

Effects of urbanization on agricultural lands and river basins: Case study of Mersin (South of Turkey)

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Abstract

Largely, Turkey is a hilly and mountainous country. Many rivers rise from the mountains and flow into the seas surrounding the country. Mean while along fertile plains around the rivers and coastal floodplains of Turkey were densely populated than the other parts of the country. These characteristics show that there is a significant relationship between river basins and population or settlements. It is understood from this point of view, Mersin city and its vicinity (coastal floodplain and nearby river basins) show similar relationship. The city of Mersin was built on the southwest corner of Cukurova where Delicay and Efrenc creeks create narrow coastal floodplain. The plain has rich potential for agricultural practices with fertile alluvial soils and suitable climate. However, establishment of the port at the shore have increased commercial activity. Agricultural and commercial potential have attracted people to the area, and eventually has caused rapid spatial expansion of the city, and the urban sprawls over fertile agricultural lands along coastal floodplain and nearby river basins of the city. But unplanned, uncontrolled and illegal urbanization process has been causing degradation of agricultural areas and river basins, and also causing flooding in the city of Mersin and its vicinity. Especially in the basins, urbanization increases impervious surfaces throughout watersheds that increase erosion and runoff of surface water. In this study, the city of Mersin and its vicinity are examined in different ways, such as land use, urbanization, morphology and flows of the streams and given some directions for suitable urbanization.

Key words

Urbanization, Land use, Degradation, Basins of river, Mersin

Introduction

In Turkey, the land use plans and policies can not be fully implemented. On the one hand infertile lands are used as agricultural land, on the other hand as a result of wrong development plans, there is irreversible uses with industrial and residential areas on 1st class agricultural lands.

The population that began to concentrate in cities with industrialization and technological developments leads to expand and spread urban fabric spatially. All such areas, industrial and commercial areas established without taking into account of survey and planning processes according to land capability affect the development of the urban fabric and cause the emergence of unplanned settlement.

Agricultural lands in the periphery of the cities serve as transition zones from natural and rural habitats to urban landscapes.

They serve as supplier of vital ecosystem services such as food, feed, clean air, soil and water to the urban areas and as buffer zones to diminish negative effects of the urban systems on the natural environment (Doygun, 2009).

The rapid and random expansion of urban centers has caused changes on land cover. Forests and water catchment areas are faced with the threat of a dense settlement (Archer, 1989; Mount, 1995). Agricultural capacity is reduced due to urban sprawl on high quality agricultural land (Kim *et al.* 2003).

Mersin and Cukurova plains have rich potential for agricultural practices with fertile alluvial soils and suitable climate. This agricultural potential has attracted people to the area, and eventually has caused rapid growing of industry and trade in Mersin. These developments have resulted rapid spatial expansion of the city. However, the desire for cheaper infrastructure and superstructure

lead to cause expansion of the city over fertile agricultural lands along the Adana-Mersin-Antalya road. These unplanned structures, along both the sides of the Adana-Mersin-Antalya road, have been causing unplanned urbanization consequently affecting agricultural areas negatively (Sandal and Gürbüz, 2003).

Mersin, which is located in the Adana subregion of the Mediterranean region, is one of the big cities in Turkey in the sense of population and economical aspects. The city of Mersin was built on the southwest corner of Cukurova where Delicay and Efenk creeks create narrow coastal floodplain, and where the state roads coming from Eastern Anatolia, Southeastern Anatolia and Interior Anatolia are intersect on the Mediterranean coast (Sandal and Gürbüz, 2003).

Materials and Methods

Study area: City of Mersin and its basins of northern river are located in east Mediterranean region of Turkey. The study area lies between 36°40'00" to 37°10'00" N latitude and 34°10'00" to 34°45'00" E longitude (Fig. 1). Study area is between coastal zone near the sea side and alpine zone which is the western part of Bolkar mountains.

The basins have an area of 1383 km² and undulating topography with steep slopes. Section of the longest on the west-east direction is 48 km and the north-south direction is 51.5 km. The elevation within study area is between mean sea level with 2557 m at watershed boundary. The main source of water is in the Northern

mountainous areas. Lithologically, the rock type of the area is belonging to different periods limestone, ophiolite and sedimentary formation.

In the study, first, the basin boundaries of four streams restricting the city were identified. According to these stream basins, forms of land use and land capability classes and relations were evaluated. Mapping of spatial information is extremely important visual data sources in the stages of decision-making related to these areas.

In order to describe the physiographic features of the study area, the topographic and geologic maps was used. Remote sensing (RS) and geographic information system (GIS) techniques were used to determine urban growth for the period 1972-2006 (using Landsat and Aster data archive). The urban areas were determined by making use of image enhancement filters. In the analysis of these data ArcGIS 9.2 and TNTmips 7.1 software were used.

The city of Mersin is between the Efenk and Delicay creeks, close to the shore until the 1970s. The urban development areas progressed rapidly in the western direction with the new zoning plans. For this reason, according to the Landsat satellite images for the years 1972, 1987 (Aster, 2006), the development period on productive land of urban is brought up. In consequence of rapid and unplanned urban development regardless of streams and basins has led to the wrong land use. However, flooding and flood risk has emerged. In this context, this study was conducted.

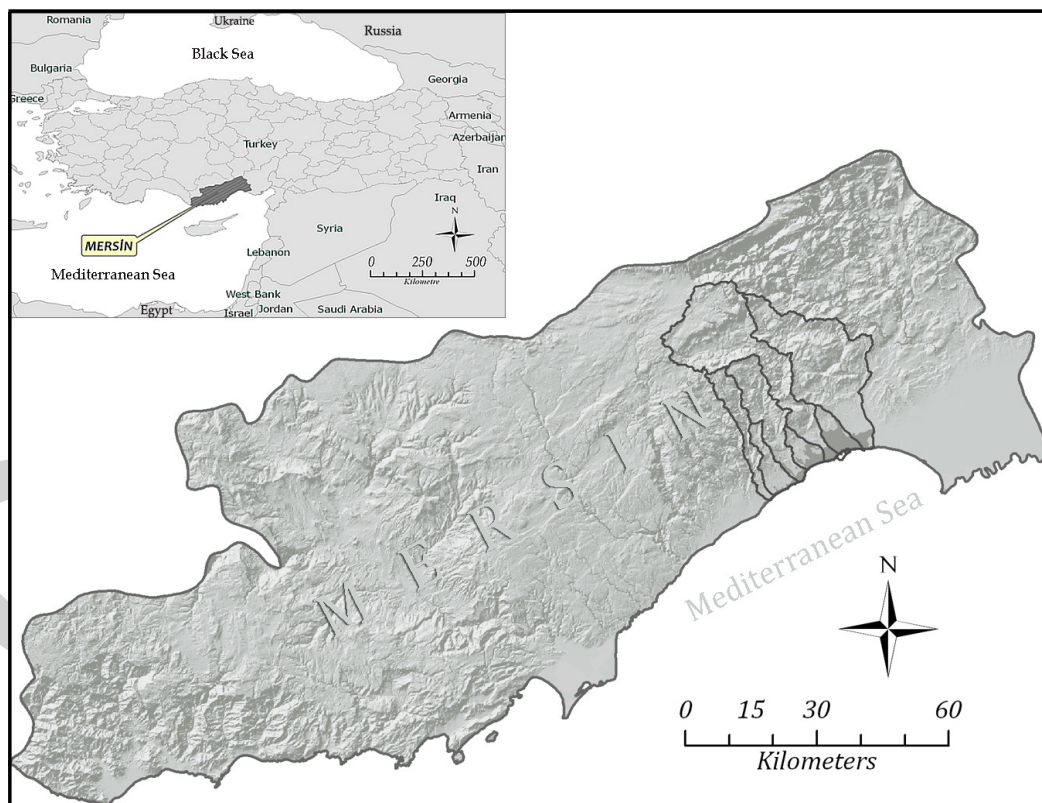


Fig. 1: Location map of the study area

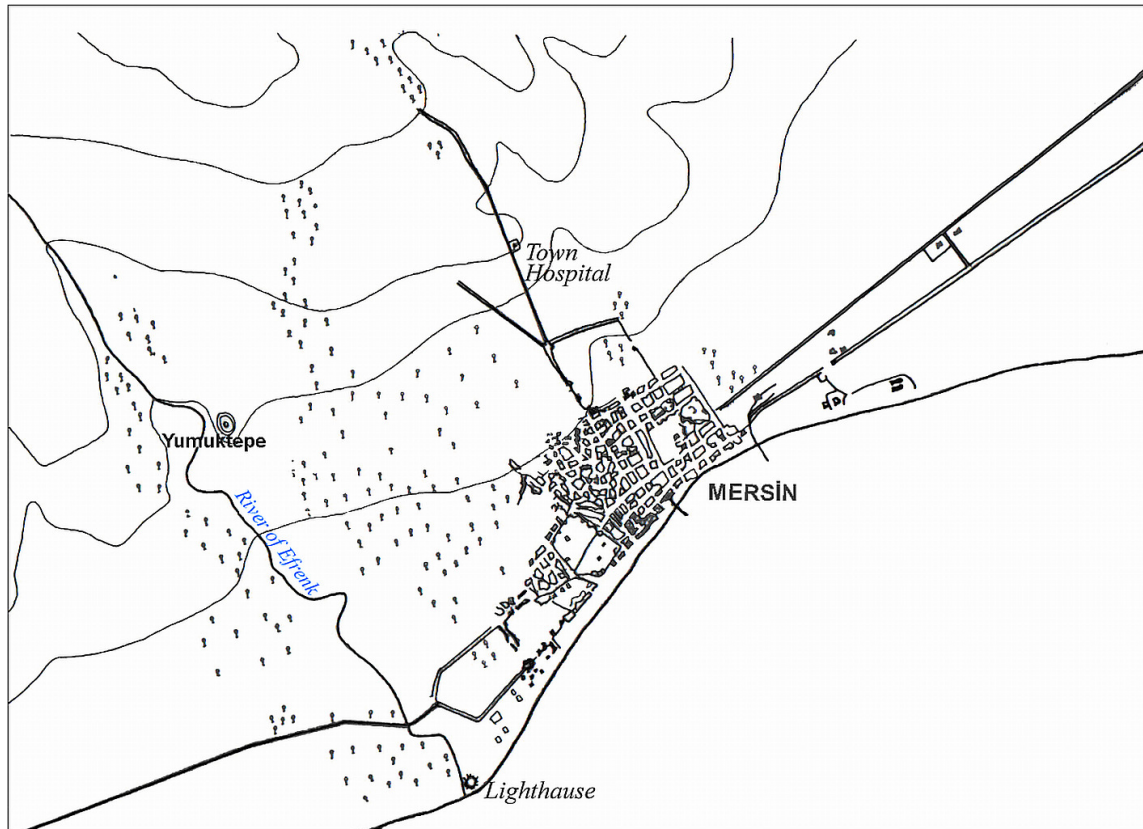


Fig. 2: Mersin city map and plan printed in 1920 in Paris (Develi, 1987)

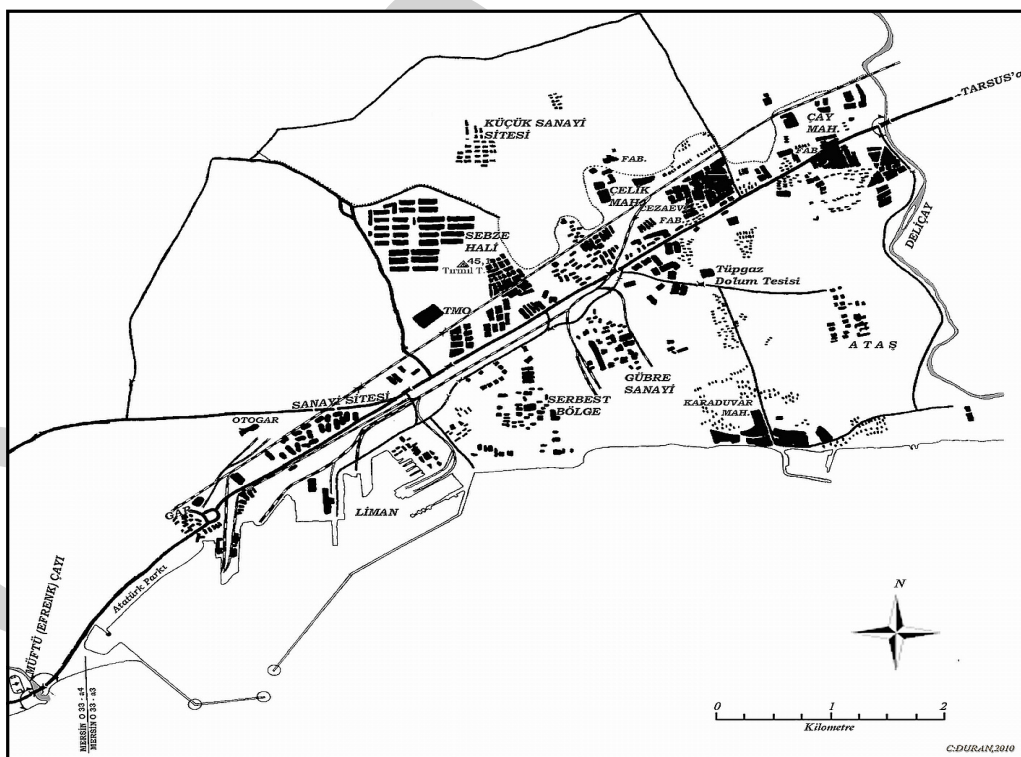


Fig. 3: The view of industrial centers and port at the east which is first development place of Mersin city

Results and Discussion

Except some general features urban history of Mersin city shows significantly different state than other cities in Anatolia. Looking to other cities in Anatolia a "continuity" will strike our attention. Here, continuity means that these cities were either started during Roman-Hellenistic period or even before this period. However, Mersin is different from others in terms of established period. It is obvious that there was a city in the place of the current city Mersin in the ancient times, but during the middle age and classical Ottoman period urbanisation was not so apparent. Moreover, in the old days Mersin strike out with its famous Soloi-Pompeiopolis port, but later it is realised that there was no port activity in the vicinity. Therefore, it is hardly difficult to mention about a historical continuity of the city of Mersin (Oguz, 2006).

In many resources examined, foundation of Mersin city relies on mid 19th century. However, information with regard to date of foundation is insufficient. Form of residential as a fishing village connected to the nearest centre, Tarsus as from its foundation is in question. Mersin forms nearest coast location of region because of its location and has function suitable for international commercial activities and this leads to show rapid development in a short time. In the early 19th century, Mersin being the identity of a village has become one of the major urban centers enough to fit into human life in a short time.

The earliest record that was found about urban fabric of Mersin is Mersin City Map and Plan printed in 1920 in Paris (Fig. 2). Avenues and streets opened with plan in that years is a feature not found in other Anatolian towns. The reason why Mersin is different from nearest city, Adana is close commercial relationship of important part of public with Europe and Lebanon (Hisarli, 1988).

Modern Mersin port which has important part of economic development of Mersin and laid foundation in 1954 is brought into action in 1962 (MTSO, 2006). Industrial organizations mostly collected around Mersin port at the east of city (Fig. 3). There are many neighbourhoods and slums formed by migration at north and north-west of industrial organizations. The areas at west of city (areas which vineyards-garden agriculture was made at past) and sections closest to coast were turned into high-rise buildings by high income groups and urbanization was accelerated in the direction of west.

The urban fabric extending to the Tece Creek at the west consists of high rise buildings made mostly for summer use of coastal areas. Urbanization which shows a horizontal development parallel to the shore today, with the actual construction storey building, has shifted towards the north coast. Suitable areas for agricultural activities slowly are eliminated because of transport and infrastructure facilities.

Transformation which has carried the city of Mersin today mainly accelerated with responses in the Mersin historical city center in the late 1960's and early 1970's and during this period, a break occurred in the city's identity.

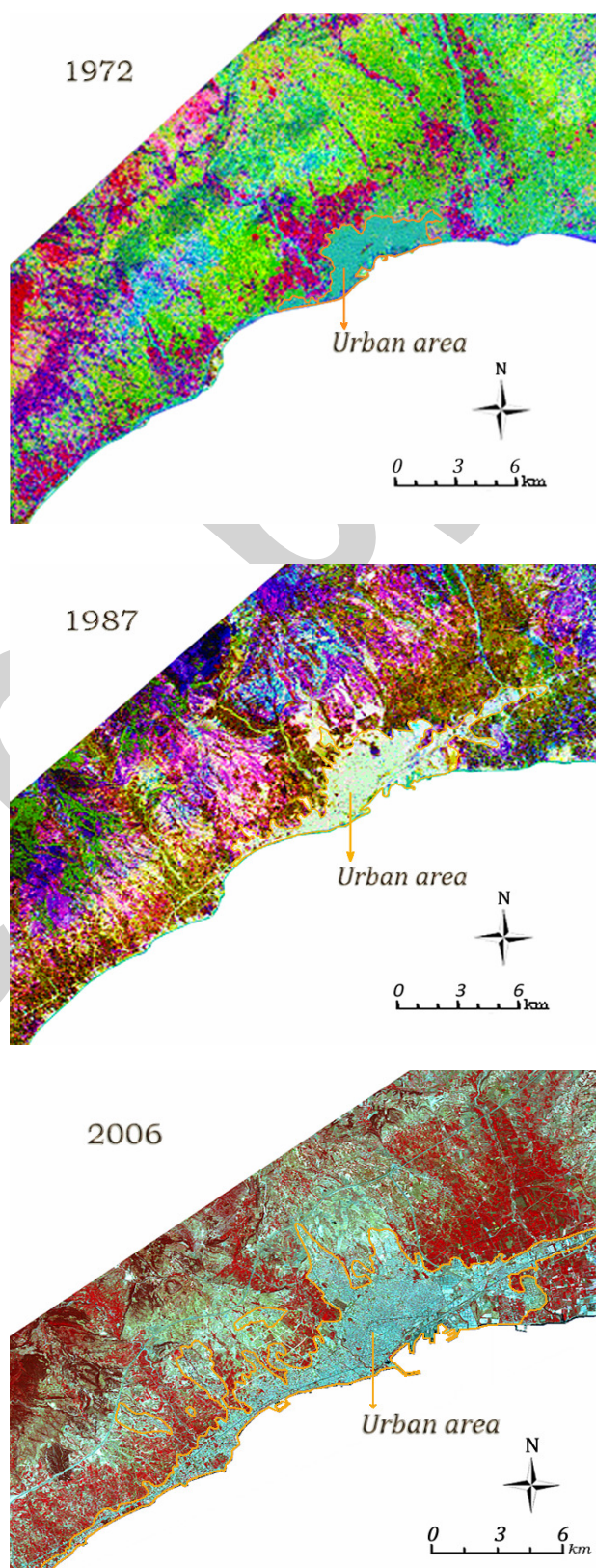


Fig. 4: The physical development of the city of Mersin depending upon the time has been shown at the satellite images belonging to the years (Using fusion image enhancement for visual inspection of urban area)

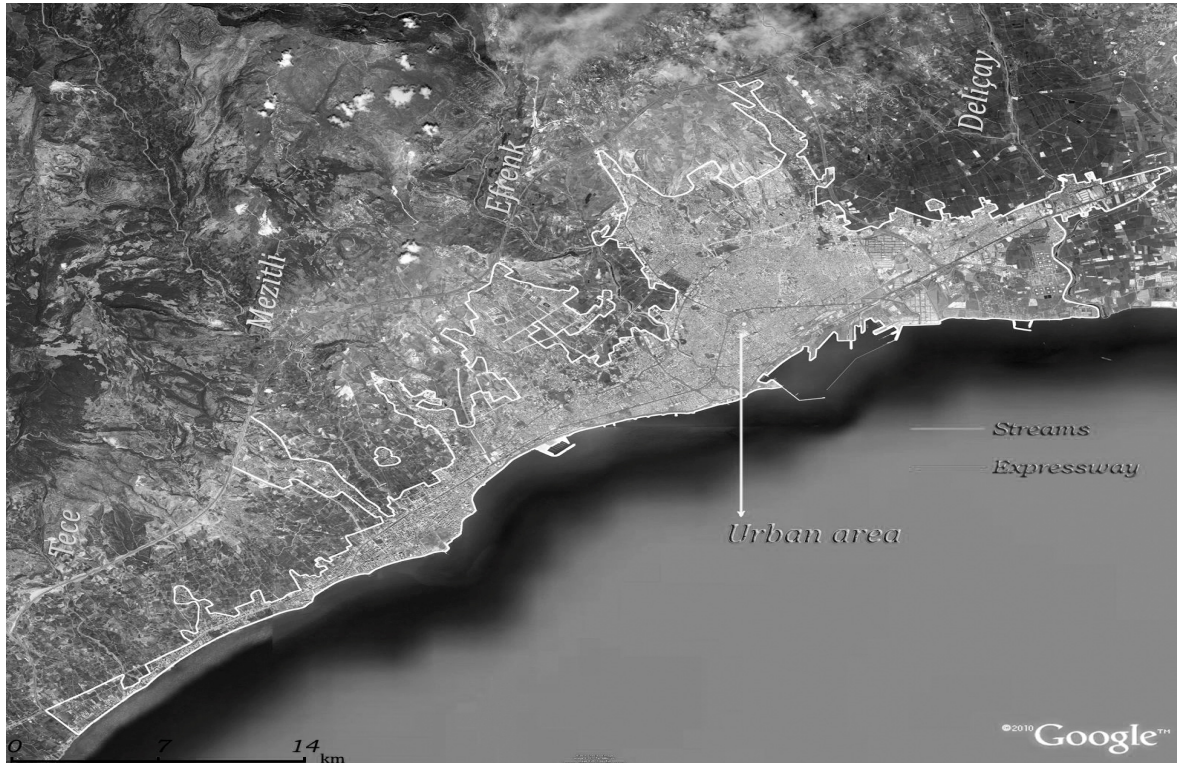


Fig. 5: Location according to Mersin city and northern rivers (from the Google Earth/2010)



Fig. 6: The overview from port and surrounding that is first establishment place of Mersin (from North to South)

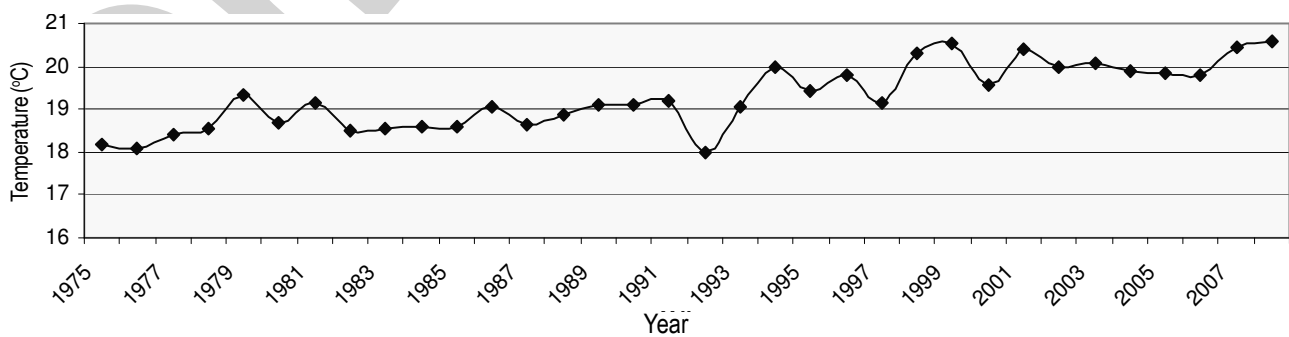


Fig. 7: The distribution of 33 year average temperature of Mersin meteorological station in between 1975-2008 according to years (source: SMS, 2009)

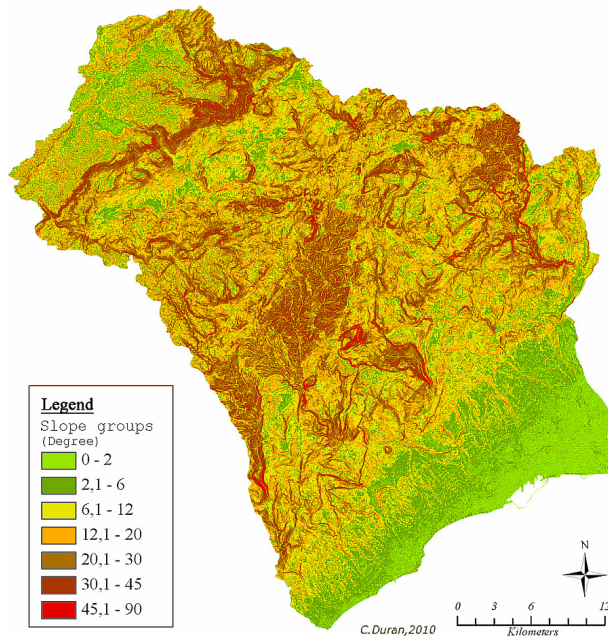


Fig. 8: Slope groups (source: Digital elevation model / 10 m)

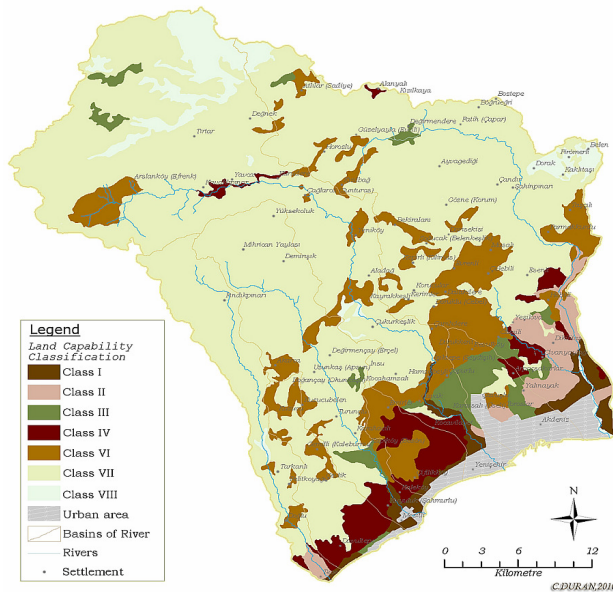


Fig. 9: Land capability classification (source: GDRS maps, 1991)

On one hand rapid population growth effects the social fabric, on the other hand, it brought the city's physical development to the third dimension, so that housing in two-storey and inside large gardens gave place to multi-layer construction process (Unlü, 2007).

In 1963 development plan, city is focusing on development trends to the north and west. Because of the first-class agricultural land in these areas, agricultural land preservation has become one of the main problems (Akcura, 1981). City mostly remained in the area between Delicay and Efrek streams until the 1970's and was generally moving in the direction of the north of port. The construction

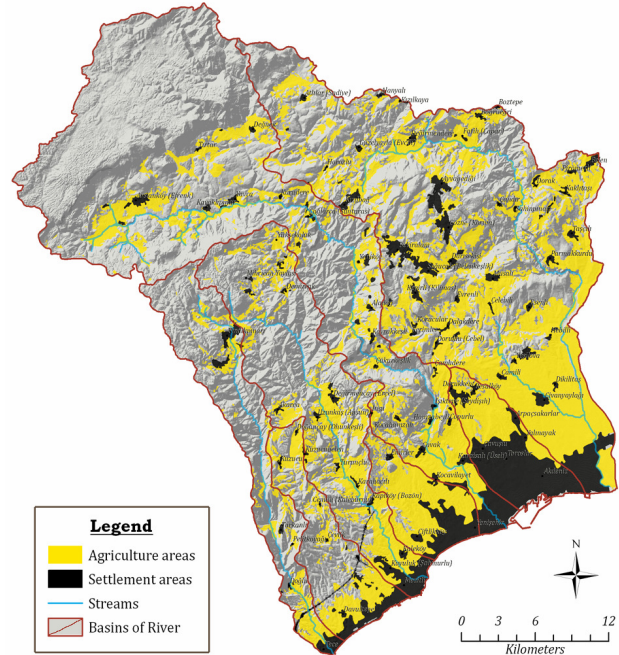


Fig. 10: Agriculture and settlement areas (source: GDF maps 2008)

period switching to the west of Efrek stream in the 1970's and later on the farmland accelerated the progress in the 1980's (Fig. 4, 5).

Mersin in the 1980's, began to receive intense internal migration from particularly lower socio-economic development level of the provinces. The expectations that free zone is being established lead to the extensive employment and the South-East conflict were the developments encouraging the migration.

While the migration of Mersin was 46000 in two years between 1983–1985, it reached by 36000 people in 1986. The migration continued up to 1990s (Table 1) (Turgut, 2006). Due to migration after 1983, coastal ecosystems in the coastal part was deteriorated. Acquired through completion coastal areas, the shoreline has been growing at unnatural rates

Mersin free zone and port is located on the slope of the straight and level area to be closer to the establishment of a wide range of economic activities has facilitated and encouraged (Fig. 6). There is very well-developed transportation network in the plains; Taurus mountains lying just behind connect the gate and plains to the inner region (Akova, 2002). Industrial and commercial sector in the rapid spread of the plains, agricultural activities has led to a shift to the north. The temperate climate which prevails in the area allows to provide agricultural activity all the year, has also led to conversion of non-arable areas to agriculture (Fig. 11).

The change in land use such as urbanization and agricultural areas causes atmospheric and environmental impact. (Kalnay and Chai, 2003; Fazal, 2000). In other words by influencing, it naturally causes local and regional climate change in air quality

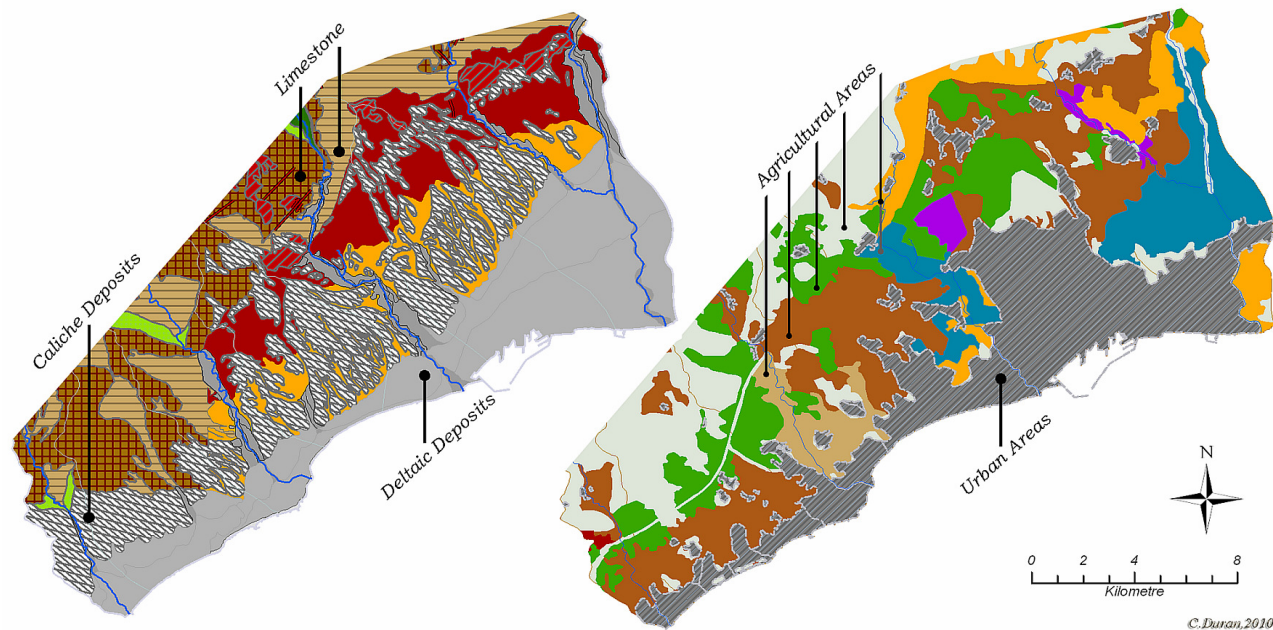


Fig. 11: Geology map (left); urban area on deltaic deposits (suitable area to agricultural activity) and agriculture areas on caliche deposits (not suitable area to agricultural activity) (source: GDMRE maps 2009; GDF maps 2008)

(Kindap *et al.*, 2008). Depending on the increase in urban construction, it is observed that there is an increase in mean annual temperature trend over the years. With expansion of urban on land, it also encourages to increase the temperature of urban structures. It is seen that there is significant increase in annual mean temperature in connection with urban development (Fig. 7). The lack of sufficient openness and greenery area of the fast-growing cities as well as a plurality of heat-absorbing structures is effective in increase of temperature.

Problems of land use on river basins of northern mersin city: As a result of rapid urbanization, other land cover has also led to changes. The natural structure of river basins is deteriorated. The risk of flooding and flood has increased (Khan 2005; Nirupama and Simonovic, 2007; Zhang *et al.* 2008). Urbanization has an irreversible impact on natural drainage patterns, and flows in the receiving water bodies' hydrologic systems (Novotny *et al.* 2000).

Mersin is at the position of significant center to be established city-basin relation. Urban lying to coast parallel to Middle Taurus limits its source to the southeast-northwest direction with river basins vertically going to sea and formed the mountainous areas. The river downstream of this position being for the 1st class of agricultural land increases the potential for rising mountainous area contains enough water. The rivers arising from all mountainous generations, for centuries, they carry with erosion as particles and pile up in front of rivers to form productive land for agriculture. A large number of small and big rivers that pass through Mersin city and reach the sea causes flooding and flood events after heavy rainfall. The city's establishment and development process took place very quickly, the river reached the sea and the debris cones and fans of high-field

structure of the revolution by filling out the skirt, to floods and flood damage has become an open position.

Deliçay, Efrek, Mezitli, Tece and Sahna streams and the arm of river valleys that these streams pass through are usually concentrated in the rural areas and towns settlements. Settlements surrounding river valleys often are located on terraces or small pond range. The settlement pattern is sparse and settlements in general, lay along a slope or valley. Bekiralani and Sogucak villages are good examples.

The majority of settlements in river basins was established and developed in the places where water supply is close. Shores of the land does not allow cultivation of agricultural products; so such activities expand around the settlements located in the river basin; the water sources were affected (Fig. 10). Depending on intense agricultural activity in this area, it leads the environmental effects of pesticides and fertilizers into the water supply. The main rivers forming the workspace has a significant impact in shaping the region's topography, the ecological environment and the human activities.

If we briefly describe these streams;

Efrek (Muftu) creek: It is due to plateau and the slopes forming southwest of the Bolkar mountains. Approximately, 70 km long Efrek Creek, divides the city placement to be centered. Efrek (Muftu) Creek, has a catchment area 464 km². The highest point is top of Kizildag (2565 m) and lowest downstream code creates the Mediterranean.

Deliçay creek: Reach the sea from the eastern part of the city, make curve in the vicinity of Degimendere and falls to the south. Delicay

Table - 1: Annual growth rate of the population of the city of Mersin and Turkey (1927-2007)

Years	Turkey		Mersin	
	The amount of the population	Annual growth rate (%0)	Population	Annual growth rate (%0)
1927	3 305 879	-	21 147	-
1935	3 802 642	17.50	27 620	33.4
1940	4 346 249	26.72	30 007	16.7
1945	4 687 102	15.10	33 148	20.1
1950	5 244 337	22.47	36 463	19.2
1955	6 927 343	55.67	50 104	65.6
1960	8 859 731	49.21	68 485	64.4
1965	10 805 817	39.71	86 692	48.2
1970	13 691 101	47.33	112 982	54.4
1975	16 869 068	41.75	152 236	61.4
1980	19 645 007	30.47	216 308	72.7
1985	26 865 757	62.61	314 350	77.6
1990	33 326 351	43.10	422 357	60.8
2000	44 006 274	26.8	537 842	24.2
2007	49 747 859	17.52	623 861	21.2

Source: TSI 2009

basin covers approximately 471 km² area. The highest elevation of the basin is Çökelekka hill with 2275 m, the lowest level constitutes the downstream Mediterranean.

Mezitli (Liparis) creek: It is fed by rainfall in the northern hills and it is flowing into the sea through the center of Mezitli town. The highest point in the basin is Kalegedigi hill with 1898 m. Basin area, in general, has the appearance of the land slopes. Approximately, 34 km in length and has a 176 km² basin.

Tece creek: The Tece creek reaches the sea at the western edge of the city, by collecting the water of Findikpinari highlands flowing to the south, and it is falling into the sea through the settlements of Tece town. Lying parallel to Mezitli creek, the creek is average 34 km in length as Mezitli creek and has narrower basin of 103 km². The highest point in the basin is Peynirdagi hill with 2041 m.

In certain parts of the land at the north of the city, the highland villages and settlements are intertwined. Because of the unbearable heat of summer, the summer houses have been built with 2nd housings within the highlands of the basin and in the villages; human activities in this way also extend to the north areas (Fig. 10).

Large plateaus such as Aslanköy, Gözne, Findikpinari, Sogucak, Bekiralani, Mihrican, Ayvagedigi and Güzelyayla are located within the basins boundaries of these settlements. The area of urban and rural areas is approximately 120 km² in total in study area. Mediterranean coastal zone during the summer season is utilized for recreation for people in the highland city of Mersin to the property indicating that the average settlement of 24 to 52 km away from the sea, the elevation is between 800 and 1500 m (Sandal, 2003).

Where the caliche lands established on arable land of the city in the north of the alluvial land is widely available and, in terms of settlement it is more suitable ground. Topography is generally favorable. Undulating flat surface is dominated (Fig. 8). The planning of this area appropriate for influence of the seismicity would be more appropriate as settlement (Fig. 11).

Mersin which continuously develops as socio-economic and spatial inception to the present greatly carried this development on soil class I, II, III and IV. (Fig. 9,11). But today, the city of the plains at the base of this development was not healthy enough. Destroyed thousands of hectares of fertile agricultural land, because of this development, and an unhealthy urbanization have brought new environmental problems (Sandal and Gürbüz, 2003).

At soundings made on the shore, the high groundwater level was observed. Urban and agricultural areas around the city for use in the north of the city opened up due to excessive water from wells, sea water is input. For this case, the structure also creates a negative situation. Highland settlements are constantly growing in terms of space and population. This situation forces the potential facilities having the plateau and highland areas are beginning to disrupt ecosystems. The arbitrary-irregular construction developed on the sea coast and productive agricultural land is threatening our highland areas. Continuous nature of people in a way that their goals tend to change according to the shores of which occur in natural and environmental degradation has resulted in increasingly moving to highland areas.

The developing cities without taking into account structure and capability of the land, often leads to form land in the way that do not conform to the class of land use ideally. The flood events, in

2009, have led to huge losses in many cities in Turkey. In the spatial development of cities, one of the most important factor to be considered as affecting the cities of the river basin planning are to be made by considering the boundaries.

Although there is no previous urban settlement for the city of Mersin, during expansion of the city, outfalls have not been considered. Moreover, this river basin covering the territory with the destruction of natural vegetation to urban flooding and flood risk has become more open.

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