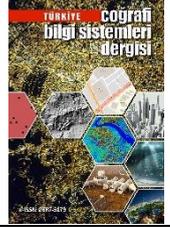




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Spatiotemporal Variations of Urban Growth in Denizli, Turkey

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Keywords

Urban Growth
Spatiotemporal Variations
Urban Sprawl
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ABSTRACT

The existence of natural resources is under threat among various land use types because of the urban sprawl regarding the increase of population density such as forests, pastures, agricultural areas, water resources, etc. These resources have been lost significantly due to differentiating factors such as disasters, physical pressure originating from urbanization and development dynamics, irreversible use of resources, etc. Among these resources, especially agricultural areas in different abilities from I to III are affected primarily from the non-agricultural use of agricultural areas. The main purpose of study is to determine the spatiotemporal variations of urban growth using Geographical Information Systems (GIS) and Remote Sensing (RS) techniques in central districts of Denizli city. The satellite images presenting the spatial changes due to urban growth in central districts (Merkezefendi and Pamukkale districts) between the years 1990 - 2018 and also 1/25.000 scaled topographic maps are used. As a result, it is observed that the existing urban macroform have changed and the misuse of natural resources have increased significantly in the 30-years period. These uses have changed in accordance with urban plan decisions based on the site selection of industrial areas and main transport routes. The effects of urban sprawl are evaluated in terms of urban planning discipline and important policies are developed in order to prevent the misuse of natural resources under threat of urbanization.

1. INTRODUCTION

The world has experienced significant changes affecting cities and urbanization in recent years. The interaction between rural and urban areas increased and reached different dimensions with the developments and population pressure. The process of urbanization has accelerated with the rapid population growth and differences in the way of production. This situation also brought about population accumulation in the cities. While there has been a one-way movement of labor and capital from rural to urban areas in the past, today there is a mutual interaction between rural and urban areas.

The concept of urbanization is affected by developments in the technology, innovation, construction and transportation sectors. These developments have led to the urban sprawl and almost all cities around the world have shown a tendency to expand into their surroundings. The process has many economic, ecological and social consequences. The rapid

population growth, the increase in consumption demands, the uninhibited expansion of cities and the environmental pressures of industrial development have brought the ecological dimension of cities to the fore. Cities are changing the conditions of the ecosystem and natural cycles due to the heat, energy, waste and impermeable surfaces. Because the agricultural lands, forest areas and natural landscapes around the cities are constructed as a result of the urban sprawl. Also, when these areas are built, their values cannot be replaced again.

The relationships of rural and urban dwellers to different dimensions has brought depending various reasons such as the tendency to live in an urban area, getting rid of negative effects generating people's demand of sheltering more cheaply, getting over negative effects of noise, traffic, etc. Increasing urbanization has become a major problem for decision makers with negative impacts on natural resources such as land and water resources. The interaction between the urban and rural areas manifested firstly itself in the

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large regions, and then spread to the small regions and districts where agricultural production is primary sector. While urban sprawl has been previously seen only as a problem caused by urbanization, today it has taken on a complex structure that directly concerns natural resources and the agricultural production.

From this point of view, it is aimed to determine the spatiotemporal variations of urban growth using Geographical Information Systems (GIS) and Remote Sensing (RS) techniques in central districts of Denizli city. The satellite images presenting the spatial changes due to urban growth in central districts (Merkezefendi and Pamukkale districts) between the years 1990 - 2018 and also 1/25.000 scaled topographic maps are used. As a result, it is observed that the existing urban macroform have changed and the misuse of natural resources have increased significantly in the 30-years period. These uses have changed in accordance with urban plan decisions based on the site selection of industrial areas and main transport routes. The effects of urban sprawl are evaluated in terms of urban planning discipline and important policies are developed in order to prevent the misuse of natural resources under threat of urbanization.

2. THE CONCEPTUAL BACKGROUND of SPATIOTEMPORAL CHANGES in URBAN MACROFORM and CASES

Generally, the concept of land use refers to anthropogenic activities and the economic function of the land in the settlements. The discussions on the types of land use and also the changes in settlements' macroforms are mainly related for agricultural purposes and natural resources' usage. In fact, this concept should mean to be used for all types of urban activities such as sectorial changes, industrial production, the use of fossil fuel, transportation, the components of built environment, etc. (Reis et al., 2016). The increasing consumption of all kinds of goods and services has increased the importance of land which is necessary for people to continue their lives due to the rapid population growth (Tümertekin & Özgüç, 2009). Urban activities and observed changes in natural processes have caused many changes in land use (Zhan et al., 2002). Although this change has occurred over the years and also developing technology has caused this change to accelerate (Gözenç, 1977).

The economic growth and industrialization policies that have been developed in developed countries in the early 1900s and in developing countries in the 1950s have brought along immigration and rapid urbanization (Karakayacı & Karakayacı, 2012). The improvements in transportation also affected the development of cities and the immigration from rural areas to urban areas has been experienced. (Akseki, 2011). The mobility that has started in the 1950s with the migration from rural to urban areas has forced citizens to choose regions differ from the urban central areas in Turkey. This phenomenon has also constituted unplanned built environment (Türkten, 2015).

The expansiveness of current urban land use pattern has occurred towards to city periphery because

of the housing need that is one of basic needs of growing population in cities (Akseki, 2011). As a result of this expansiveness, a new growth form of cities as noncontinuous and including unused areas began and this process is called urban sprawl (Karataş, 2007). Definite areas under the pressure of urban sprawl have some characteristics. Actually, these areas have lost their rural characteristics by the time (Karakayacı & Karakayacı, 2012). Urban sprawl can also be directed towards natural areas in the city periphery because of some functions start to choose definite regions in this periphery (Akseki, 2011).

The soil contains not only its natural potential and the built environment related to the human civilizations. According to Keleş and Hamamcı (2015), the importance of soil from human perspective stems from the economic and social function of it. In addition, the situation of soil has made it the main object of current urbanization problems that allows the settlements in built environment (Keleş & Hamamcı, 2015). Cities have always been established around or on fertile cultivated areas from the past (Akseki, 2011). The process of urban areas' spreading towards the surrounding agricultural lands has caused the irreversible destruction of fertile agricultural land over time (Türkten, 2015).

The irreversible destruction of fertile agricultural land raises the importance of the sustainable agricultural facilities. This phenomenon is generally expressed as a form of agricultural production that meets the nutritional needs of people, preserving the natural resources necessary for today and future generations (Eryılmaz & Kılıç, 2018). Because of developments in rapid urbanization process, the soil is removed from being a means of production. Actually agricultural lands are used for non-agricultural purposes depending industrialization, unhealthy and rapid urbanization, inefficient use, tourism investments, etc. (Sezgin, 2010). Among these purposes, there exist various urban facilities such as urban settlements, transportation, tourism, industry, etc. (Karakayacı & Karakayacı, 2012). The demand for these agricultural areas increases due to the cheap land prices and topographic conditions of these lands (Türkten, 2015).

This change with the phenomenon of urban sprawl results in definite negative consequences of non-agricultural use of these lands. Among these consequences, there exist the unnecessary land usage, divided open spaces, the automobile dependency, large spaces between developed and developing areas, the lack of public areas and public centers, low-density residential and commercial areas, large financial disparities between settlements, different land use types in current land use patterns, etc. This situation has led to a change of ownership in land ownership. Moreover, current properties of these lands have led to physical plan decisions and the development process of these areas (Karataş, 2007). Land prices are causing the land speculation and gradually losing the property of being an agricultural area (Türkten, 2015).

Actually, the prerequisite for both the implementation of urban planning processes in an environmentally sensitive manner and the

implementation of sustainable land use plans successfully is the analysis of macroform changes due to physical plan decisions and the development process of urban areas (Bagheri et al., 2012). The main goal of this analysis is to determine the bearing capacity of natural resources and to support appropriate land uses without degradation of these resources in the long term (Cengiz et al., 2013). The analysis of spatiotemporal variations due to the urban growth is an interdisciplinary study (Prakash, 2003; Groot, 2006; Feizizadeh & Blaschke, 2012) and is expressed as a dynamic process governed by physical, economic and social conditions (Zander and Kachele, 1999; Herrmann & Osinski, 1999).

There exist many studies in the academic literature on the subject of spatiotemporal changes, which are used Geographical Information Systems (GIS) and Remote Sensing (RS) tools. Remote Sensing (RS) a branch of science that allows researchers to photograph the earth without any intervention with satellites and aerial vehicles and to obtain data about the relevant area through the resulting images (Sunar et al., 2016). Since satellite data is readily available and time-efficient, remote sensing technology has become one of the most commonly, used tools for the changes land use pattern and urban macroforms in recent years (Albarqouni, 2022). Therefore, Geographical Information Systems (GIS) provides the opportunity to present all kinds of communication between humans and nature to the user in a planned and reasonable way and to create analyses in which we can get the optimal benefit in terms of time and location (Koçak, 2009). It is also possible to define GIS as a set of technical instruments that allow collecting earth-related information for a specific purpose, storing, controlling, questioning, analyzing and displaying it in a computer environment (Tecim, 1999).

Gandhi et al. (2015) aim to find the vegetation change of Vellore Region between the years 2001 - 2006 via GIS and RS. As a result of a series of analyses by applying NDVI to satellite observations, it is determined that the built environment has been increased due to the urban growth, in contrast, the size of agricultural areas and forests decreased accordingly (Gandhi et al., 2015). Karabulut et al. (2006) have determined the changes in urban development and land use pattern using raster and vector-based change analysis methods in Kahramanmaraş city center. According to the results, it has been determined that the annual growth rate of the city is 11% and also many industrial structures have been established on agricultural areas recently (Karabulut et al., 2006). Gülersoy (2013) followed the change of land use and urban macroform in Çorum city center between the years 1987-2011 in his study. While there has been a significant decrease in pasture areas, there has been an increase in built environment in 25 years (Gülersoy, 2013). In the study conducted by Bayar and Karabacak (2017), the change of land use pattern in Ankara city is examined in the years 2000 - 2012 via CORINE data. It has been found that there is a negative linear relationship between the measured of agricultural areas and the development of the city of Ankara (Bayar & Karabacak, 2017).

Moreover, Denizdurdan et al. (2017) have examined the temporal changes in land use pattern and macroform due to the urban development in Afşin district by applying the uncontrolled classification technique on Landsat satellite images. According to the results, it has been stated that urban development has shown a continuous increase from 1984 to 2016 (Denizdurdan et al., 2017). In the study conducted by Kurt and Duman (2016), it has been aimed to determine the interactions between urban development, land use and geomorphological units in Sakarya city by using GIS and RS. It has been found that the site selection of residential areas is settled on agricultural areas, agricultural areas have also caused pressures on forest areas and led to a decrease in forest area and an increase in agricultural area (Kurt & Duman, 2016). Geymen (2016) followed the change of land use pattern and macroform temporally in Elmalı Basin, İstanbul city. It is observed that the residential areas in the Elmalı Basin have increased over the years, while the agricultural lands and forested areas have decreased (Geymen, 2016).

3. DATA and ANALYSES

Denizli city is located in the east of the Aegean region and is a gateway between the Aegean, Central Anatolia and the Mediterranean regions. The area of the city is 11.868 km². This city has this area and constitutes approximately 1.5% of Turkey and 18.5% of the Aegean region in terms of area size. As the study area, central districts (Merkezefendi and Pamukkale districts) of Denizli city are selected.

Pamukkale district is one of the central districts of Denizli and the area of this district is 186 km² (Denizli Metropolitan Municipality, 2022). According to the population data for the year 2022 obtained from Turkish Population Registration System directed by The Turkish Statistical Institute, the total population of Denizli city is 1,056.311 people, while the total population of Pamukkale district is 347.926 people. This district is the largest district of Denizli city in terms of population.

Merkezefendi district is another central district of Denizli and the area of this district is 282.42 km² (Denizli Metropolitan Municipality, 2022). According to the population data for the year 2022 obtained from Turkish Population Registration System directed by The Turkish Statistical Institute, the total population of Denizli city is 1,056.311 people, while the total population of Merkezefendi district is 329.451 people. This district is the second largest district of Denizli city in terms of population. Figure 1 shows the locations of Denizli Metropolitan City and central districts as the study area.

The selected districts are in the frame in terms of socio-economic development level in Denizli city. These districts are mainly affected from important developments in the industrial and service sectors and has strong trading network with both the city center and other counties in surrounding area. A definite development corridor that runs to the north west of the districts significantly affects the urban development

process mainly through logistical activities carried out from Izmir Port. The geographical connection between Denizli Metropolitan City and others as Izmir, Antalya, Ankara and Istanbul is provided by the important road connections that pass through these districts. Therefore, agricultural activities accounted for 4.6%, industrial activities for 42% and the service sector for 53.4% of the economic activities in the whole of central districts (Denizli Metropolitan Municipality, 2022).



Figure 1. The locations of Denizli metropolitan city and central districts

In this study, the spatial and temporal changes depending on the urban growth are determined in central districts located in Denizli city between the years 1990 - 2018 using GIS and RS techniques. For this purpose, the comparative satellite images are used which are representing spatial and temporal changes during the nearly 30 – year period. In the 1980s, when globalization and urbanization dynamics have gained momentum in Turkey, Denizli city has significantly affected by this process. Significant investments have been made in many different sectors devoted to tourism from industry to the city, which is designated as a development priority region by the government. As a result of these investments, a rapid industrialization process has been observed and economy-based connections have been established on national and international scale. In addition, it is known that empty areas in urban macroform have been filled up, urban annuity has increased and the migration process has accelerated due to changes in trade and service sector.

4. RESULTS

The neoliberal politics has had a dramatic impact on Turkey's urban development and industrialization dynamics that started in the 1980s. During this period, when the industrialization process gained momentum, Denizli city has become one of the Anatolian cities representing the traditional places of national industrial formation. In the sustainable development plans, it is envisaged that industrialization will bring about many socio-economic changes in the city as a driving force. It has been estimated that significant changes will be observed in the processes of urban development and sprawl in parallel with these changes. Denizli city, where about 44% of the industrial production in the country is realized, has received significant migration especially from rural areas and surrounding cities in the 1990s. As a result of the concentration of industrial investments, the population has largely preferred especially the central districts (Pamukkale and Merkezefendi districts) that came to the city by migration. In the 1990s, the employment rate in the agricultural sector in Denizli decreased from about 60% to 49%. During this period, the size of the area considered as a study area and having an urban character is measured as 5843 hectares. Figure 2 shows the satellite image for the year 1990 with changing urban macroform in the central districts.

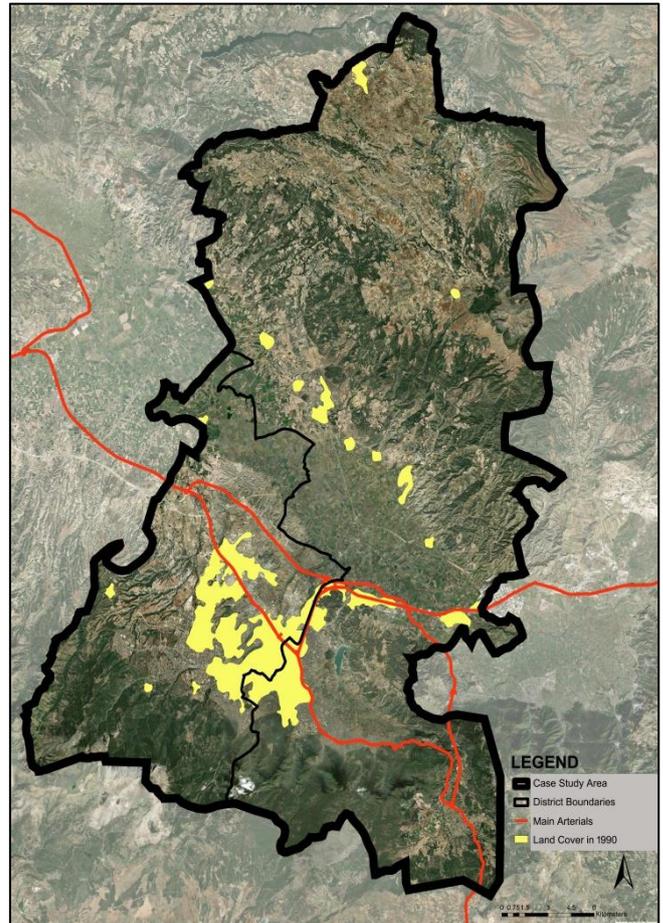


Figure 2. The satellite image for the year 1990 with changing urban macroform

By the 2000s, it is observed that the urban area has been bounded by natural thresholds, which are expanding, to the north and east of the central districts. During this period, the size of the area considered as a study area having an urban character is measured as 8471 hectares. The size of the urban area has increased by about 2628 hectares (by 45%) when this size is compared to the previous period. Among the factors causing the urban sprawl in this period, the changes in administrative structure has a critical role in addition to the dynamics of urban planning. Figure 3 shows the satellite image for the year 2000 with changing urban macroform in the central districts.

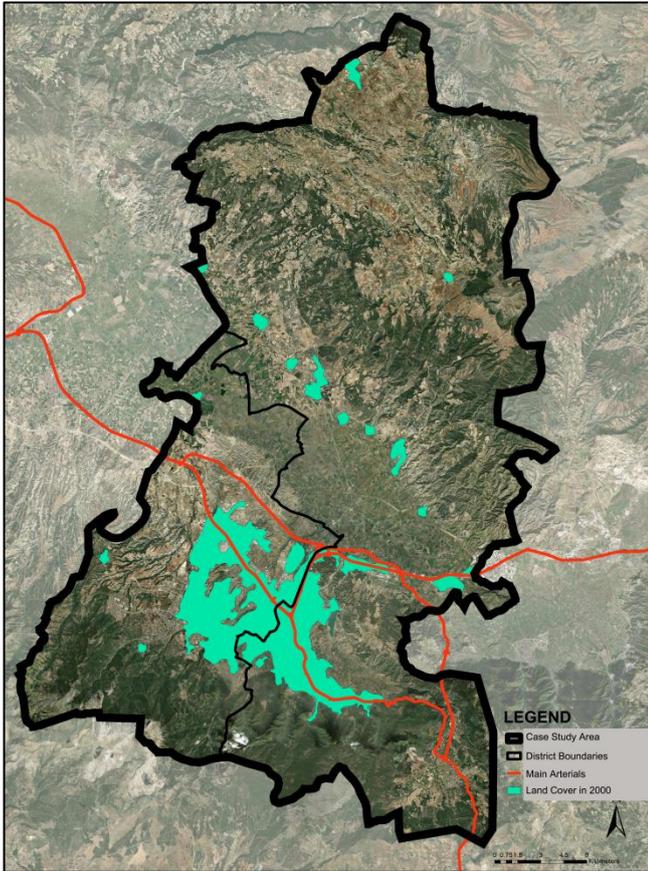


Figure 3. The satellite image for the year 2000 with changing urban macroform

Due to the spatial changes that occurred in Denizli city by the time, the industrial and slum areas remained within the existing built environment area of the city. The housing demand increased especially on the routes of main arterials regarding the increase in population and labor force in this period. By the 2006s, it has been determined that the urban form has developed in both city center and central districts around the three important arteries of the city (Denizli – Izmir main arterial, Denizli – Antalya main arterial, Denizli – Ankara main arterial), the current settlement areas has expanded and also fertile agricultural areas and natural areas have started to use for non-agricultural purposes. During this period, the size of the area considered as a study area having an urban character is measured as 9094 hectares. The size of the urban area has increased by about 623 hectares (by 7%) when this size is compared to the previous period. Figure 4 shows the

satellite image for the year 2006 with changing urban macroform in the central districts.

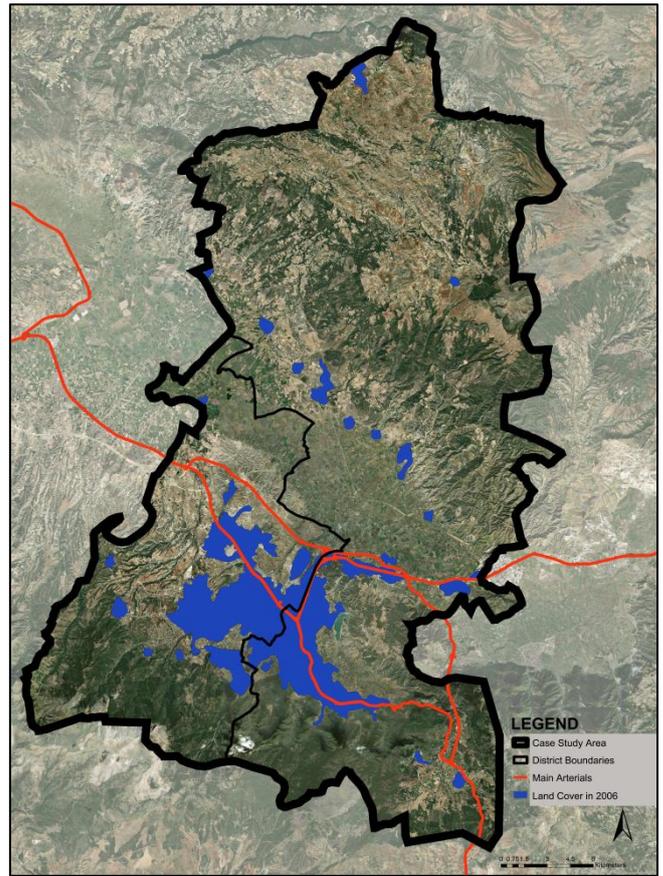


Figure 4. The satellite image for the year 2006 with changing urban macroform

By the year 2012, a statutory regulation has been introduced that closely concerned the discipline of urban planning and significantly changed the future of cities. The Metropolitan Municipality Law No. 6360 has changed the structure of local administrations and the transformation of rural settlements into urban neighborhoods has been in this process. This legal regulation has significantly accelerated the process of urban sprawl in metropolitan cities where intensive and rapid urbanization practices are seen. The selected study area is one of these settlements in Denizli city. In 2012, the land use pattern has changed and sprawled uncontrollably and disorderly during the process of the city becoming a metropolitan area and transforming the settlements' legal status. This sprawl has resulted in the significant loss of fertile agricultural areas around current settlements for non-agricultural purposes. During this period, the size of the area considered as a study area having an urban character is measured as 9862 hectares. The size of the urban area has increased by about 768 hectares (by 8%) when this size is compared to the previous period. Figure 5 shows the satellite image for the year 2012 with changing urban macroform in the central districts.

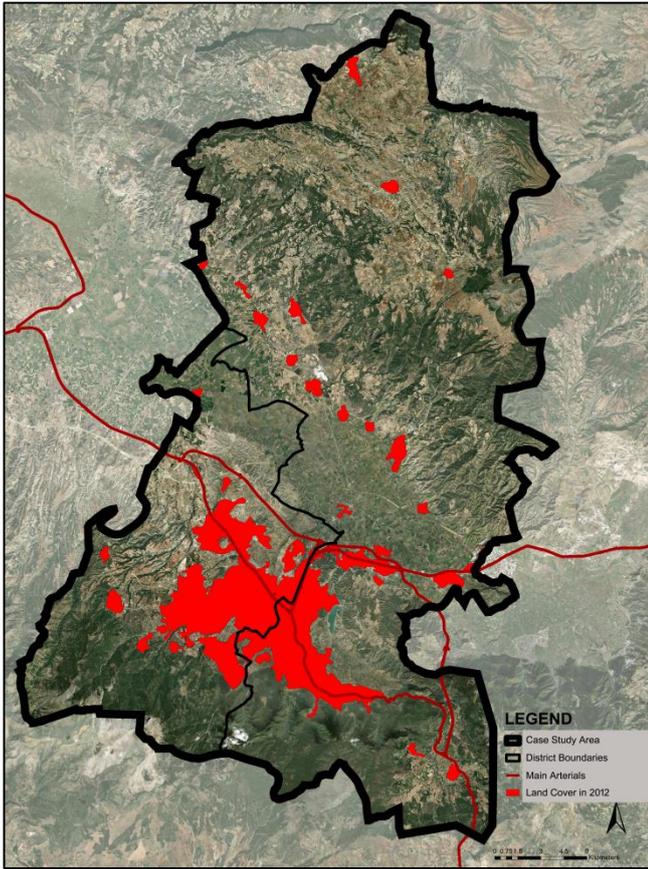


Figure 5. The satellite image for the year 2012 with changing urban macroform

A comprehensive planning study has been carried out both in Denizli city and its hinterland including the current urban land use pattern by the year 2018. In this context, two important developments have taken place such as the preparation of regional plans and leaving behind the concept of partial planning. The direction of sprawl cannot be in the south direction because of the topographical conditions as natural thresholds. The urban macroform can spread only in the northwest and northeast directions. The findings using satellite imagery have shown that the increase in urban settlements is mainly due to the change of agricultural areas and forest areas. Therefore, it is determined that medium and high density residential areas have been planned in the city center, while low density residential areas are located in the periphery of the city as a result of urban sprawl. The increase of industrial and tourism investments triggers the intensity experienced in quantitative and qualitative respects. During this period, the size of the area considered as a study area having an urban character is measured as 10739 hectares. The size of the urban area had increased by about 877 hectares (by 9%) when this size is compared to the previous period. Figure 6 shows the satellite image for the year 2018 with changing urban macroform in the central districts.

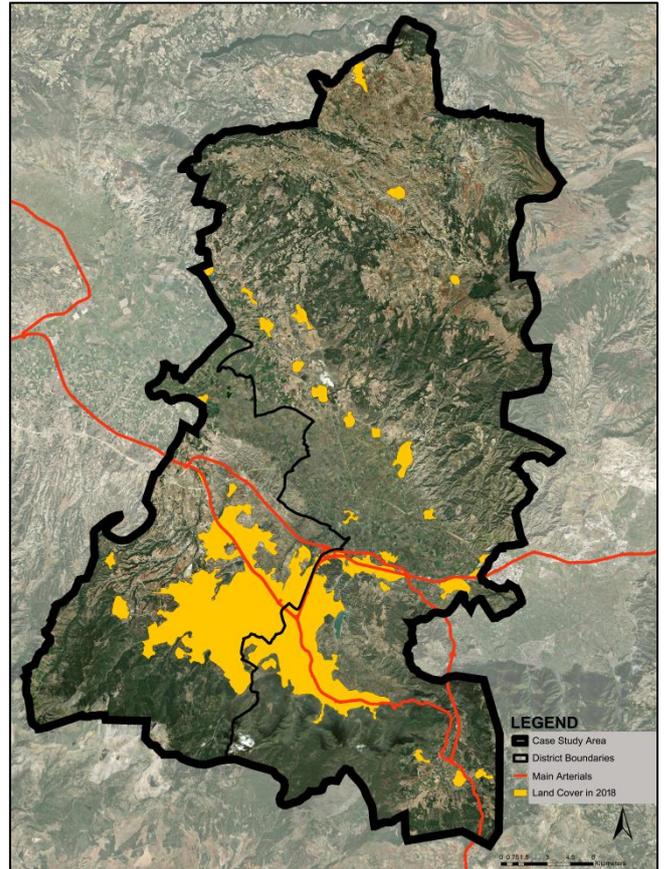


Figure 6. The satellite image for the year 2018 with changing urban macroform

When the changes in urban macroform of central districts in Denizli city are carefully examined during the approximately 30-year period between the years 1990 and 2018, it has been seen that the urban sprawl is generally towards the north-west of the city. The main reasons for this determination include the presence of natural thresholds located in the south and east of the city, the concentration of industrial investments on the Izmir road in the north-western direction of the city, the fact that new development areas have shifted to the west of the city due to the upper income group choosing a location outside the city center, The Metropolitan Municipality Law No. 6360 allows urban development areas to be shifted to rural areas. While urban sprawl has been seen by urbanization and industrialization in Denizli city, it can be said that this sprawl is directly concerned natural areas especially agricultural areas and forests located in the north-west of the city for non-agricultural purposes. In the period of about 30 years, the size of the urban area has increased from 5843 hectares to 19739 hectares, in other words, it is found that the size of the urban area has increased by about 84%. In Figure 7, the spatial changes in urban pattern in the district between the years 1990 – 2018 and the defined areas throughout development axes of the district are represented. Moreover, Figure 8 shows spatiotemporal variations in land use types which are under threat as a result of the pressure of the built environment and investments such as agricultural areas and forests.

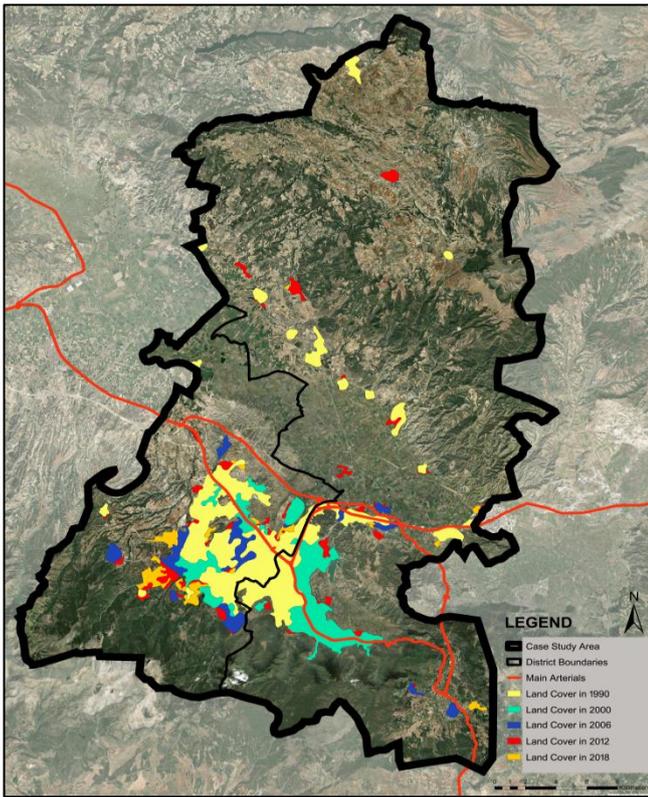


Figure 7. The spatial changes in urban pattern between the years 1990 – 2018

areas and forests due to urbanization and tourism investments; B Zone: Spatiotemporal variations related agricultural areas and forests due to industrial investments and urbanization; C Zone: Spatiotemporal variations related built environment due to urbanization and transportation investments]

5. CONCLUSION

It is vitally significant to monitor the changes in spatial organization of various urban areas and to compare previous and following periods of the Law No.6360 in terms of losses, advantages, etc. In this study, the main aim is to analyze the spatial changes of urban macroform that varies within the urban planning process. Moreover, the determination of spatial variation is occurred between the years of 1990 - 2018 in terms of urban planning discipline. For the selected study area as Merkezefendi district including 50 settlements and Pamukkale district including 61 settlements that their statuses are changed as neighborhood, the results of this study are crucial. Because, these have revealed that the decisions of local governments are so decisive and directive in terms of leading the development dynamics and trends of urban areas. In addition, the consequences of this study are established using satellite images of different years between the years 1990 – 2018, urban qualified areas have become more dominant over the rural areas (especially agricultural areas and forests) by the time and new investments (Figure 7).

In 30 years period between the years 1990 - 2018, it is certainly observed that the current land use pattern has been significantly changed in Merkezefendi and Pamukkale districts. In other words, the observed spatial changes and development trends have affected urban macroform critically and significant land losses especially in natural environment in this period. There exist triggering reasons to occur these changes as new investments' decisions depending economic growth and industrialization policies, development routes for urbanization through the three important arteries of the city, inadequate supply for housing and urban facilities, increasing demand for medium and high density residential areas in city center, etc.

As a result of the amendments to the Law 6360, it is clearly understood that Merkezefendi and Pamukkale districts as metropolitan districts will have to face new challenges such as the sustainability of rural qualified areas, the bringing local dynamics into prominence, etc. These problems will become increasingly visible with economic, social and spatial dimensions to the local governments that have authorities and responsibility of settlements and citizens that settle in dense urban areas with increasing housing demand.

Geographical Information Systems (GIS) and Remote Sensing (RS) technologies play a critical role in terms of exposing the pressure consisted by urbanization processes especially on natural areas. As mentioned before, these technologies offer the possibility of collecting and processing spatial and non-spatial data in the most up-to-date form, quickly and easily. The observation of temporal and spatial changes

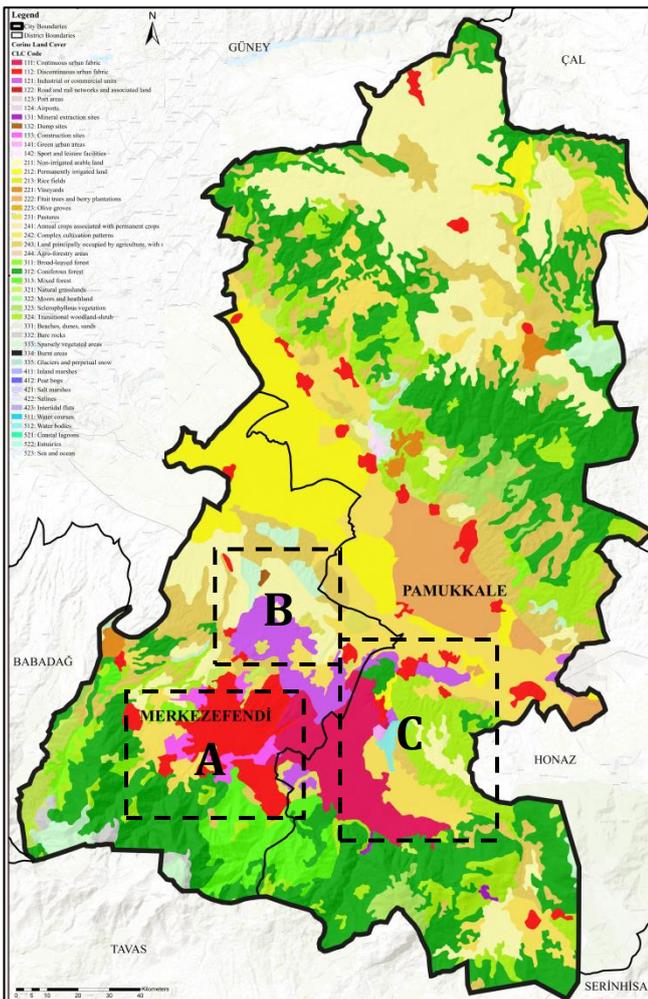


Figure 8. Spatiotemporal variations in land use types [A Zone: Spatiotemporal variations related agricultural

will help local governments to clearly analyze the current land use pattern and urban macroform and also take necessary measures especially in areas where disaster risks are high, natural thresholds limit the built environment and urban rent is relatively higher.

The increase of population arriving by migration over time not only poses the risk for natural areas related the construction process, but also causes urban areas to become less resilient in the face of disaster risks in cities where different types of disasters (earthquake, landslide, drought, rockfall and flood) coexist such as Denizli city.

For the decision makers, these spatial and temporal changes in urban areas must be taken into consideration. These changes have occurred regarding the urbanization process based on rural – urban dilemma. In this process, the authorities should prioritize certain phenomenon because the land is used only with economic interests and for non-agricultural purposes. As mentioned before, the protection of the soil is indispensable for the survival of life because the soil as a natural resource cannot be produced is also nonrenewable and limited. Therefore, it is necessary to be protected and used efficiently in order to meet the needs of today and the future.

Author Contributions

The article has a single author.

Statement of Conflicts of Interest

The author declares no conflicts of interest.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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