	
	Patch area (ha)	2.16	3.07	-	-	-		1.05	2.21	3.02	-	-	-		1.05
5	No. of patch	8	2	-	-	-	10		5	-	-	-	-	5	
	Patch area (ha)	2.42	2.82	-	-	-		0.52	1.12	-	-	-	-		0.22
6	No. of patch	21	8	-	3	-	32		20	8	-	-	-	28	
	Patch area (ha)	7.14	19.29	-	45.70	-		2.25	6.20	13.00	-	-	-		0.69
7	No. of patch	62	3	-	-	-	65		65	9	1	-	1	76	
	Patch area (ha)	10.88	3.57	-	-	-		0.22	12.70	17.38	7.83	-	51.97		1.18
8	No. of patch	-	-	-	-	-	-		-	1	-	-	-	1	
	Patch area (ha)	-	-	-	-	-		-	-	0.87	-	-	-		0.87

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Table 5. cont. *Patch numbers of LULC categories according to patch area coverages*

		Years													
		1996							2018						
		Patch size category (ha)													
		0-0.9	**1-4.9**	**5-9.9**	**10-49.9**	**50 or more**	**No. of patch (total)**	**Av. patch area (ha)**	**0-0.9**	**1-4.9**	**5-9.9**	**10-49.9**	**50 or more**	**No. of patch (total)**	**Av. patch area (ha)**
9	No. of patch	86	16	2	-	-	104		124	12	-	-	-	136	
	Patch area (ha)	28.39	26.40	13.79	-	-		0.66	33.22	25.48	-	-	-		0.43
10	No. of patch	228	18	-	-	-	246		209	13	-	-	-	222	
	Patch area (ha)	57.64	24.97	-	-	-		0.34	55.99	17.64	-	-	-		0.33
11	No. of patch	39	23	-	-	-	62		53	18	-	-	-	71	
	Patch area (ha)	19.78	38.47	-	-	-		0.94	19.71	31.04	-	-	-		0.71
12	No. of patch	2	-	-	-	-	2		4	-	-	-	-	4	
	Patch area (ha)	0.87	-	-	-	-		0.44	1.82	-	-	-	-		0.46
13	No. of patch	44	3	-	-	-	47		39	14	-	-	-	53	
	Patch area (ha)	11.59	4.89	-	-	-		0.35	15.44	28.63	-	-	-		0.83
14	No. of patch	10	-	1	1	-	12		4	-	1	-	-	5	
	Patch area (ha)	1.47	-	6.37	12.31	-		1.68	0.74	-	6.80	-	-		1.51
15	No. of patch	8	-	-	-	-	8		5	-	-	-	-	5	
	Patch area (ha)	1.31	-	-	-	-		0.16	0.52	-	-	-	-		0.10
16	No. of patch	-	-	-	-	1	1		2	-	-	-	1	3	
	Patch area (ha)	-	-	-	-	88.97		88.97	0.22	-	-	-	62		20.74

LULC = land use and land cover. 1. discontinuous urban fabric; 2. industrial or commercial units; 3. road and rail networks and associated land; 4. port areas; 5. dump sites; 6. construction sites; 7. green urban areas; 8. sport and leisure facilities; 9. non-irrigated arable land; 10. permanently irrigated land; 11. fruit trees and berry plantations; 12. sclerophyllous vegetation; 13. sparsely vegetated areas; 14. inland marshes; 15. water courses; 16. coastal lagoons

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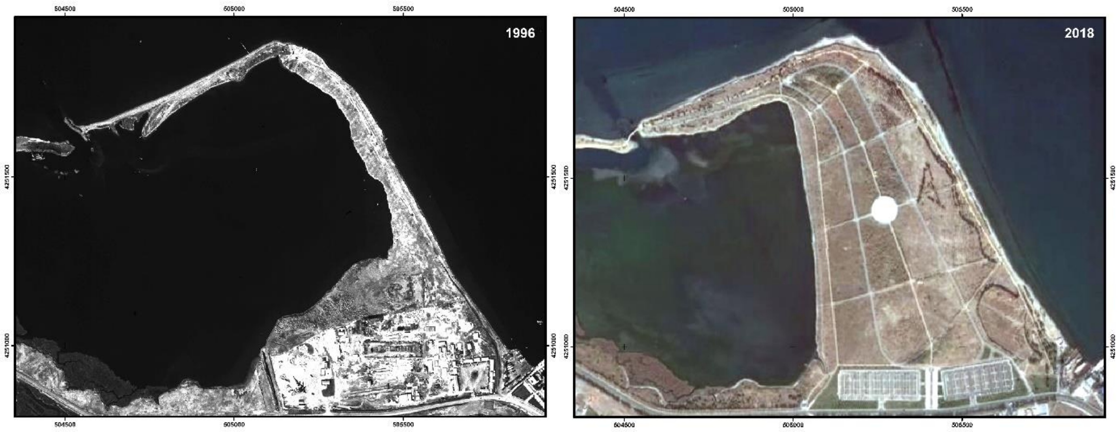

Figure 6. *Conversion of coastal lagoons in Inciralti*

In addition to the change/conversion of the LULC classes, patch numbers and patch area sizes reveal the state of agricultural areas and wetlands in Inciralti. The increase in the patch number with the smallest area size (0-0.9 ha) indicates that the discontinuous urban fabric spread throughout Inciralti (as agricultural enterprises and villas). This result is supported by the view that if the number of small patches increases, fragmentation also increases (Lasanta et al., 2015)

The extension of the discontinuous urban fabric to the west caused fragmentation of the agricultural areas particularly by creating pressure on these areas. The result of this study coincides with the view that the spreading construction areas occupy agricultural areas and divide large agricultural patches into small ones (Liang et al., 2015). A study assessing LULC changes in Romania found that serious fragmentation of agricultural land caused significantly decreasing in the quality and quantity of land use (Popovici et al., 2013).

When the changes in the total patch number, the number of patches with small sizes, the average patch area and total area size of the agricultural areas together, it is observed that these areas were subjected to conversion by severe fragmentation.

The changes in the total area size, total patch number and average patch area and the number of patches with small sizes of wetlands indicates severe fragmentation and rapid conversion. Similarly, on the analysis of LULC changes; it is stated that the total class area, the number of patches, the average patch size and the largest patch size provide information about the fragmentation of the landscape (Grecchi et al., 2014).

The results of the study are important in terms of revealing the LULC changes, conversions and fragmentations in Inciralti in detailed. The results of the study are important to reveal the LULC changes, conversions, and fragmentations in Inciralti in detailed. The results of the study are also important in terms of understanding the agricultural potential and ecological value of the area and contribute to the development of social awareness for the preservation of the agricultural and wetland character of Inciralti.

Conclusion

Changes, conversions, and fragmentations of LULCs in the study area over the years have caused changes in the existing natural and cultural structure of Inciralti. For this

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reason, ecological importance of coastal areas should be prioritized (Rahman et al., 2017). The wetland characteristics of Inciralti can be protected by preventing the filling works for obtaining green urban areas and making wetland restoration.

Small patches of agricultural areas should be combined in order to reduce the severity of fragmentation.

Planning and management studies for Inciralti should focus on the protection of agricultural lands and wetlands as well as physical and economic development. An ecosystem-based conservation approach can be supported in areas accommodating different uses that meet the needs of multiple bird species/communities (Ma, et al., 2010). Appropriate land management is a way to avoid the negative effects of unplanned development (Rahman et al., 2017). To achieve this, planning and management studies should take into account landscape dynamics and LULC changes/conversions.

In future studies, the effects of temporal changes, conversions and fragmentations of the LULC on the agricultural product model, flora and fauna diversity, and people’s mental health can be examined. Future studies provide quantified metrics for their study areas such as percent impervious surfaces, road density, and human population density. The effects of the intense demands of landowners for the development of agricultural land, the most important problem threatening Inciralti, on LULC changes can be analyzed. The pressure of green space demands on agricultural areas and wetlands can also be evaluated.

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