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REVIEW PAPER

Spatial development of Adapazarı City (Turkey) after the 1999 earthquake (1999–2017)

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Abstract

Determination of urban development directions and causes will provide useful information to decision-makers for urban planning. This study aims to determine the developmental aspects of Adapazarı, the central district of the Sakarya province, after the 1999 earthquake. In this regard, satellite images of 2000, 2005, 2010, and 2017 were used to determine the temporal and spatial developmental aspects of the city and the factors affecting this development. The ERDAS IMAGINE 2014 software was used in all phases of the processing of the satellite images. The ArcGIS 10.2 software was used to display reference maps for accuracy analysis and prepare output maps. Land use was determined using the generalized first level (level I) classification method developed by Anderson et al. (1976). The pixel-based controlled classification method was preferred in the study. The maximum likelihood method as the most commonly preferred controlled classification method was also used in the study. The study examined the urban development directions of the existing settlement areas, the zones of development, and the reasons why these areas were preferred in Adapazarı. As a result, it was determined that the city has experienced a rapid growth in the north, west, south, and east directions during the recent years. The city area of 1755 ha in 2000 reached 5971 ha in 2017. The first development direction of the city was towards the north. Serdivan, which is the closest area to the city center and also a convenient settlement area in terms of earthquakes, and the surrounding settlement have developed rapidly in the following period.

Keywords Adapazarı · Earthquake · Urban development · Remote sensing

Introduction

Settlement, settlement texture, population, and economic features depend largely on natural environment conditions. In other words, natural environment conditions affect the location, functions, and development of settlements (Curebal et al. 2008). Physical geography with human and economic activities suitable for settlement attracts human communities and forms main living centers by accelerating the development of settlement areas (Yıldız 2016). These densely populated areas, expressed as cities, maintain their natural development at varying rates depending on these characteristics.

This kind of changes and developments in cities may be attributed to one or more of the socio-economic, political, and climatic conditions of a region. However, the main factor behind these changes in cities is similar for most cities: population growth (Kafi et al. 2014). In the course of time, cities need renewal, transformation, resettlement, and improvement due to reasons such as overpopulation, economic reasons, inadequacy of social development, misplaced settlement, and natural disasters (Sisman and Kibaroğlu 2009). This resettlement or transformation may depend on the industry, trade, and service sectors, as well as natural factors. These factors directly or indirectly affect the development and direction of development of cities, and they may also cause cities to spread to areas not suitable for settlement. This causes agricultural areas to be

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zoned for construction/housing and areas without solid ground to become settlements.

Identification and monitoring of this spatial development of settlement areas are possible with remote sensing techniques. Rapidly developing remote sensing technology is widely used in provision, mapping, and evaluation of information on human-induced activities such as urban development, land cover and land use, as well as information on nature-induced activities (Curebal et al. 2008; Ikiel et al. 2012; Maktav et al. 2010; Babamaaji and Lee 2014; Kaya and Toroglu 2015; Yıldız and Doker 2016).

The use of very high-resolution (VHR) satellite data and processing of these data with remote sensing technology provide opportunities for extraction of urban features (Bhaskaran et al. 2010). Time-dependent changes in a settlement unit may be obtained by processing of its satellite images at different times and classifying the obtained data using geographic information systems (GIS) (Herold et al. 2003; Yılmaz et al. 2007).

Sakarya is located on a belt on the North Anatolian Fault System where the earth has experienced destructive earthquakes (1943-1957-1967-1999) (Kurt and Duman 2016). Particularly the 1999 earthquake caused severe damage to the city center. This earthquake, which completely destroyed the city center, has become an earthquake that affected the city's future because it led governmental authorities to take effective decisions on the current land use and future development of the city (Doldur 2003). Since the 1999 earthquake until now, the population of the city has continuously increased with the help of job opportunities, especially in the industry. In relation to this increase, urban settlement areas have shown a very fast development. However, not many studies have been carried out on towards which directions the urban development of the city, which is on a first-degree earthquake zone, has been. Additionally, in Adapazarı, which is also a significant agriculture city, the degree of the pressure of urban development on agricultural lands has not been researched much. Therefore, this study aims to determine the development directions of the central districts of the Sakarya province after the 1999 earthquake. The study discussed the development directions of the city after the earthquake and the factors leading to development. By examining the areas created by urban development, recommendations for a sustainable urban development were developed. The limited number of studies on this topic increases the significance and uniqueness of this study.

The spatial development and directions of the city after the earthquake were aimed to be revealed using Landsat satellite images. Thus, the speed of development in old settlements and places and the reasons for new settlements after the earthquake were examined. The obtained data revealed the development of the Adapazarı city with its details by presenting the area-based size of urban development after the earthquake, the directions of development, and the factors that affected these directions. Determination of urban development directions and causes will provide useful information to decision-makers for urban planning.

Study area

Sakarya is a provincial administrative unit located to the east of the Marmara Region in Turkey (Fig. 1). Adapazari is a city settlement centered on Sakarya. The city consists of four districts: Serdivan, Erenler, Adapazarı, and Arifiye. The city, which is located on the Adapazarı plain, is a plain settlement suitable for horizontal development due to its geographical location.

The Adapazarı plain, which was created as a result of the accumulation activities of the Sakarya River, has a very wide and flat alluvial ground base, which has been remarkable in terms of the population density and distribution, the spread of economic activities since ancient times, and the most important roads extending to Anatolia (Inandık 1952–1953; Bilgin 1984). Its proxy location to Turkey's major industrial and commercial centers (Istanbul, Kocaeli, and Bursa) has positively affected its development (Erten 2004). The city's economic structure was previously based on agriculture, but it has evolved rapidly in favor of the industry in the last decades.

Data and methodology

Data

The city's satellite images were obtained using USGS (United States Geological Survey Earth Resources Observation Systems). In order to obtain better results in determining spatial development, June and July, as the months with low cloudiness rate, were chosen. Since the study aimed to determine the urban development after the earthquake on 17 August 1999, Landsat satellite images of 4 different years of 2000, 2005, 2010, and 2017 were used. The study determined 5 different time periods, and the last interval period included 7 years to cover updated data. It was paid attention to keep same the row-column and resolution values of the Landsat satellite images with the spatial resolution of 30 m (Table 1). Google Earth, Landsat 7 satellite images, and aerial photos obtained from the GIS unit of Sakarya Governorship were used in the accuracy analysis of satellite image classification.

Method

The study was conducted in three stages. At the first stage, satellite images were obtained and made ready for classification. Subsequently, the existing satellite images were subjected to a classification process. The final stage consisted of

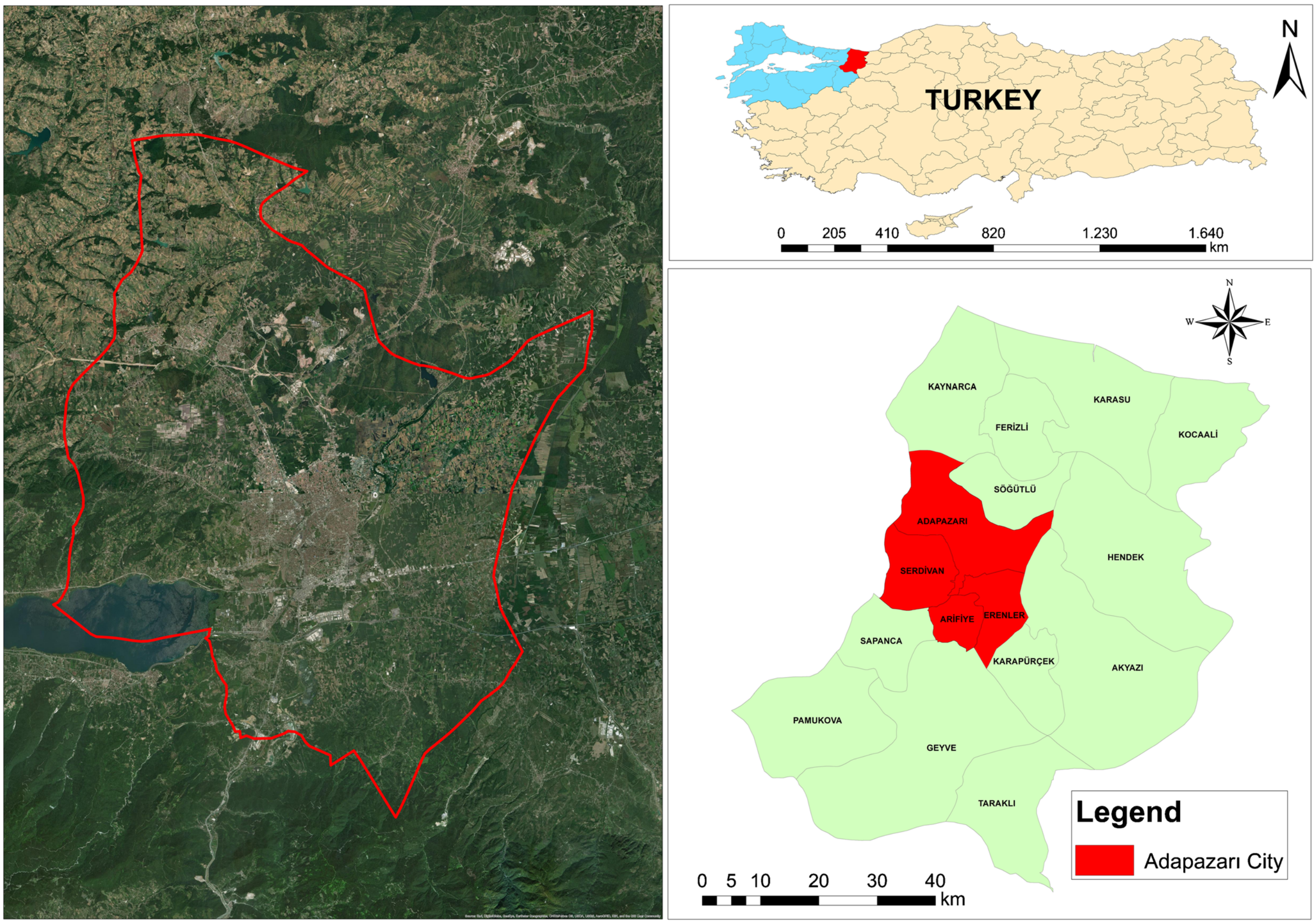

Fig. 1 The location map of the study area

construction of accuracy analyses (Fig. 2). The ERDAS IMAGINE 2014 software was used at all stages of processing satellite images. The ArcGIS 10.2 software was used to display reference maps for accuracy analysis and prepare output maps.

Definition of land use classes and classification

Land use was determined using the generalized first level (level I) classification method developed by Anderson et al. (1976) as follows: settlement area, agricultural land, forest, and water bodies (Table 2).

Thus, the land use classes needed to make the classification and the areas they represented on the satellite images were determined. Following determination of the land use classes, preliminary studies were carried out for the classification stage. In this sense, the first stage consisted of the segmentation process.

Segmentation is the process of disassembling an object and background or regions with different features in an image (Dogan 2008). This process, which is the first step of classification, aims to extract meaningful objects from the image (Maktav et al. 2010). To do this, segmentation was applied on the satellite images, and each satellite image was made ready for classification. Sampling areas were created on the satellite images for each land class, and it was considered to be over 100 to increase the classification accuracy of the total sample areas of these four classes. All these sampling areas

Table 1 Satellite image features

	2000	2005	2010	2017
Satellite sensor	Landsat 7 ETM+	Landsat 7 ETM+	Landsat 7 ETM+	Landsat 8 OLI TIRS
Display date	27.07.2000	23.06.2005	07.07.2010	02.07.2017
Row-column	179–32	179–32	179–32	179–32
Resolution (m.)	30 m.	30 m.	30 m.	30 m.

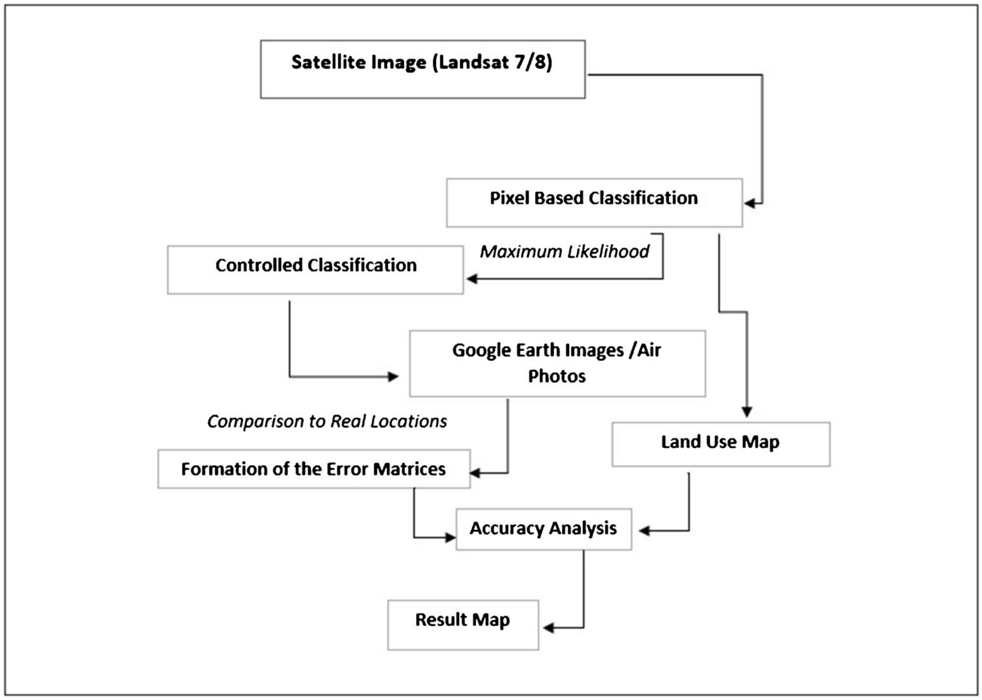

Fig. 2 Satellite image analysis workflow diagram

were created by taking the spectral characteristics of the images into account and comparing them to the actual maps of the present year.

In classification based on segmentation results, the image is firstly segmented and then classified based on the mean spectral information of the segments. Pixel-based classification identifies the class of each pixel by comparing its value to the training data and allocates it to a proper class based on a certain algorithm (Gao et al. 2007). Pixel-based classification methods may be roughly divided into two categories as controlled and uncontrolled classification. The analysis is controlled in the controlled classification method with higher accuracy (Babamaaji and Lee 2014). The maximum likelihood method as a controlled classification method provides good results in urban areas and can control the number and quality of desired classes (Bauer and Steinnocher 2001). Pixel-based classification yields better results in multi-band and low spatial resolution (Kalkan and Maktav 2010). Therefore, the pixel-based controlled classification method was preferred in this study. Among controlled classification methods, the maximum likelihood method, which is the most frequently preferred method in grouping the numerical values of pixels in satellite images, was utilized.

In studies in the literature, the maximum likelihood method is among the controlled classification algorithms that come to mind first with its prevalent usage. It is one of the most effective methods in classification of satellite images. Maximum likelihood uses statistical values as variance, covariance, and mean value (Mather and Koch 2011). In our study, too, probability functions were calculated for the classes that constituted the control areas. The values obtained from here were used to compare to which class the pixels in the image were the closest. The process was ended by assigning the candidate pixel to a maximum likelihood group after calculation of its probabilities of belonging to each class. According to Tombus (2019), in this method, it is assumed that the information constituting the image data is normally distributed. In addition to the brightness values of pixels, the method also uses variance-covariance matrix information for the purpose of increasing the discriminatory power for each class.

Table 2 Definition of land use classes

Land use classes	Definition
1. Settlement area	Settlement, roads and transportation areas, education and public spaces, commercial and industrial areas
2. Agricultural land	Arable areas, fields, vineyards and gardens, meadows and pastures
3. Forest	Broad-leaved and coniferous forests, mixed forests
4. Water	Seas, lakes, dams, streams and channels

Table 3 Accuracy analysis results of land use map for 2000

	Urban area	Agriculture	Forest	Water bodies	Total	User error %
Urban area	*58*	12	1	0	71	22%
Agriculture	1	*125*	9	0	135	8%
Forest	0	7	*100*	0	107	7%
Water bodies	0	0	0	*21*	21	0%
Total	59	144	110	21	*334*	
Producer error %	1%	15%	10%	0%		9%

Italicized values: correctly classified sample point number in real land use

Since they have the best and most striking feature of reflection in image classification, green, near-infrared (NIR) and short-wave infrared (SWIR) (Yıldız and Doker 2016) values were used. Composites were applied to the 2, 4, and 5 bands in the satellite images of the years 2000, 2005, and 2010, and the 3, 5, 6 bands in the satellite image of the year 2017, reflecting these values.

Accuracy analysis

The stratified random sampling method was used for the accuracy analysis of the classified satellite images. Accuracy analysis was applied to the land use maps of the years 2000, 2005, 2010, and 2017, and then, the error matrices were obtained. Google Earth, Landsat 7 satellite images, and aerial photos obtained from the GIS unit of Sakarya Governorship were used in the accuracy analysis of the classification. Sampling points taken for each year were plotted on the land use maps, and each point was compared accounting for the classification image and real land classes. The real class values corresponding to each of the sample points were defined (Tables 3, 4, 5, and 6).

The final step of the accuracy determination process is to compute more quantitative accuracy measures such as classification accuracy, producer accuracy, consumer accuracy, omission error, function error, and kappa coefficient by using all the information content of the error matrix derived from utilizing the classified image to be evaluated for accuracy and the reference data for which the accuracy of the same area has been accepted (Yener et al. 2006).

As a result of the accuracy analysis for the satellite images, the urban area user and producer accuracies for the year 2000 were found to be 78% and 99%, respectively. For 2005, they were determined as 89% and 99%, respectively (Tables 3 and 4).

The urban area user and producer accuracies for the year 2010 were found to be 86% and 99%, respectively, whereas for 2017, they were determined as 99% and 71%, respectively (Tables 5 and 6). As a result, the user and producer errors were below 50% for the four periods. These ratios also indicated that the errors were on a low level.

The general accuracy, which is another measure of the error matrix, is calculated by dividing the sum of the inputs forming the main diagonal form (i.e., the number of accurate classifications) by the total number of samples taken for a given classified image or map (Story and Congalton 1986). The general accuracy was calculated for each table as follows:

For Table 3**:**

$$\frac{58+125+100+21}{334}=\frac{304}{334}=0.91\%$$

For Table 4**:**

$$\frac{117+113+96+21}{376}=\frac{347}{376}=0.92\%$$

For Table 5**:**

$$\frac{98+145+100+22}{398}=\frac{365}{398}=0.91\%$$

Table 4 Accuracy analysis results of land use map for 2005

	Urban area	Agriculture	Forest	Water bodies	Total	User error %
Urban area	*117*	13	1	0	131	11%
Agriculture	0	*113*	10	0	123	8%
Forest	0	5	*96*	0	101	5%
Water bodies	0	0	0	*21*	21	0%
Total	117	131	107	21	*376*	
Producer error %	0%	15%	11%	0%		8%

Italicized values: correctly classified sample point number in real land use

Table 5 Accuracy analysis results of land use map for 2010

	Urban area	Agriculture	Forest	Water bodies	Total	User error %
Urban area	*98*	14	0	0	112	14%
Agriculture	0	*145*	15	0	160	10%
Forest	0	4	*100*	0	104	4%
Water bodies	0	0	0	*22*	22	0%
Total	98	163	115	22	*398*	
Producer error %	0%	12%	15%	0%		9%

Italicized values: correctly classified sample point number in real land use

For Table 6**:**

$$\frac{131+107+104+21}{422}=\frac{363}{422}=0.86\%$$

The kappa statistic value was also calculated in this study. The Kappa statistical values for the years 2000, 2005, 2010, and 2017 were calculated as 91%, 92%, 91%, and 86%, respectively.

Results

This study was conducted to determine the development direction of the city of Adapazarı after the 1999 earthquake which led to heavy destruction at the city center and adoption of significant decisions in the development of the city, as well as the influential factors. In this context, satellite images of the year 2000 were used to determine the first city development directions after the earthquake. It is observed from the land use map of the year 2000 that a new settlement area was added to the existing city settlement in the north direction (Fig. 3a). The city, which had shown development over the Adapazarı plain until this data, started to develop outside the plain for the first time. The total area of the city in this period was 1755 ha (Table 7).

This was because the central and local governments aimed to direct the city population after the earthquake to areas with more solid ground. For this purpose, permanent residential areas were established in the Karaman, Camili, and Korucuk districts located in the north of the city. The housing construction in the north side also affected the development direction of the city (Hayır and Akyol 2009). In the first place, Camili and Karaman were the areas attracting the population (Fig. 4, area no. 1).

It was observed that the city continued to develop northward between 2000 and 2005 (Fig. 3b). The Korucuk district was observed among the intensively settled areas during this period. People who suffered from the 1999 earthquake had previously settled in this region. However, the population of the region has increased over time due to the housing projects with affordable prices, low rental rates, transportation of governorship units to this area, opening of public and private education institutions, and construction of important health institutions in the region (Fig. 4, area no. 1).

The city was observed to develop in three directions between 2005 and 2010: north, west, and south (Fig. 3c). The most striking direction of this development is development of the central district of Serdivan towards the west direction.

The fact that new residential areas in the north are located about 20 km far from the old settlements and the city's commercial center has led many of those accustomed to easy accessibility to the city center to return to their former residential places. However, the earthquake risk, which makes the city center unsafe for residential purposes, has created a great demand for places with solid ground closer to the city center. One of these places is Serdivan, so it has become one of the places where the people living in the Adapazarı plain have wanted to live most (Hayır and Akyol 2007). This is one of the important reasons for the development of the city towards the west, Serdivan. The

Table 6 Accuracy analysis results of land use map for 2017

	Urban area	Agriculture	Forest	Water bodies	Total	User error %
Urban area	*131*	2	0	0	133	1%
Agriculture	38	*107*	6	1	152	42%
Forest	0	12	*104*	0	116	11%
Water bodies	0	0	0	*21*	21	0%
Total	169	121	110	22	*422*	
Producer error %	29%	13%	5%	4%		14%

Italicized values: correctly classified sample point number in real land use

Table 7 Spatial development (ha) and population in Adapazarı (2000–2017)

Year	City area (ha)	City population
2000	1755	283,752
2005	2525	321037[1]
2010	4239	414,537
2017	5971	535,261

Source: Population data obtained from TURKSTAT

[1] Since there were no census data for 2005, it was calculated according to the annual population growth rate

settlement areas in Serdivan were not built by local and central administrations. The choice of location and settlement has evolved entirely depending on individual preferences. The Serdivan Hills, which are the nearest to the present city, have become new settlement areas for middle- and upper-income groups (Karakuzulu et al. 2014).

The first residential areas in Serdivan consisted of residential areas built in a site plan style with low-rise villa-type houses. However, in the following period, especially after 2005–2006, the rapid development of the Sakarya University campus and the increase in the number of students day by day and the accompanying increase in need for housing in the form of dormitories and shared hotel-style dwellings have promptly turned the city's direction towards this district. As the population has increased (by 3.3 times in the last 17 years), the number of commercial establishments has increased in this district. This region has become an area especially concentrated in cafes, restaurants, and other social areas which are appealing to students. The increase in the number of private hospitals, opening of shopping malls, and increase of park and garden areas of the municipality, as well as orientation of new road routes to this region, also have created a gravitational force towards Serdivan (Fig. 4, area nos. 2–3).

The urban development continued in all directions between 2010 and 2017 but it intensified more in certain areas (Fig. 3d). Particularly the Yazlık settlement in the north, Arifiye and Erenler in the south, and Serdivan in the west are the most developed areas in this period. The spatial development of the city towards Arifiye led Arifiye to become a central district in 2008. Despite the large industrial establishments (Otokar, Goodyear, etc.) in this region before the earthquake, the development of the city in this direction was extremely weak. As Arifiye has become a central district, a slow spatial development has been observed in this direction. Transportation of the intercity bus terminal to Arifiye in 2011 was another factor accelerating its development process. Additionally, mass housing projects have also been initiated in this area (Fig. 4, area no. 6).

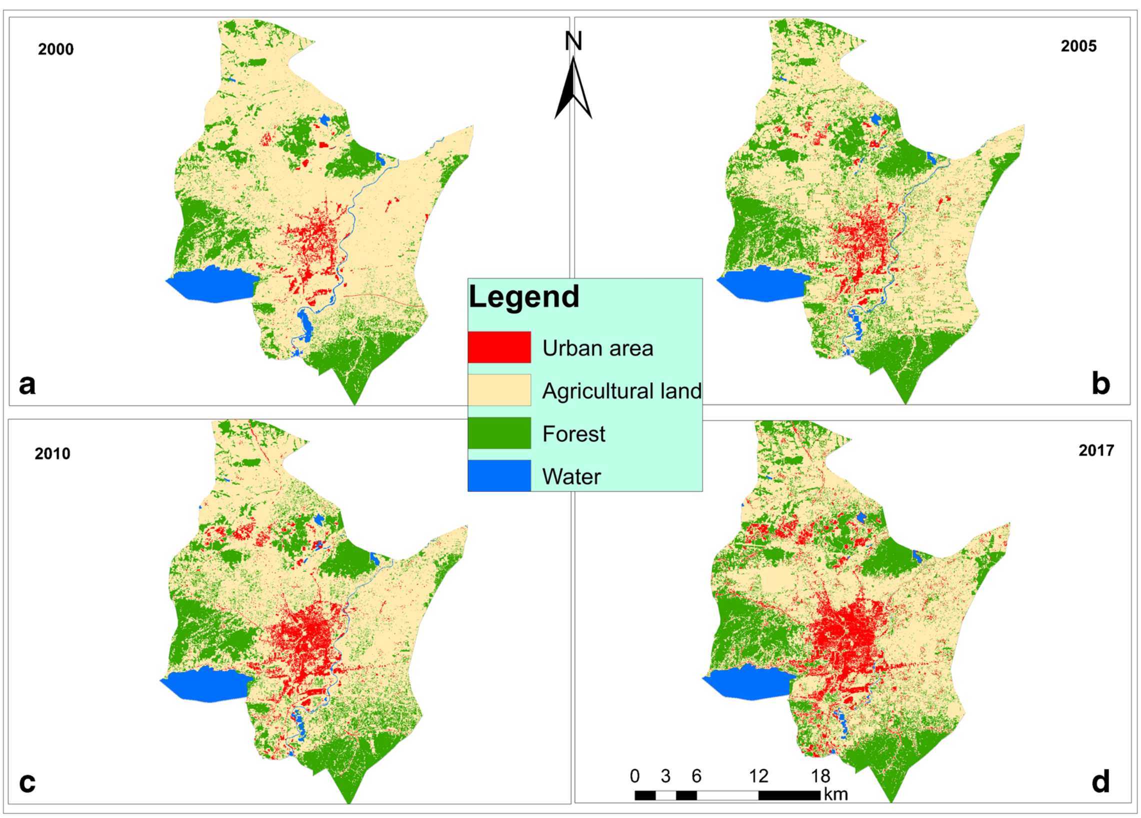

Fig. 3 The growth process of Adapazarı (2000–2017). **a** 2000, **b** 2005, **c** 2010, **d** 2017 Urban development

The same driving force shaping the development direction of Arifiye has also played a similar role in the spatial development towards the Erenler district. The fact that Erenler has become a central district in 2008 accelerated the spatial development of this area. Additionally, opening of a shopping center in the district, implementation of the first urban transformation projects in Erenler, and construction of green spaces such as parks and gardens have increased the socio-cultural standards of the area (Fig. 4, area nos 4–5).

The development areas of 2, 3, 5, and 6 in the study field draw the attention as the areas where agricultural land was misused. The city, which is located on one of the major seismic zones of the country, has a limitation on the number of floors in buildings with a permission of maximum 3 floors. However, this situation causes the city to grow more horizontally and lead city-dwellers to misuse agricultural areas due to the rapidly increasing population demand for housing. This has been because the city population has increased by 1.9 times, and the urban area has increased by about 3.4 times in the last 17 years (Table 7).

Discussion

The destruction created by the latest large and destructive earthquake experienced by Adapazarı led some radical decisions on urban development to be taken. These decisions made in 2000 led to creation of new settlement areas outside the center of Adapazarı. While new settlements were established on more earthquake-resistant areas, some government offices were also shifted to these areas for the sustainability of urban development. Right after the earthquake, urban development took place in the expected direction. However, the diminishing psychological effects of the earthquake and commercial concerns have led urban development to progress outside the decisions that were made. This situation is clearly seen in the directions towards which the city showed development in this process. While the urban development in the period of 2000–2005 consisted merely of the newly planned settlement areas, after 2005, in addition to this direction, development also gained momentum towards the directions of west and south.

This situation was related to having overcome the psychological effect of the earthquake and the desire to be close to the commercial center of the city. Leaving location selection completely in the hands of individuals has also become effective in the current development. In this context, the location closest to the center, Serdivan, has turned into a new settlement area for people with middle- and high-income status.

In the following process, in line with transportation, industry, and other investments, urban development showed itself on geomorphological units that are unsafe for earthquakes. The development towards the west and the south is an example of this. Moreover, in relation to the limitation of the number of floors that can be built regarding the earthquake risk, horizontal growth is continuing at the basis of the plain for the housing needs of the increasing population. Approximately 40% of the total area of the city in the last year (5971 ha) resides on agriculture lands with slope values of 5° or lower. The residential units with flat and close-to-flat slope values are the Adapazarı and Arifiye central districts. However, in Adapazarı, which is a significant agricultural city, it is

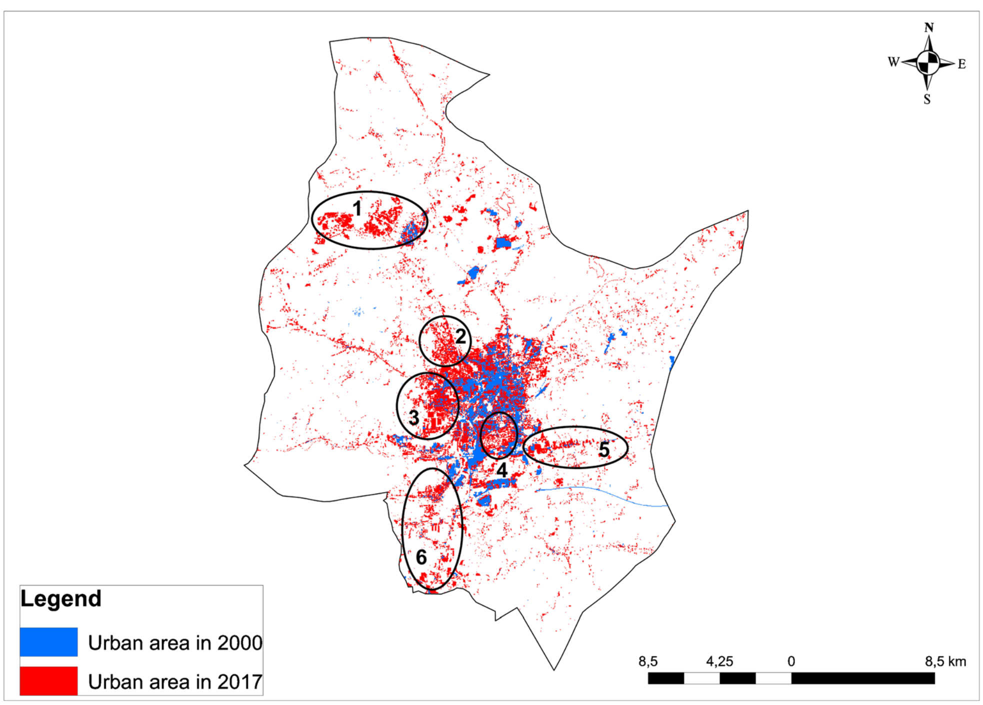

Fig. 4 Urban development directions

important to prevent the urban development towards these fertile agricultural lands. Considering the agricultural potential of the city and the contributions it made to the country's agriculture, this significance rises even more.

Adapazarı, which is a city of industry and also agriculture, showed a 3.4-fold urban development in the short period of time after the earthquake. This increase is only the development experienced in the central districts of the city. In addition to the natural increase in population, the population of the city constantly increases with migration. Considering the job opportunities offered by the city, it may be stated that this phenomenon of migration will continue increasingly. The position of the city in an earthquake zone leads to restrictions on vertical development, that is, number of floors. In this case, horizontal architecture has become a necessity in the city, and the urban spread reached even broader areas. For the residential needs of the increasing population, the base of the lowland close to central job areas is preferred. When education and health investments are made in these areas, it becomes inevitable for urban development to progress in these areas. These earthquake-prone and first-degree agricultural lands are filling with housing fast. However, considering the heavy destruction with losses of life and property experienced in the last earthquake, the progression of development in these directions is concerning.

Therefore in the city that is located on a first-degree earthquake belt and experienced heavy damages in the 1943, 1957, 1967, and 1999 earthquakes, the properties of the ground should be reevaluated rather than socioeconomic concerns in spatial development. Development of residential areas that are safer for earthquakes towards the north (Camili, Korucuk, Karaman) which showed a development by the hands of the state after 2000 should be promoted. The fact that they are physically separated from the city center has been effective in the failure of these residential areas in developing to a desired extent. On the other hand, the Yazlık settlement, which showed a development in the period of 2010–2017, has achieved a connection among these settlement units that are considered relatively distant from each other and made this connection more sustainable. If the process regarding planning is managed well, the horizontal growth continuing towards the south, east, and west of the plain may be shifted towards the hill areas to the north with this advantage. This way, urban development may be carried from earthquake-prone areas with fertile agricultural soil and high levels of underground water resources towards hill areas which are more resistant to earthquakes. Furthermore, transportation systems whose construction towards the north is continuing will make the area more attractive for commercial workplaces which are lacking in these regions. If local governments consider the issues discussed above in their planning, more sustainable urban development may be achieved.

Conclusion

In order to spatially and temporally present the urban development of Adapazarı and its surroundings after the 1999 earthquake, the Remote Sensing and Geographic Information Systems technologies were utilized. A controlled classification method was used in the study. The general accuracy of the classification for the years 2000, 2005, 2010, and 2017 was respectively 91%, 92%, 91%, and 86%. The direction of development was revealed by the analysis of Landsat satellite images with date intervals suitable for the purpose. The data obtained by processing satellite images helped the determination of the spatial development. Determination and assessment of the geographical factors influential on the development directions that were determined as a result of the analysis were also performed.

As a result of the assessments, it was determined that the city area of 1755 ha in 2000 increased 3.4-fold in 17 years and became 5971 ha. In this process, the highest annual development rates of the city were in the period of 2005–2010. Urban development took place mostly at the basis of the plain and on fertile agricultural soil. In the process of spatial development, Adapazarı has shown a fast growth in the north, west, south, and east directions in the last 17 years. In Adapazarı, which is a city established on a plain, while urban development took place towards every direction, it was to the highest degree towards the west. Considering socioeconomic factors in addition to private and public investments, it may be projected that this development in this direction will continue. This is because, in the period of 2000–2005 right after the earthquake, it was seen that urban development was shifted towards the north, meaning more suitable areas in terms of earthquake safety, by the state. Considering the directions of development after 2005, it was seen that development took place at the basis of the plain again.

Therefore, the urban development after 2005 is progressing on agricultural lands which are weak in terms of earthquakes and have high levels of underground water. For this reason, to prevent the use of agricultural lands outside their purpose and minimize earthquake-related damages, it is important to stop the development in this direction. Shifting the development towards hilly areas that are more earthquake-resistant in the north and northwest of the city will contribute to establishment of a more sustainable settlement area. Stopping the urban development over agricultural lands is also important for the continuity of the agricultural production of the city. In the city which is at high ranks in the country in terms of many products, preservation of these lands carries importance in terms of feeding the population of both the city itself and the entire country. Thus, local decision-makers need to shift investments to earthquake-resistant and low-agricultural-quality areas for a sustainable city and sustainable urban development. More determined policies need to be practiced in residential location selection, and not only building stocks but also residential location selections should be inspected. The current housing based on individual preferences should only take place in areas determined by local governments with changes in development plans.

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