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Araştırma Makalesi

URBAN SPRAWL IN NİZİP CITY: ASSESSING WITH REMOTELY SENSED AND POPULATION DATA

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Abstract

Based on Remote Sensing image processing and Geographic Information Systems analysis, population-dependent urban structures can be accurately monitored, analysed, and potential spatial or environmental problems restrained by professional land use management. In this study, the city of Nizip, located within the province of Gaziantep, was evaluated in this perspective and its development in the last thirty years was determined. The satellite images of 1990 and 2019 were evaluated within the framework of CORINE land classification system. The controlled classification method was implemented in the analysis and the city's growth rate and direction were determined while land cover changes were investigated both statistically and spatially. According to the analysis, residential areas in the study area, which were 555 ha in 1990, exceeded 1000 ha in 2019, due to industrialization and population growth. Urban sprawl was observed in NE and E directions. In addition, the bare lands of the city have been converted to dry agricultural lands in the last three decades which is supposedly due to long term climate effects. Along with the increasing industrialization movement in this period, the population increased by 30% on average in the central neighbourhoods. Migration from evacuated villages to the city centre following dam construction and water impoundment phases has increased the population. Rapid urbanization is also observed alongside newly built highways and motorways. Regarding increasing population movements in recent years, it is predicted that there could be spatial and environmental problems due to rapid and unplanned urbanization in Nizip city. It is stated that the elimination of these problems can be carried out through accurate and planned land use decision support systems.

Keywords: *Remote Sensing, Geographic Information Systems, Land use/Land cover change, Population growth, Nizip City.*

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NİZİP ŞEHRİNDE SAÇAKLANMA: UZAKTAN ALGILAMA VE NÜFUS VERİSİ DEĞERLENDİRMESİ

Öz

Uzaktan Algılama (UA) görüntü işleme ve Coğrafi Bilgi Sistemleri (CBS) analiz yöntemleri ile nüfusa bağlı değişen şehir yapılanmaları doğru bir şekilde izlenebilmekte, analiz edilebilmekte ve olası mekânsal veya çevresel sorunlar profesyonel arazi kullanımı yönetimi ile kontrol altında tutulabilmektedir. Bu çalışmada Gaziantep il sınırı içerisinde yer alan Nizip şehri, bu perspektifte değerlendirilerek, son otuz yıl içerisindeki gelişimi Uzaktan Algılama yöntemi ile belirlenmiştir. 1990 ve 2019 yıllarına ait uydu görüntüleri CORINE arazi sınıflandırma çerçevesinde değerlendirilerek, kontrollü sınıflandırma yöntemi uygulanarak, şehrin büyüme oranı ve yönü belirlenmiş, arazi örtüsü değişimleri istatistiksel ve mekânsal olarak değerlendirilmiştir. Buna göre endüstrileşme ve nüfus artışına bağlı olarak 1990 yılında 555 ha olan yerleşim alanları 2019 yılına gelindiğinde 1000 ha alanı geçmiştir. Şehirleşme KD ve D yönünde gerçeklemiştir. Ayrıca çalışma alanında var olan çıplak alanların uzun süreli iklimsel etkilerle kuru tarım arazilerine dönüştürüldüğü düşünülmektedir. Bu dönemde artan endüstrileşme hamleleri ile birlikte, nüfus merkez mahallelerde ortalama %30 oranında yükselmiştir. Şehrin doğusunda yer alan baraj inşaatı ile birlikte, kamusallaştırılan ve boşaltılan köylerden şehir merkezine doğru göç artmıştır. Şehirleşme ayrıca yeni açılan otoyol ve duble yollar çevresinde de hızla arttığı görülmektedir. Son yıllarda artan bu nüfus hareketlerine bağlı olarak Nizip şehrinde, hızlı ve plansız şehirleşme kaynaklı mekânsal ve çevresel sorunlar oluşabileceği öngörülmektedir. Bu sorunların kaldırılması doğru ve planlı arazi kullanım karar destek sistemleri ile olabileceği ifade edilmektedir.

Anahtar Kelimeler: *Uzaktan Algılama, Coğrafi Bilgi Sistemleri, Arazi kullanımı/ Arazi değişimi, Nüfus artışı, Nizip Şehri.*

INTRODUCTION

Urbanization is so complicated process of transition in terms of its consequences. The physical change of human needs over time leads to an irreversible situation if it develops in an unplanned and uncontrolled way. Developing countries use urbanization as an accelerating and guiding tool in reaching forward development goals and besides, they are exerting serious efforts to eliminate the problems unwilling effects caused by urbanization (Dodman, 2017; Vasenev et al., 2018; Wolsko & Marino, 2016). Cities are settlements with large population masses including non-agricultural activities, meet the social needs of population (Solecki & Leichenko, 2006). Many topics, from environmental problems to quality of life, from economic life to social development and services, need to be addressed with urbanization (Zeman, 2012). This situation, which takes place by intervening in the space with human activities, reveals a city structure is dynamic. In addition, depending on the industrialization and economic development, the migration movement from rural settlements to urban settlements has accelerated, and has also caused rural areas to evolve with various city functions and turn into urban spaces

(Chen et al., 2014). Investigation of urbanization process is vital as rapid urbanization can lead to deterioration in ecosystems by transforming physical landscape in an unsystematic and unplanned way. An assessment on the “urban dynamics” which promotes land-cover transformation, is, consequently, mandatory for dealing with environmental deterioration and maintain sustainability (Fang & Wang, 2013; Grossman & Krueger, 1995; Liu et al., 2011). So far, a large percent of urban areas across the world has been exposed to large scale land cover changes throughout the years. Due to rapid urbanization in countries it is likely to cause intolerable burden on various natural resources regarding transformation in land use and land cover change (Han et al., 2016; Kumar et al., 2018; Liu et al., 2017). In order to estimate such a degradation an ecosystem, we need to maintain a robust and planned land use management scheme for policy makers and city planners.

Large number of researchers have pursued to assess land use/ land cover (LU/LC) changes utilizing Remote Sensing (RS) and Geographical Information Systems (GIS), such as monitoring the spatial development of city areas, determining the changes in LU/LC and modelling possible urban sprawl (Corner et al., 2014; Dingle Robertson & King, 2011; Fallati et al., 2017). By this means, LU/LC maps are created by analysing satellite images taken at various time periods, and the temporal changes of a desired area are revealed by GIS analysis tool. Yang and Lo, (2002) investigates the possible triggers that cause land cover/land use change in Georgia Metropolitan city in United States. Yuan et al., (2005) study land cover transformation between twin cities in Minnesota. Li, Long and Liu, (2010) investigates land cover change in Changshu province in China due to industrial development. Ikiel et al., (2013) uses combined technology in order to estimate land cover transition in Duzce city and its neighbouring areas. Butt et al., (2015) investigates land cover change in watersheds in Pakistan. Kindu et al., (2018) engage in various scenarios on to what extent the land cover changes of the Ethiopian highlands. Sunbul, (2019) uses combined analysis in order to monitor land cover change in Sakarya province following the 1999 large earthquake.

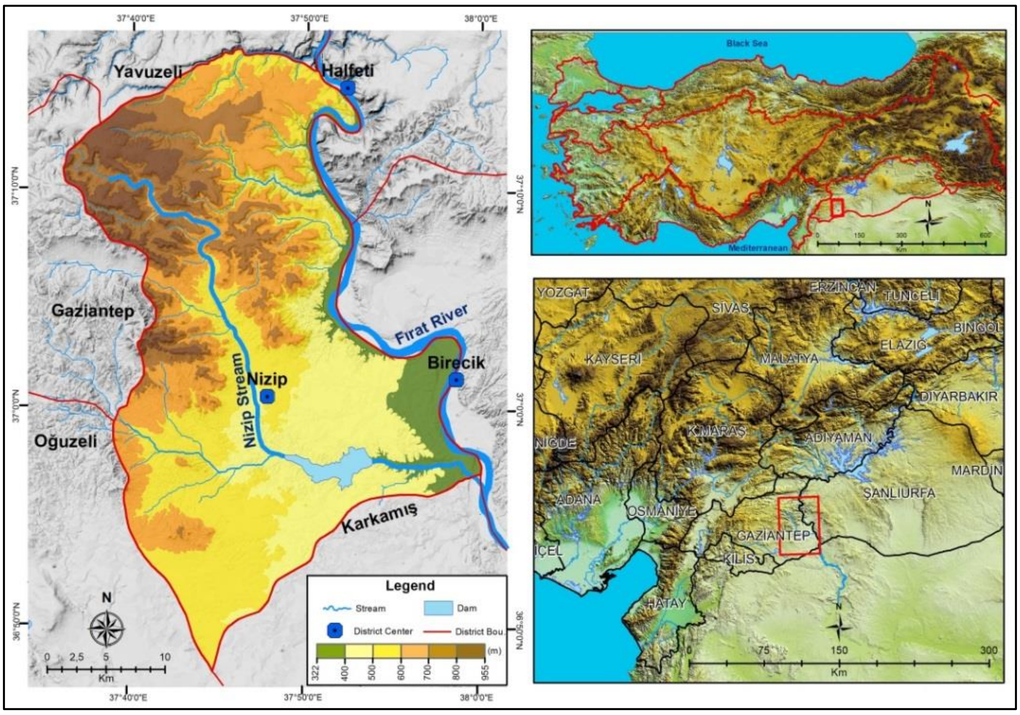
Here, we have focused on Nizip city in Gaziantep province, SE of Turkey. This area has rapid population growth and effective land use transition since 1980s, due to industrialization and economic development in the region. This may cause some serious consequences upon the environment. In order to determine the impact of urbanization for the last three decades, we have used RS technology combined with GIS, to monitor land use land cover change in the study area. The research also covers the possible causes and consequences of urbanization in this region.

Study Area

Geography

Nizip city is located in the south-eastern section of Gaziantep province, SE of Turkey, lies between 37.03 N-36.96 N latitudes and 37.72 E-37.83 E longitudes. The study area stands in the Gaziantep sub-region of the Middle Euphrates river (hereinafter Fırat river) watershed of the South-eastern Anatolia Region (Figure 1). The district is located on the east of Gaziantep Plateau, by the Fırat River. It is neighbours with Şehitkamil and Oğuzeli districts in the west of the city, Karkamış in the south, Birecik district of Şanlıurfa province in the east and Halfeti districts in the northeast. The Fırat River draws a natural border to the east of the district while it flows southward from the north-eastern parts of the district. It flows through narrow and deep valleys from Rumkale to Aşağıçardak village and forms Birecik Dam reservoir. The study area is covered the area of approximately ~84 km^2.

Figure 1: Location map of Nizip City



According to meteorological data, it is observed that the climate type reflects the characteristics of transition of Mediterranean and semi-arid climate. The summer drought and high temperatures experienced in the city, the semi-arid climate, and the more frequent precipitation in the winter season are the characteristics of the Mediterranean climate (Yucekaya & Uslu, 2020). This region is the second regarding receives the least amount of rainfall of Turkey. The annual rainfall rate is 568 mm (Table 1). The number of streams (perennial stream) is small due to low average rainfall, high temperature as well as evaporation (i.e. Kuzucuoğlu et al, 2019). Differently, Fırat river, Nizip stream, Birecik, Hancağız and Karkamış dams, which form the eastern border of the research area, are critical hydrographic suppliers of the city.

Table 1: Meteorological data of Nizip city covers the period of 1940-2019 (MGM, 2020).

Measurement Period of 1940-2020	*Average Temp. (°C)*	*Average Max. Temp. (°C)*	*Average Min. Temp. (°C)*	*Average Monthly Rainfall (mm)*
January	*3.0*	*7.4*	*-0.7*	*102.8*
February	*4.4*	*9.3*	*0.1*	*83.4*
March	*8.1*	*13.8*	*2.9*	*72.5*
April	*13.3*	*19.6*	*7.2*	*52.7*
May	*18.7*	*25.4*	*11.8*	*31.3*
June	*24.4*	*31.2*	*17.0*	*8.5*
July	*27.9*	*35.1*	*21.0*	*7.1*
August	*27.7*	*35.2*	*20.9*	*5.2*
September	*23.3*	*31.0*	*16.1*	*7.2*
October	*16.6*	*24.1*	*9.9*	*37.3*
November	*9.8*	*16.2*	*4.4*	*62.0*
December	*4.9*	*9.6*	*1.0*	*98.5*
Annual rate	***15.2***	***21.5***	***9.3***	***568.5***

The abundance of precipitation in Nizip city from January till March provides water accumulation in the basin. This accumulated water is consumed rapidly due to temperature increase from the beginning of April. The accumulated water in the city begins to be consumed rapidly by increasing in temperature. The water deficiency lasts from mid-May until the first week of November. In order to eliminate the water shortage that lasts for about 6 months, farmers continue their agricultural activities by obtaining water from the surrounding river or dam reservoirs. In terms of local agricultural activities, agricultural products that are resistant to summer drought are preferred. Pistachio is a plant resistant to summer drought that is cultivated in summer without irrigation. In addition, olives are also a drought resistant plant. Olives unlike pistachios need precipitation during the fruiting period. Olives blossom and bear fruit in the winter season. Ample winter rains are required for the best quality of olive fruit. The hydrographic resources of the region are also used for other agricultural activities.

Geology and Geomorphology

The Anatolian plate was formed by both oceanic and continental crust during the vary active geological process of Alpine orogenesis (Göncüoğlu, 2019). The geodynamic process of the region is associated with relative movement of Eurasian, Nubian and Arabian plates (Reilinger et al., 2006). The fundamental orogenic evolution in the region is speculated by the collision of the various component of Neotethys Ocean (Şengör et al., 2003). The collisions along the plate boundaries result in complex tectonic and volcanic activities occurred since Neogene (Le Pichon et al., 2016). Palaeozoic and Mesozoic formations dominate the basement rocks in the region. The Palaeozoic is characterised by sedimentary rocks and the Mesozoic is characterised by aquatic facies and ophiolites (Coskun & Coskun, 2000).

The Firat formation which forms the northern section of the study area, is composed of limestone. Creamy beige, hard brittle, thin bedded, fossil stromatolite limestones dominates this unit. The formation unit, which consists of white coloured, silty and chalky limestones, which are observed commonly in the province of Gaziantep, was named as 'Gaziantep Formation. The unit starts with white-cream coloured, thin-medium bedded, clayey, fossilized and chalky limestones at the bottom, and towards the top, white-cream coloured, abundant fossils and algal limestones and thin-medium bedded carbonate cemented, chalky limestones and partly marls. At the top, the unit develops in the Fırat Formation with clayey, cherty limestones (Ulu, 1996).

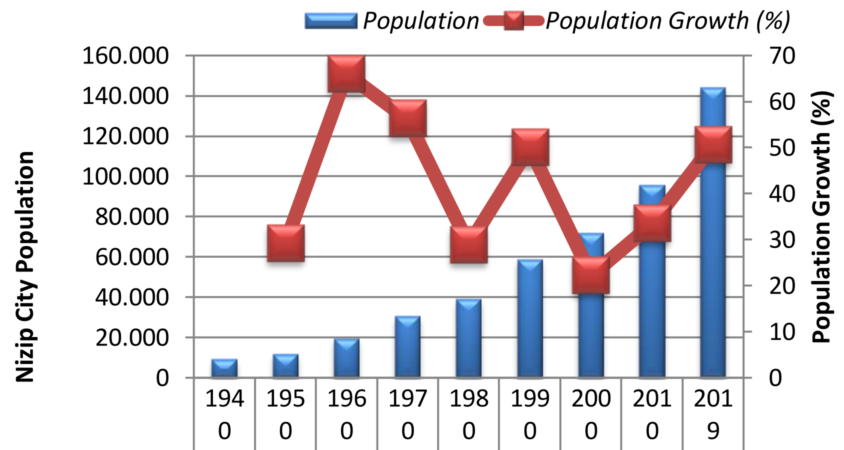
South-eastern Anatolia Region consists of a plain (rugged terrain in some parts) lying from the southern parts of the Taurus Mountains to the Syrian border. This area, which is fragmented by streams, forms the extension of the Syrian Arab Platform in Turkey. Gaziantep and Sanlıurfa Plateaus, named South-eastern Anatolian Plateaus, have an altitude ranging from 500 to 800 meters. In the southern parts of the Gaziantep Plateau, the altitude decreases up to 300 meters (i.e. Kuzucuoğlu et al, 2019).

In parallel with the decrease of the slope, Nizip Stream forms meanders in the centre and southern section of the city, as consequences of both erosional and depositional process, result in widespread alluvial deposits. There are also wide alluvial plains on the edge of the river valley located in the western part of Nizip city. In the southern part, streams formed wide alluvial deposits along their slopes. Bozalıoğlu Stream, which flows east after Hanip Dam, flows through the Fırat River alluviums and pours into the main River. An expanding alluvial deposit area to the south is observed from Birecik city located in the east of Nizip. In addition to these deposits, the wide alluvial plains of Mizar Stream are observed in the southeast of the research area, since the elevation in the basin is still low.

Demography

The Turkish Statistical Institute (TURKSTAT) has started to hold regular census in 1927. Since then, the city population has risen steadily (Figure. 2). The population of Nizip, which was 28208 in total with the villages in 1927, increased by 5.1 times in 92 years and became 143994 in 2019. The population distribution according to the first census shows that 75.8% of population lives in villages and rural areas where 24.2% lives in cities. As a result of industrializations and urbanizations the statistic show that almost 75% of inhabitants lives in cities where 25% lives in rural areas and villages. While the rural population in Nizip city was more than the city population until 1975, the city population has exceeded the rural population since that year (TURKSTAT, 2020).

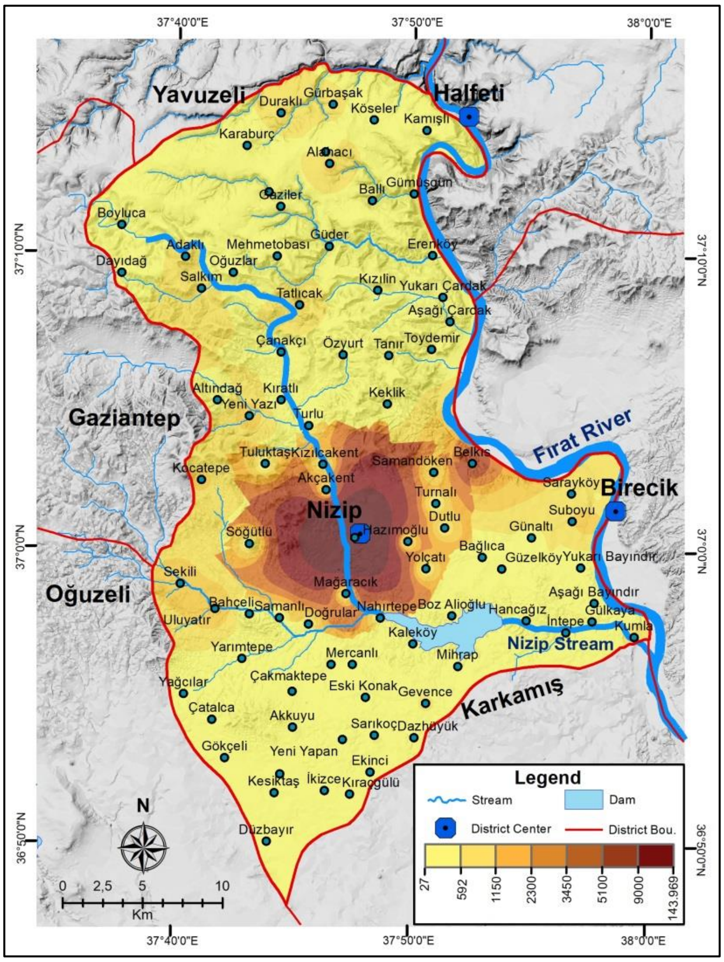
Figure 2: Population growth and growth rate in Nizip city since 1940 (TURKSTAT, 2020)



	1940	1950	1960	1970	1980	1990	2000	2010	2019
Population	9.009	11.64	19.33	30.21	38.96	58.60	71.62	95.60	143.9
Population Growth (%)		29,2	66	56,2	28,9	50	22,2	33,4	50,6

Reasons such as the development of industry, the start-off train services and new roads/highway constructions made the city more attractive (Erdogan, 2011). For the aforementioned developments, people lived in rural areas, moved to the city centre and led to a decrease in rural population growth (Figure 3).

Figure 3: Population density distribution in the study area.



METHODOLOGY

Data Processing

Spatio-temporal analysis of LU/LC change provides significant information to city planners and policy makers about past and up-to-date picture of urbanization in a desired area. Two Satellite images that covers the last three decades (1990 and 2019) downloaded via United States Geological Survey (USGS) GloVis data server, utilized in the analysis (Table 2). In terms of accuracy assessment, summer period recordings were preferred.

Table 2: Characteristics of the satellite images utilized within the scope of the study.

	1990	2019
Satellite sensors	L1-5 Multispectral Scanners (MMS) DOI: /10.5066/F7H994GQ	Landsat 8 OLI/TIRS DOI: /10.5066/F7H994GQ
Date	22.07.1990	28.07.2019
Composite band	3,2,1	3,5,6

During the analysis, there main steps a) pre-processing of the satellite image, b) identification of land cover characteristics, and c) accuracy assessment was implemented (Figure 4). We have used IDRISI Selva software for making the satellite images ready for classification, as well as classification and accuracy analysis. For illustration, including area calculations and preparation of thematic maps, ArcGIS 10.6.1 software has been utilized.

Figure 4: Flowchart of the analysis.

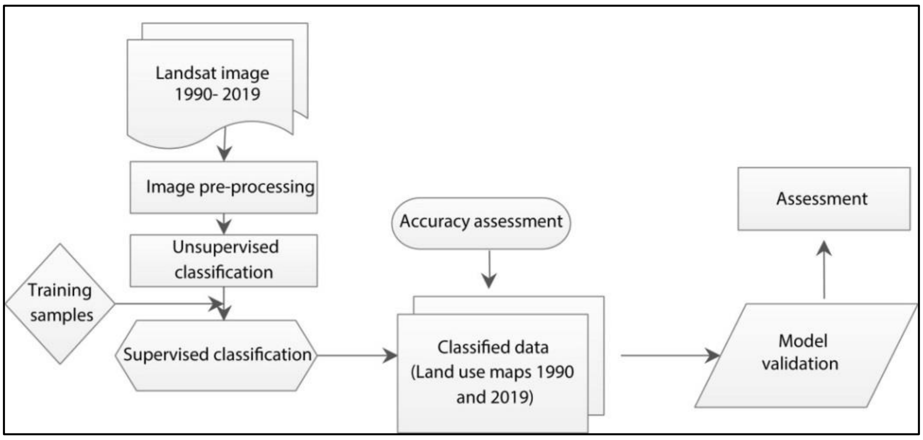
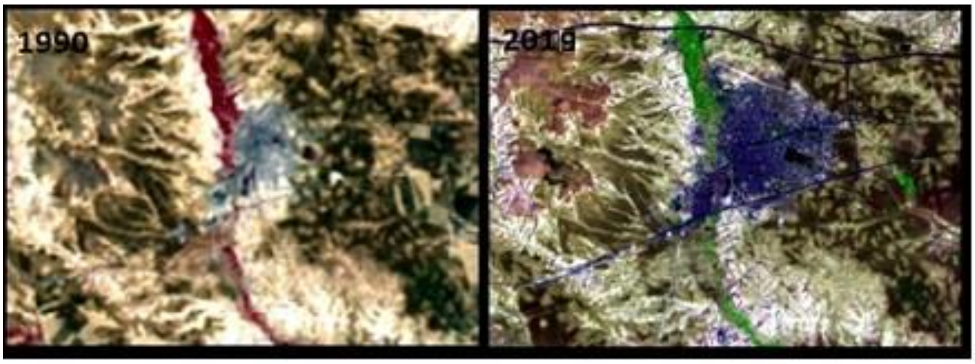


Image Pre-processing

Each band of Landsat satellite images with GeoTIFF (.tif) format has been converted to raster (.rst) format to be compatible with IDRISI software (Eastman, 2015). Then, each band was truncated within the study area polygon and composite process was applied using tapes with the same wavelengths. According to this, L1-5 MMS of 3,2,1 band and Landsat 8 OLI/TIRS band of 3,5,6 were utilized during the analysis (Figure 5).

Figure 5: Composite process for 1990 and 2019 satellite images.



Classification

This step includes implementing pixels to define LU/LC classes in classification and image analysis. The Coordination of Information of the Environment (CORINE) land cover system, has been employed in the classification (Feranec et al., 2016) (Table 3).

Table 3: Land use classification used in the literature (compiled after Feranec *et al.*, (2016).

Classes of land use	Definition
Urban area	Settlement, highways, transportation, public places and educational premises, industrial or commercial sections
Agricultural areas	Wet or dry farming land
Forests	Forests
Water	Sea, lake and dam
No data	Black regions, outside of the desired area

Accuracy Assessment

Image pixels are assigned to a land use/land cover category by users during classification and image analysis. The categories demonstrate as characteristics of the objects or specific theme or condition in a desired area (Fielding and Bell, 1997). Here, we follow similar way; satellite images adapted for analysis were classified according to CORINE land cover system: classes are determined as settlement, wet-land farming, dry-land farming and bare areas (Feranec et al., 2016). It is a controlled classification method that expresses the process of use with similar examples already known/experienced in the classification system of unknown similar pixels. In the analyses, an average of 70 sample areas were defined in the data of 1990 and 2019, and data sets were created (Lillesand & Kiefer, 2015). Land cover maps were also produced using the Maximum Likelihood technique, which benefits the average and deviation values of the sample areas to predict the probability of the pixels of each class by using training data sets (Eastman, 2015). Kappa Index of Agreement (KHAT) defined as *k* adjust accuracy in the classified data related to reference data in a data base. The Kappa is the value that express degree to which classified datum is distributed in the matrix of error. The Kappa value is calculated in 0 to 1 scale. If this value is above 0.80, then the analysis gives more reliable results (Congalton & Green, 1999). The Kappa is reckoned as:

$$K = P_{(o)} - P_{(e)} / 1 - P_{(e)} \quad (1)$$

where $P_{(o)}$ is the observed distribution of agreement and $P_{(e)}$ is the distribution predicted by probability (Berry et al., 2014; Lin, 2013).

In order to perform accuracy analysis of the obtained maps, 50 sampling points were defined for both maps using the Stratified Random sampling method (Jensen, 1991). As a result of the error matrices, 83% accuracy for 1990 and 89% for 2019 were achieved. Kappa values were found to be 68% and 79%, respectively (Tables 4 and 5).

Table 4: Accuracy estimation for the 1999 land cover mapping.

	Settlement	Wet-farm Land	Dry-farm Land	Bared Land	Total	User`s Accuracy (%)
Settlement	4	1	1	0	6	66
Wet-farm land	0	1	0	0	1	100
Dry-farm land	0	0	31	1	32	97
Bared land	0	0	5	6	11	55
Total	4	2	37	7	50	
Producer`s Accuracy (%)	100	50	84	86		84
1990 Overall classification accuracy = 83%, Overall Kappa statistics = 68%						

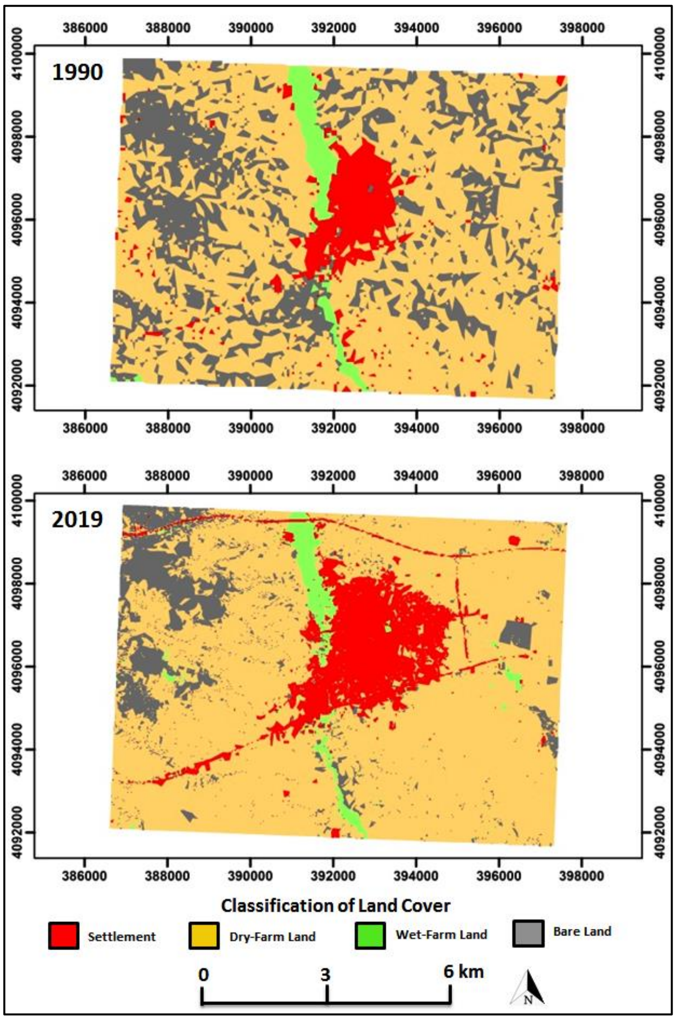
Table 5: Accuracy estimation for the 2019 land cover mapping.

	Settlement	Wet-farm Land	Dry-farm Land	Bared Land	Total	User`s Accuracy (%)
Settlement	4	3	0	0	7	55
Wet-farm land	1	2	0	0	3	68
Dry-farm land	0	0	32	1	33	97
Bared land	0	0	1	6	7	88
Total	4	5	34	7	50	
Producer`s Accuracy (%)	76	45	98	86		88
2019 Overall classification accuracy = 89%, Overall Kappa statistics = 79%						

ANALYSIS

LULC analysis of Nizip city illustrates the urbanization for the last three decades. The city area, which covered the eastern edge of the Nizip Stream in 1990 in the north-south direction, towards the east in 2019. Urban sprawl including newly constructed buildings, roads and concrete recreation areas which can interfere with natural resources. This situation has led to constant change and transformation in land cover and use in urban areas. In addition, the northeast and east centred growth observed in Nizip, shows possible expanding directions for future periods. The Gaziantep-Sanliurfa highway project has also influenced the settlement distribution aligned to the north (Figure 5).

Figure 5: Classification of land cover maps of 1990 and 2019.



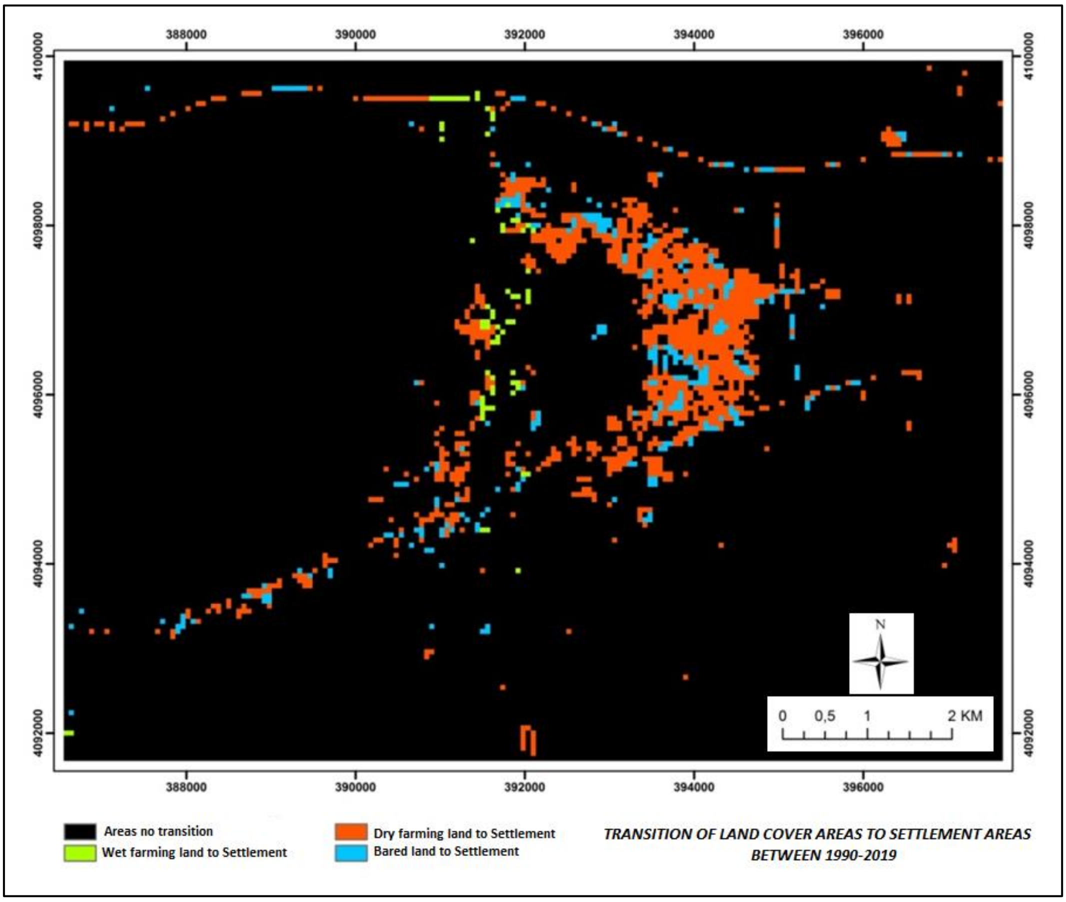
Considering the change in the study region, the settlement area with 555,3 ha in 1990 has transformed to 1000,4 ha in 2019 with an increase of 445,1 ha equal to 11,9% in total area of 8382 ha. An increase has been observed in dry farming land; where the area was 5406.2 ha in 1990 and reached 6231.6 ha in 2019 with a gain of 825.4 ha. The other significant change has been observed in the transition of bare areas in the north, south and eastern parts to dry farming lands. The bare land, which constituted 25.77% of the total area with 2160.8 hectares in 1990, decreased to 897.5 ha (10.7%) in 2019 with a loss of 1263.3 ha (Table 6).

Table 6: Land cover change in percentage values (%).

	1990		**2019**		**1990-2019 Area changed (ha)**
	ha	**%**	**ha**	**%**	
Settlement	555,3	*6,62*	1000,4	*11,93*	+445,1
Wet-farm land	259,6	*3,09*	251,7	*3,0*	-7.9
Dry-farm land	5406,2	*64,49*	6231,6	*75.5*	+825.4
Bared land	2160,8	*25,77*	897,5	*10,7*	-1263,3
Total	8382	*100*	8382	*100*	

During the period of 1990 to 2019, settlement areas has expanded mostly to the north east and east direction and during this development dry farming land has been occupied by the settlements. In conclusion, the analysis implies that the city area has expanded on the dry farming area in the east, resulting in the destruction of ecosystem, as converting farming lands into concrete settlement areas (Figure 6).

Figure 6: Change in land cover areas to settlements between 1990 to 2019.



DISCUSSION AND CONCLUSIONS

In this study, we have employed Land use and land cover change analysis on satellite images in Nizip city for 1990 and 2019. Four primary classes namely settlement, wet-farm, dry-farm and bare lands derived from the analysis according to CORINE land cover classification. The land use and land cover analysis show apparent changes in settlement area in the city between 1990 and 2019.

In the year of 1990, the Nizip area involved considerable small scale of settlement area where dry farmland was the prevailing land cover type. Dry farmland consists of 64.5% land cover with 5405,1 ha in the total of 8382 ha. The bared land was the second prevailing land cover which illustrates 2160.7 ha with a 25.8% rate in total. Settlements and wet land farming were 556,5 ha and 259.7 ha with rates of 6,6% and 3,1%, respectively. In 2019, following the developments in industry and economy in Turkey, main settlement areas were able to progress without hindrance and expand in NE and E directions as well as increasing along the main transportation lines.

In an evaluation of the last three-decade frame, there is an increase in the settlement area with 439,4 ha forms a 995,3 ha with a rate of 11.8%. On the other hand dry farm land has increased 831,4 ha and forms 6236,5 ha with a rate of 74.5% in total. In contrast the bared lands have declined steadily with a 1265 ha loss in total whereas wet farm land has slightly increased with 5,8 ha. At this point, many factors such as industrial activities, improvement of transportation networks and development in health services have led to continued population growth in the study area.

The demographic graphics also show an increase in population in the city centre for the last three decades. The reasons for this migration can be discussed as follows. The share of rural population in the total population, decreased below 50% since 1970 when industrial facilities had been started. As consequences of urbanization, city centres became attraction point for the public which results in powerful migration from rural areas to the city centre. In 1990s, according to border trade with Iraq and Syria, the fuel trade was at its peak. The number of companies that design truck carriers started to appear in the city centre. The need of manpower was met from the villages and most of the farmers were employed in this business. In 2000s the decline in rural population continued. During the construction and water impoundment phase in Birecik dam, some villages evacuated as a result of the expropriations and the people were moved compulsively to the city centre. In addition, the establishment of a municipal organization in the city centre, situations such as fragmentation of land in rural areas, insufficient income of existing lands and higher income of business in the city leads greater increase in city populations. As increase in the number of manufacturing facilities as well as service industry branches, results in increase in demand for the labour force, Nizip receives labour migration from neighbouring villages.

Today, the region where Nizip`s population shows the densest distribution is the central part of the city. Especially Fatih Sultan Mehmet (13137 inhabitant), Mimar Sinan (11974 inhabitant) and Sultan Abdülhamit (8890 inhabitant) neighbourhoods are high populated areas in the city centre. Many agriculturally based industrial enterprises such as olive oil, soap as well as grains are concentrated on the west and southwestern edge of the city due to its proximity to the transportation network. In addition, the population working in these premises has an E-W axis movement between the workplace and residence areas during the day time. It is estimated that the upper income group will move eastward due to its closeness to Birecik at a distance.

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