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Using Abies's Needles as Biomonitors of Recent Heavy Metal Accumulation

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ABSTRACT

In our modern age, heavy metals are one of the major causes of air pollution, which is one of the biggest problems facing the globe. This is due to the fact that heavy metals can stay in nature for a long time without dissolving, and that the concentration of these metals is ever increasing. Heavy metals tend to bioaccumulate and often present serious health hazards even at low concentrations. Therefore, the determination and monitoring of heavy metal concentrations is of great importance in terms of identifying risky areas and the levels of risk involved. In this study, the usability of fir organs in monitoring the change of the element of Barium (Ba), which is one of the very important elements for human and environmental health, was investigated. The change of Ba concentration in fir needles, organs and shells due to organ age and traffic density was evaluated. As a result of the study, it was determined that the accumulation of Ba concentration in fir organs is quite different, and there are great differences in terms of Ba concentration between organs of the same age, between organs of different ages and between organs of individuals grown at different traffic densities. This situation can be interpreted as fir organs being good biomonitors in examining Ba concentrations.

Anahtar Kelimeler:
Ağır metal,
Barium,
Abies,
Biomonitor.

ÖZ

Modern çağımızda ağır metaller, dünyanın karşı karşıya olduğu en büyük sorunlardan biri olan hava kirliliğinin en önemli nedenlerinden biridir. Bunun nedeni, ağır metallerin doğada uzun süre çözünmeden kalabilmeleri ve bu metallerin konsantrasyonlarının giderek artmasıdır. Ağır metaller biyolojik olarak birikme eğilimindedir ve düşük konsantrasyonlarda bile genellikle ciddi sağlık tehlikeleri sunar. Bu nedenle, ağır metal konsantrasyonlarının belirlenmesi ve izlenmesi, riskli alanların ve ilgili risk seviyelerinin belirlenmesi açısından büyük önem taşımaktadır. Bu çalışmada insan ve çevre sağlığı için çok önemli unsurlardan biri olan Barium (Ba) elementinin değişiminin izlenmesinde köknar organlarının kullanılabilirliği araştırılmıştır. Göknar iğneleri, organları ve kabuklarındaki Ba konsantrasyonunun organ yaşı ve trafik yoğunluğuna bağlı olarak değişimi değerlendirildi. Araştırma sonucunda köknar organlarında Ba konsantrasyonu birikiminin oldukça

farklı olduğu, aynı yaştaki organlar arasında, farklı yaşlardaki organlar arasında ve bireylerin organları arasında Ba konsantrasyonu açısından büyük farklılıklar olduğu tespit edilmiştir. farklı trafik yoğunluklarında büyümüştür. Bu durum, köknar organlarının Ba konsantrasyonlarının incelenmesinde iyi biyometreler olduğu şeklinde yorumlanabilir.

1. Introduction

In addition to the increase in the world population in recent years, the increasing population in urban centers has brought many problems [1-4]. In this process, air pollution arising directly or indirectly due to human activities in city centers is one of the most important problems [5-6]. So much so that it is estimated that 1 out of 8 people worldwide die due to reasons related to air pollution. Air pollution manifests itself more in urban areas where the population density is high, and according to the World Health Organization data, it was reported that 92% of the world population lived in regions with low air quality in 2014 [7].

HMs tend to bioaccumulate in living bodies, and some of them can be toxic even at low concentrations. They are not easily degradable nor dissolvable in nature, and even metals necessary for living organisms such as Mn, Zn, Cr, Cu, Fe, Ni can cause harmful effects at high levels [8-10].

The most important heavy metals are mostly caused by industry and traffic [11]. Many studies have been conducted to monitor the concentrations of heavy metals due to their effects on humans and the environment. However, the studies conducted mostly focus on heavy metals such as Hg, Cd, Cr, Ni, Co and Pb [12-15]. Barium (Ba), which is largely neglected in studies on heavy metals, plays a key role in the production of many products in the industry. In the production of Zn, Pb and Ag, brake pads, rubber, ink, paint, rat poison, radio vacuum tube and lamps, medicine, optical glass, machine oils, detergents, photo papers, waxes, glues, drilling applications, paper coatings, batteries, plastic and textile products, oil paints, special glasses, fireworks and ceramic glazes, barium, isotopes, compounds and alloys are used. However, Ba is one of the most dangerous heavy metals and all of the Barium compounds are toxic [16]. Therefore, it is very important to monitor the change in Ba concentration in the air.

2. Material and Method

The study was carried out on the goose fir (Abies nordmanniana (Steven) Spach subsp. Equi-trojani (Asch. & Sint. Ex Boiss). In the scope of the study, fir individuals were determined primarily in areas with heavy traffic, low density and no traffic, and samples of these individuals' side branches. Organs were divided into ages first, then into needles, shell and wood. and the amount of heavy metals were determined by ICP Analysis at the Research Center.

3. Results

When the Table 1 values are examined, it is seen that the Ba concentration varies between 1100.67 ppb and 7835.67 ppb in the needles, 1132.00 ppb and 5166.33 ppb in the woods and 1655.00 ppb and 5204.33 ppb in the shells depending on the age in the areas where there is no traffic. Ba concentrations in areas with low traffic range from 938.00 ppb to 3714.33 ppb in needles, 2494.00 ppb to 6507.67 ppb in woods, and 1757.00 ppb and 6189.33 ppb in shells. In areas with high traffic, it ranges from 1414.00 ppb to 4010.00 ppb for the needles, 670.33 ppb to 6504.00 ppb for the wood, and 2012.00 ppb to 8565.00 ppb for the shells.

Table 1. Change of Ba (ppb) Element Dependent on Organ, Organ Age and Traffic Density

Organ	Needle Age	Density of Traffic			F Value
		Unavailable	Low intensive	Intense	
Needle	1	2832,33 Ce	1980,67 Bd	1414,00 Aa	17010,538***
	2	7835,67 Cg	1892,00 Bc	1590,67 Ab	93125,974***
	3	2825,00 Ce	2763,00 Be	1766,67 Ac	7625,837***
	4	2487,67 Ad	3714,33 Ch	2948,00 Bg	11971,687***
	5	1100,67 Aa	3486,33 Bg	4010,00 Ch	20919,567***
	6	1907,67 Ab	2830,00 Cf	2735,00 Be	10279,466***
	7	2338,67 Bc	938,00 Aa	2901,67 Cf	59884,388***
	8	4071,00 Cf	1296,33 Ab	2563,00 Bd	28975,404***
	F Value	56628,204***	16218,331***	20002,281***	
wood	1	1132,00 Ba	3348,67 Cc	998,00 Ac	66091,860***
	2	1291,67 Bb	3017,67 Cb	1226,00 Ad	15596,284***
	3	2026,00 Bd	3985,00 Cf	670,33 Aa	67672,723***
	4	1530,33 Ac	3568,67 Bd	6504,00 Ch	42186,341***
	5	2469,33 Bf	6507,67 Ch	788,00 Ab	33001,870***
	6	2200,00 Ae	3772,33 Be	4701,67 Cg	37608,039***
	7	5166,33 Bh	4945,00 Cg	2719,67 Af	63962,142***
	8	2500,33 Bg	2494,00 Aa	2539,67 Ce	14,211**
	F Value	44056,942***	10942,095***	67780,981***	
Bark	1	1655,00 Aa	3707,00 Ce	2012,00 Ba	23669,074***
	2	3049,00 Bd	3482,00 Cd	1994,00 Aa	24407,347***
	3	5204,33 Bg	1757,00 Aa	8565,00 Cf	14618,125***
	4	3004,33 Bc	6189,33 Ch	2016,00 Aa	32193,488***
	5	3264,33 Be	4567,33 Cf	2899,00 Ab	5413,389***
	6	3535,67 Bf	2530,67 Ac	4537,33 Ce	30100,028***
	7	2946,00 Bb	1965,67 Ab	3531,67 Cd	73495,074***
	8	3001,00 Ac	4654,33 Cg	3217,00 Bc	8128,000***
	F Value	5220,110***	26981,117***	22000,589***	

Uppercase letters show horizontal direction, however lowercase letters indicate vertical directions.
*Significant at 0.05 level, **Significant at 0.01 level, ***Significant at 0.001 level, *ns* not significant.

When the Table values are examined, no significant relationship between Ba concentration and organ ages can be observed. Similarly, it is not possible to say that the change in Ba concentration at different ages of different organs is also related to traffic density. In the same traffic density, there may be a 10-fold difference between organs of different ages in Ba concentrations, as well as more than 8-fold differences between samples taken from different traffic densities of organs of the same age.

4. Discussions

The results of the study reveal that the concentration of Ba varies considerably in terms of organ, organ age and traffic density. However, it is not possible to say that the change in Ba concentration is proportional, depending on both organ age and traffic density. This situation can be interpreted as that the passage of Ba concentration between organs is at a very limited level. This result shows that the fir subject to the study is a good biomonitor for monitoring the change in Ba concentration.

Heavy metals, many of them are extremely dangerous and harmful elements for human and environmental health, and monitoring the change of their concentrations in the air is of great importance. Although many studies have been carried out on the monitoring of heavy metal concentrations to date, the studies have mostly focused on elements such

as Pb, Cd, Ni, Co, Cr [17-21]. However, Ba, which is the subject of this study, is both widely used in many areas and an extremely toxic element [16]. However, it has been addressed in quite a few studies to date.

The results of the study show that the accumulation of Ba concentration in different organs is quite different. In studies carried out so far, it has been determined that, in general, heavy metal concentrations vary significantly on organ basis. It is known that there can be a significant difference between the heavy metal concentrations in the same organs of different species grown in similar environments. For example, Saleh [22] stated that the difference between species is more than 5 times in Cu and more than 24 times in Cd. Akarsu [23] generally states that there is a very high difference between the outer crust and the inner crust, this difference is 10 times more in Mn, and the Mn concentration value obtained in the outer crust is 50 times that of wood. Similarly, it is stated that there may be significant differences between different ages of the same organ [24-25].

In many studies, it has been determined that different heavy metals are more concentrated by different plants and different organs of plants [11,26]. This situation is mostly shaped by the anatomical structure of the plant and the interaction between the plant and heavy metals. Heavy metal uptake from leaves varies depending on factors such as physical and chemical properties of the metals, forms, morphology of organs, surface area, surface texture, habitus of the plant, exposure time to heavy metals, environmental conditions and gas exchange [11,3,4,27,28].

The accumulation of heavy metals in the plant is closely related to environmental conditions. Heavy metals can be carried far away from their source with the help of wind. Apart from this, environmental conditions directly affect plant metabolism and in this process, the entry of heavy metals into the plant structure also differs. Additionally, it is stated that there is a significant relationship between the entry of heavy metals into the plant structure, especially air humidity and rainfall [11,23,29].

Studies show that some of the heavy metal concentration in plants varies depending on factors such as plant species, organ, washing status, traffic density [11,30,31]. However, apart from these factors, there are also factors that may affect the change of heavy metal concentration in plants. For example, different levels of heavy metal concentrations can be expected in the subspecies, forms, varieties and origins of the same plant. Because the studies conducted reveal that many phenological, morphological and anatomical structures change depending on these features. In this case, it is inevitable that plant metabolism will also change and this will affect heavy metal absorption [25,32-40].

5. Suggestions

Heavy metal accumulation in plants is shaped under the interaction of many factors and these factors, from plant genetic structure to plant phenology, from the structure of heavy metal to air conditions. The mechanisms that shape heavy metal accumulation in plants have not been fully resolved. Therefore, studies on the subject should be continued in detail.

Competing Interest / Conflict of Interest

The authors declare that they have no competing interests.

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Author contribution

We declare that all Authors equally contribute.

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Investigation of the Usage Areas of Different Fiber Reinforced Concrete

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ABSTRACT

Nowadays, the need for concrete to be used in different areas has led to some concrete technology developments. One of the developments in this area is the production of fibrous concrete. It is a material that has a wide application area in fiber concrete, concrete and reinforced concrete building applications. Because of this widespread usage, many studies have been done to improve the properties of concrete. Fiber Reinforced Concrete obtained with different types of fibers added to concrete is one of these studies. Fiber-reinforced concrete; hydraulic cement, aggregate and discontinuous dispersed fibers mixed with water. The fibers are not very effective on the compressive strength of concrete, but they significantly increase the concrete's flexural toughness. Polymer fibers used in concrete are mostly preferred to reduce shrinkage. Metallic fibers such as steel fiber are used to increase toughness. Also nowadays, it is produced with steel fibers and ultra-high-performance concrete (UHPC).

Anahtar Kelimeler:
Lifli beton,
Plastik büzülme,
Tokluk,
İşlenebilirlik,
Eğilme dayanımı.

ÖZ

Günümüzde betonun farklı alanlarda kullanılması beton teknolojisinde bazı gelişmelere yol açmıştır. Bu alandaki gelişmelerden birisi de lifli beton üretimidir. Lifli beton, beton ve betonarme yapı uygulamalarında geniş uygulama alanına sahip bir malzemedir. Bu yaygın kullanım nedeniyle betonun özelliklerini iyileştirmek için birçok çalışma yapılmıştır. Betona eklenen farklı tipteki liflerle elde edilen lifli beton bu çalışmalardan birisidir. Lifli beton; su, çimento, agrega ve süreksiz dağılmış liflerden oluşmaktadır. Lifler beton basınç dayanımı üzerinde çok etkili değildir, ancak betonun eğilme tokluğunu önemli derecede arttırmaktadır. Betonda kullanılan polimer lifler daha çok büzülmeyi azaltmak için tercih edilirler. Çelik lif gibi metalik lifler ise tokluk arttırmak için kullanılmaktadır. Ayrıca, günümüzde çelik lifler ile ultra yüksek performanslı betonlarda (UYPB) üretilmektedir.

1. Introduction

A concrete structure is a material with a wide usage area. Because of this widespread usage, many studies have been done to improve the properties of concrete. Fiber-reinforced concrete obtained with different fibers added to concrete is one of these studies—fiber reinforced concrete; cement, aggregate, and discontinuous dispersed fibers.

One of the important features of the structural elements is their resistance to fire or high temperatures. Although fire or high-temperature effects are not considered during the buildings' design phase, they can only be used in special-purpose buildings such as factories, thermal plants, high-temperature chimneys so on. The exposure of a typical structure to high temperature is not considered much. However, especially industrial development brings more energy use and fire risk [1].

Considering the concrete as a whole, it is known that the thermal expansion of components such as hardened cement paste and aggregate is different from each other. Therefore, the concrete's temperature changes cause various volume changes in the constituents, crack formation, and decrease in concrete strength. This phenomenon is known as the thermal incompatibility of members in concrete. When the hardened cement paste is heated from room temperature to approximately 150 ºC, it expands to a maximum of 0.2%. When the temperature is increased from 150 ℃ to 300 ℃, the hardened cement paste starts to shrink. When the temperature is increased to 800 ℃, the cement paste's shrinkage can reach up to 2.2%. Generally, at high temperatures above 150 ℃, aggregates begin to expand and disperse, while the cement paste shrinks due to the hydration products' dehydration. Therefore, thermal expansions and cracks develop under high-temperature conditions. In this respect, the behavior of concrete under high temperatures arouses curiosity [2].

By adding fibers into the concrete, the concrete is given new properties and specific properties are increased. Fibers commonly used in concrete today; steel, polymer, glass and carbon-based. The addition of fibers to concrete; is one of the most effective methods for improving the tensile and flexural strength of concrete, energy consumption capacity and crack growth properties. In addition to its superior additives, the extent to which glass fiber reinforced concrete will improve fire performance has been considered a void of debate [3].

2. Fiber Types for Concrete

It is a composite material produced using essential components such as concrete, aggregate, cement and water. The tensile strength and tensile unit deformation capacity of concrete are very low. To improve these weak properties of concrete, fibers produced from different materials and having high technical properties are added and the type of concrete obtained is called fibrous concrete. Today, fiber, concrete, natural, steel, polymer and glass-based fibers are widely used. The use of fibers in concrete, the concrete's resistance to crack development and increase the ductility property and concrete; strength and energy absorption capacity properties. The most critical factors affecting fibrous concrete properties are the slenderness ratio, the amount of fiber, and the fiber's homogeneous distribution in the concrete matrix. Homogeneously dispersed fibers prevent cracks in the concrete and slow the cracks' progression in the concrete, making the concrete more durable [4].

The use of fibers in building materials is a method that has been practiced since ancient times. The use of fiber, the first examples of which were seen using straw in adobe, has gained diversity and functionality with application examples such as steel, polymer and glass. There are many types of fibers in terms of application areas [5].

Natural Fiber

Natural fibers; fibers used in the form obtained from natural sources such as animals, plants, and minerals [46]. For example, adobe, known as a traditional material, uses straw from vegetable fibers combined with clay pulp. It is also known that flax or hemp fibers, animal fibers such as horsetail, goat hair are used in gypsum, plaster and plasterboard applications [6].

Natural Fibers Types:

- Animal Fibers
- Vegetable Fibers
- Mineral Fibers

Physical properties of some natural fibers are given in Table 1:

Table 1. Physical Properties of Different Types of Natural Fibers [7]

Fiber Type	Specific Gravity (gr / cm^3)	Maximum Elongation (%)	Modulus of Elasticity (GPa)	Tensile Strength (MPa)
Mineral Wool	2,7	0,6	69-117	483-759
Cotton-Wool	1.5	10-25	6.9	414-621
Cotton	1.5	3-10	4.8	414-690
Horse fiber	2.62	3	29.49	630
Goat fiber	2.64	5	22.57	455

Steel Fiber

Metals are widely used in industry and construction today due to their high plastic deformation capabilities. Fiber formation of metals is also used for many years. Physical properties of some metallic fibers are given in Table 2:

Table 2. Typical properties of some metallic fibers [8].

	Tensile Strength (MPa)	Modulus of Elasticity (GPa)	Melting Temperature (°C)	Metal Specific Weight (gr / cm^3)
W (Tungsten)	2890 (<250 μm) 3150 (<125 μm) 3850 (<25 μm)	350	3410	19.3
Mo (Molybdenum)	2200	330	2625	10,2
Cu (Copper)	450	125	1083	8.9
Be (Beryllium)	1100	310	1350	1.8
Al (Aluminium)	300	70	660	2.7
Stainless steel (0.05 mm)	2400	198	1535	7.8
0.9% Carbon Steel (0.1mm)	4000	210	1300	7.9

Stainless steel fibers are the most commonly used metallic fibers. The fact that the fibers are made of stainless steel eliminates the defect of metals being corroded, and the high elasticity module and strength of steel make the steel fiber superior to all other fibers.

In American Standard ASTM A 820-96 [9], which classifies steel fibers used in concrete reinforcement and specifies their properties, steel fibers are classified in 4 different ways. These:

- Type 1: Cold drawn steel fibers,
- Type 2: Steel fibers cut from plate,
- Type 3: Rolled steel fibers,
- Type 4: Other fibers

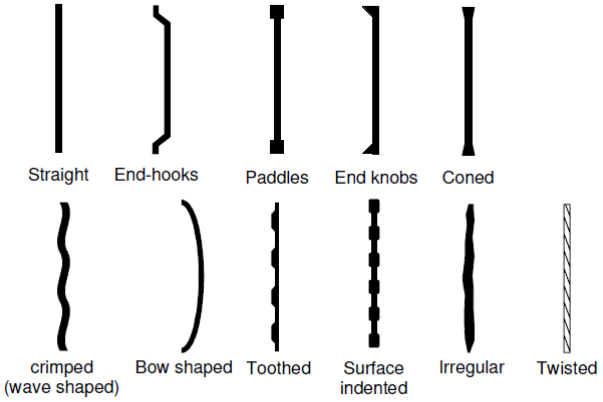

Figure 1. Some of the standard shapes of steel fibers [9]

These fibers are only classified according to the way they occur. The Turkish standard TS 10513-92 [11] also separates the fibers according to their types as follows:

- A: Straight, smooth surface fibers,
- B: fibers deformed along their entire length,
- C: Fibers with hook ends.

Class B fibers, according to the way they are deformed along their length;

- Fibers with indentations (notches) on them,
- Wavy (curled) fibers throughout its length,
- Moon shape wavy fibers

Class C fibers according to the end hooks;

- Fibers with twisted ends,
- It is divided into two as curled fibers at one end.

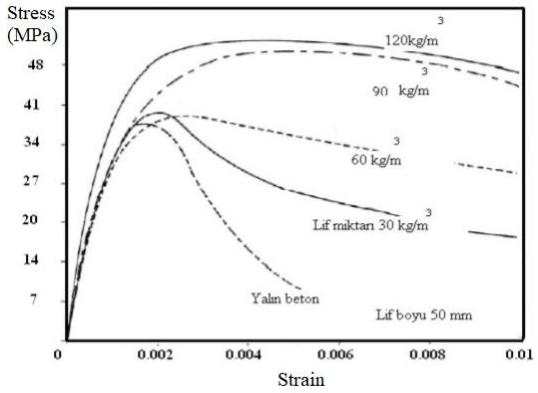

Figure 2. Normal strength concrete with steel fiber stress-strain [44]

Metals are widely used in the construction sector today due to their high deformation properties. Among the metallic fibers added to concrete, steel fibers are the most commonly used. Steel fibers are made of either carbon steel or

stainless steel. The task of steel fibers is to create adhesion force in concrete. The frictional forces in the concrete are irregular due to micro-cracks in the material. Therefore, by using steel fibers in concrete, it is provided to transfer the tensile forces formed in weak areas as a bridge [12].

The properties and classification of steel fibers to be used in concrete are divided into four groups according to American standard ASTM A 820-96. These; cold drawn fibers, plate-cut fibers, melt-drawn fibers and other fibers [13].

Table 3. Physical Properties of Steel Fibers [7]

Fiber Type	Specific Gravity (gr/cm^3)	Maximum Elongation (%)	Modulus of Elasticity (GPa)	Tensile Strength (MPa)
Steel	7,8	0,5-3,5	200	276-2760

Polymer Fiber

The main types of polymer fibers; polypropylene, nylon, polyethylene, aramid and perlon. Polypropylene fibers are the most suitable fiber added to cement paste from polymer fibers. These fibers are an essential reinforcement material with their high strength, resistance and low costs. It is also preferable that the polypropylene reinforcement material's surface is not hydrophobic, so it does not get lumpy in the cement-bonded matrix material [14].

The most important effect of polypropylene fibers in concrete is to control the cracks caused by plastic shrinkage within the first few hours after casting. The hardening of the concrete is slower than the rate at which the concrete gains strength and the shrinkage caused by the shrinkage in the first stage of the setting. This causes plastic shrinkage. polypropylene fibers provide resistance to these shrinkage stresses and minimize cracking risk due to shrinkage [15].

Fiber volume ratios are used as 0.1% - 0.05%. The processing of polymer fiber concretes on the type, length, content, and concrete strength. The fibers that are added to concrete from polymer fibers and give the best results are polypropylene fibers. Just like steel fibers, polypropylene fibers can also increase some properties of concrete. Polypropylene fibers are available in both fiber pulp and singular forms. There is little difference between fiber types [16].

An important feature of high-performance concretes is to reduce the water/binder ratio very low by using a superplasticizer. Due to the decrease in water content, there is little perspiration in these concretes. If silica fume is also used as an additional binder, a significant part of the free water is bound and sweating is hardly seen due to the large surface area of the silica fume grains. Concrete becomes very sensitive to plastic shrinkage cracks. For this reason, plastic shrinkage is prevented by adding a minimal amount of polymer-based fibers to high-performance concretes while not much effect on mechanical properties [17].

High-performance concrete is not resistant to fire has gained importance after the fire in 1996, especially in the English Channel between England and France [18]. Figure 3 shows the load-deflection curve of concrete produced with polymer fiber.

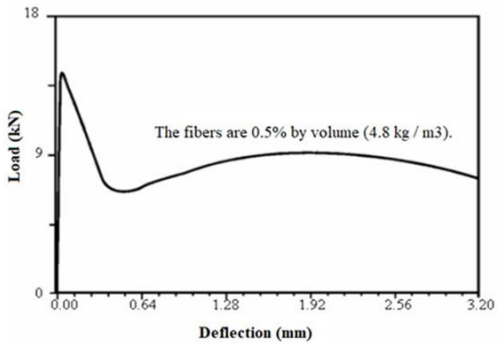

Figure 3. Typical load-deflection curve for polymer fiber-reinforced composites [19].

Polymer fibers cannot effectively increase the mechanical properties of concrete than steel fibers and negatively affect applications used more than a specific value. However, they add energy absorption properties to concrete, even if only a little, and are particularly effective in plastic shrinkage. PP fibers do not create a strength-increasing reinforcement effect in hardened concrete. Their impact is valid in the plastic phase of concrete and they act as a kind of additive material [20].

Another benefit of adding polymeric fibers to concrete is to ensure that the concrete is less damaged in fire due to the escape of water vapor that expands in the concrete at high temperatures. In high-performance concretes, the fact that the gaps are minimal, few and unrelated, prevents water vapor escape. As a result, the outer shell of the concrete bursts and pours. As a precaution, it is recommended to add polypropylene fiber to concrete. These fibers, which melt at temperature, create the necessary voids and channels and allow water vapor to escape [21]. The most important effect of polypropylene (PP) fiber in concrete or plaster is to control cracks that will occur due to plastic shrinkage within the first few hours after casting. In the first stage of hardening, the formation of concrete strength is slower than the rate of occurrence of internal tensile stresses caused by shrinkage. This plastic shrinkage is a natural result of the chemical reaction between water and cement and water evaporation. PP fibers create resistance to shrinkage stress and minimize cracks' risk due to shrinkage [20].

The typical load-deflection curve of a beam containing 0.5% single polypropylene fiber is shown in Figure 1. From this figure, it is seen that the load capacity drops significantly after the first crack. The low amount of fiber by volume added and the fibers' low elasticity modulus are factors in this behavior. Such a reduction can be observed even where the volumetric fiber percentage is 0.1%. [19].

Table 4. Physical properties of Polymer fibers [7]

Fiber Type	Specific Gravity (gr/cm^3)	Maximum Elongation (%)	Modulus of Elasticity (GPa)	Tensile Strength (MPa)
Polypropylene	0.91	40 to 100	1.35 - 1.79	24.1 - 97.0
PVA	1.30	220.7	16.1	800
Polyethylene	0.95	3–4	10 - 22	2.9 - 5.1

Glass Fiber

Glass fibers; rigid, corrosion-resistant, flexible and lightweight materials [47]. It also does not react with other materials and is low cost. Because of these properties, it is widely used in industrial applications. Since glass fibers have high strength, defects on the fiber surface are both small in number and small in size [22].

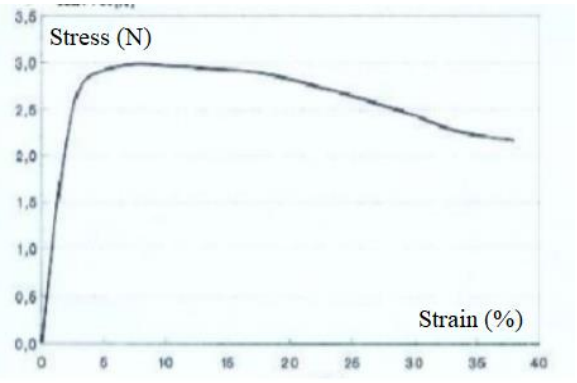

Figure 4. Stress and strain of a sample glass fiber [42]

Glass fibers have a high degree of hardness and are resistant to abrasion. Also, they are not very reactive products. In addition to these advantages, it also appears as flexible, lightweight and low-cost fibers. Glass fibers are divided into

classes within themselves. Although all-glass fibers have similar elasticity modules, they have different strength values and their resistance against environmental influences is also different. E-type fibers are fibers with low tensile strength and low chemical resistance. S-type fibers have higher strength and higher cost. Other C-type fibers can be used in applications requiring corrosion resistance [48]. The physical properties of some glass fiber types are given in Table 5.

Table 5. Physical and mechanical properties of some glass fibers [8]

Glass Fiber Type	Modulus of Elasticity (GPa)	Tensile Strength (GPa)	Specific Gravity (gr / cm^3)
CEM-FİL	80	–	2,7
C	70	1.7-2.8	2.48
S	85	2.0-4.5	2.48
E	69-72	1.7-3.5	2.54

Basalt Fiber

The most important properties of these fibers are that they can be obtained easily [45]. However, it is a problem that these fibers tend to break down in an alkaline environment. To solve this problem, additives that reduce the alkalinity of concrete should be used. The oldest known natural fibers are straw and horse mane. Other natural fibers used with Portland cement consist of fibers such as bamboo, coconut, sugarcane and wood [23]. Basalt is among the materials used recently to produce fabrics made of fibers and threads. Basalt fibers obtained by melting basalt rock at high temperatures are non-polluting, corrosion-resistant, insulating, and elastic. One of the first studies evaluating the effects of basalt fibers on improving concrete properties is Sim et al. (2005). Basalt fabric, on the other hand, appears as an alternative to carbon and synthetic fiber fabrics, which are similar products in the construction sector, and also, with its high mechanical properties, chemical resistance, sound and heat insulation properties, especially in the automotive sector, aviation, defense industry, shipping, etc. It is used in many sectors [24].

Table 6. Physical Properties of Basalt Fiber Concrete [25]

Fiber Type	Density (g/cm^3)	Maximum Elongation (%)	Modulus of Elasticity (GPa)	Tensile Strength (GPa)
Basalt Fiber	2.67	3.15	85–87	2.8–3.1

Basalt fiber reinforcement produced in the form of steel used in reinforced concrete structures using basalt fibers and epoxy resin is also one of the products used to reinforce steel in some structural elements in many countries, especially in countries such as America, Russia and Ukraine. Fiber reinforcement constitutes an important alternative for reinforcement steel, especially in structural elements with corrosion risk. Basalt fiber reinforcement, which has higher strength than reinforcement steel, is approximately three times lighter than steel reinforcement. At the same time, the thermal expansion coefficient is very close to the expansion coefficient of concrete. Considering its high resistance to alkali reactions, it has the potential to be an alternative to reinforcing steel in many areas [26].

Carbon Fiber

Advantages of carbon fibers: available in many shapes and sizes with a wide variety of features, elasticity module too high, very high strength, very low density, good thermal stability in the absence of oxygen (O_2), very high thermal conductivity, which gives good properties to fatigue, low coefficient of thermal expansion, excellent creep resistance, good chemical resistance, low electrical resistance.

Disadvantages of carbon fiber; ıts cost is relatively high, but prices drop over time, low stress leading to fracture, compressive strength less than tensile strength and does not give improved compressive properties to more significant diameter fiber, low impact resistance, it is electrically conductive. It does not cause damage to electrical systems. Care

required when handling carbon fiber oxidizes at temperatures above 450 °C, anisotropic, with different characteristics in axial and transverse directions.

Table 7. Physical Properties of Carbon Fiber [44]

Fiber Type	Density (g/cm^3)	Elastic Module/Density Ratio (mm^2/s^2)	Modulus of Elasticity (GPa)	Tensile Strength (MPa)
Carbon Fiber	1,8-2,2	130-380	240-830	2200-5600

3. Fiber Reinforced Concrete Properties

Steel fiber reinforced concrete has high energy absorption capacity, impact and fatigue resistance. The steel fiber reinforcement makes the composite mechanics completely different [27].

In the case of steel fiber reinforced concrete, the crack zone stresses are carried through the fibers after the first crack formation. Some of these stresses are carried by the fiber itself, and some of these stresses are transferred to the solid regions of the matrix by acting as bridges. The energy required for the formation of the first crack in the fibrous concrete and the crack's growth is very high compared to the fibreless concrete [28].

Mechanical properties of steel fiber concrete are directly related to fiber length, shape, a percentage in concrete, slenderness ratio, type and quantity of cement, size of sample, shape, preparation methods, water/cement ratio, type of aggregate used and grain strength.

The effect of steel fibers on the compressive strength of concrete is not much. The increase in compressive strength of concrete by steel fibers rarely exceeds 25% [29].

It is the low performance of thin concrete against design which is its greatest weakness. For this reason, fiber reinforcement mainly increases the high deformation and tensile strength of concrete [30].

Composites are subjected to flexural loads in most cases. In all reinforced concrete cases, the increase in bending strength is higher than compressive and splitting tensile strength. The most important parameters affecting the flexural strength are the type, length, geometry, percentage of the volume, the structure of the matrix and sample dimensions. The increase in fiber ratio increases bending tensile, splitting tensile stresses, and makes the most difference in toughness [31].

Polypropylene fibers are the fibers that are used with concrete in polymer fibers and give the best results in polypropylene fiber reinforced concrete, splitting tensile strength increases. In contrast, the compressive strength and elasticity modules do not change much. Synthetic fibers are often used to improve fresh concrete properties in high-performance concrete [32].

In high-performance concretes, superplasticizers minimize the water/cement ratio. Also, thinner materials are used to reduce the void rate in concrete. Examples of these fine materials are silica fume. Silica fume is a very fine-grained material. This fine-grained structure retains mixed water in the concrete and does not allow sweating. Retention of most of the mixed water will cause the plastic shrinkage to change shape in the concrete. The addition of synthetic fibers to the concrete prevents shrinkage cracks and contributes to the concrete. Polypropylene and polyester fibers are among the most widely used polymer fibers. Also, polyolefin-based polymer fibers have been used in recent years. Polyolefin competes with other polymer fibers with its high modulus of elasticity, alkali resistance and improved mechanical behavior in concrete [33].

Nylon fiber reinforced concrete is a type of fiber-reinforced concrete developed by American Army Engineers in the 1960s to construct military structures resistant to blasting effects.

In the experimental studies, it was observed that the impact strengths of the concretes containing 0.5% by volume nylon fiber were approximately five times higher than those of plain concrete. It was observed that impact strength

values of nylon fiber reinforced concrete with a fiber volume ratio of 1% were approximately 17 times higher than that of plain concrete [34].

In the experimental studies conducted on compressive strength and tensile strength of nylon fiber reinforced concrete, it was observed that nylon fibers did not cause a significant increase in compressive strength and tensile strength of splitting [35].

Regarding the tensile strength of nylon fiber reinforced concrete, some researchers have observed increased values, while others have not observed any significant increase or a slight increase. Therefore, there are conflicting results in the relevant publications on the tensile strength of flexural of nylon fiber reinforced concrete. This is because nylon has a high water absorption capability. Because if the water absorbed from the concrete mixing water does not leave enough water for cement hydration in the region around the fiber or if the fibers form a separating layer in the cement paste, this region becomes a defective region. Therefore, bending strength and compressive strength is low. However, it still increases the energy absorption capacity of concrete [36].

Glass fiber concretes are fibrous composites formed by mixing Portland cement, fine aggregate, alkali resistant glass fibers and specific additives. Glass fiber composites are flexible and have high impact resistance. The concrete's flexibility and low weight are encountered in many exterior and design applications [37].

Initially, alkali glass was used in the production of glass fibers. Thereupon, silicate glasses with a low alkali ratio were produced. These are called E-glass. Although E-glasses are used in many industries, they are not used frequently in the construction sector due to the alkali effect of concrete [38].

4. Fields of Use of Fiber Reinforced Concrete

Fiber composites are widely encountered in both industrial and construction sectors. Not every fiber will be compatible with all kinds of matrices, and not every fiber composite will be available in every application. Therefore, each different fiber composite is used in various application areas [39].

The use of fiber-reinforced concrete varies depending on the structure of the fibrous material. Steel fibers are primarily used in industrial facilities and highway pavements, bridge stands and piled floors, airport runways, explosion hazard buildings, hydraulic constructions with cavitation loads, tunnel and gallery constructions. Due to its high ductility and high tensile strength, steel fibers can be used in earthquake-resistant structures, sprayed concrete in tunnels, precast elements, road and safety structures.

On the other hand, synthetic fibers increase early plastic shrinkage and toughness of concrete and absorb the water in the concrete and prevent the water from getting away from the concrete [40].

Also, polymer fibers have started to replace steel fibers in shotcrete technology in recent years. This is because steel fiber is an abrasive material and can permanently damage shotcrete equipment. Polymer fibers, which are encouraged to be used more, appear to develop further with technology and leave the steel fibers behind. Glass fiber concretes are used frequently for exterior cladding by taking advantage of their lightweight and good workability. Polypropylene fibers have many applications. These fibers are mostly used in concrete road superstructures, industrial floors, shotcrete applications, airports, fire-resistant concrete structures, concrete pipes and military security structures [41].

On the other hand, glass fiber reinforced concrete is widely used in building facades, roofing, tribune elements, pipes and sound insulation walls due to their lightweight and good processing.

Table 8. Application areas of various fiber types [42]

Fiber Type	Applications
Glass	Precast panels, curtain wall coverings, sewer pipes, thin concrete roofs and plaster of concrete blocks.
Steel	Porous concretes used in roof applications, pavements, bridge slabs, fire-resistant elements, concrete pipes, airports, wind-resistant structures, tunnel coatings, ship keels.
Polypropyle	Basic scraping, prestressed piles, cladding panels, walkways, scaffolding

ne, nylon	elements of marinas, road patches, coating of large diameter underwater pipes.
Asbestos	Sheet metal pipes, sheets, fire-resistant materials and insulation materials, sewer pipes, corrugated and flat roof sheets, wall coverings.
Carbon	Wavy shaped roof covering elements, single or double layers of thin membrane structures, hulls, scaffolding boards.
Basalt Fiber	It can be applied to cement concrete in roads, bridges, airport runways, dams and other projects. Basalt fiber can be used as thermal insulation composite material

5. Conclusion

In this study, fiber types used in fibrous concrete production and their usage areas are examined. The most important factors affecting the performance of fibrous concrete; fiber type, geometry, volumetric utilization ratio, slenderness ratio and homogeneous distribution in concrete.

Fiber composites are materials used in the production of concrete that change the properties of fresh or hardened concrete or mortar and do not harm concrete properties when used in sufficient amounts.

Fiber composites added to concrete include setting accelerator admixtures, air-entraining admixtures, admixtures that increase the resistance of concrete to chemicals. The most common of these are superplasticizers.

While increasing the strength of concrete, the reduced water/cement ratio and the frequent use of fine-grained materials have created the need for such an additive and made it necessary to develop day by day.

Also, the fiber used in fiber reinforced concrete, which is increasing in use in today's concrete technology, decreases the collapse value of fresh concrete and causes the fibers to agglomerate. This creates a defect in concrete and adversely affects its mechanical and durability properties. For this reason, superplasticizers have a major role in improving and protecting the mechanical and durability properties of concrete.

Especially thanks to the new generation plasticizers developed in recent years, the water/cement ratio in concrete has been attracted to very low amounts.

Competing Interest / Conflict of Interest

All financial and non-financial competing interests must be declared in this section.

If you do not have any competing interests, please state "The authors declare that they have no competing interests" in this section.

The authors declare that they no conflict of interest. The none of the authors have any competing interests in the manuscript.

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Air Quality Change Related to Particulate Matter in Some Selected Green Areas in Sanliurfa

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ABSTRACT

The air, which is of vital importance for human and other living creatures to survive, must have a certain quality. Depending on various reasons, the air quality decreases at different places and times and the air can be polluted. Especially with the industrial revolution, the problem of air pollution started to affect people first locally and then globally. With the industrial revolution and the development of technology, the rapid population growth, intense and unplanned urbanization, the great increase in the number of motor vehicles and the developments and changes in land use made people's lives easier, and they also faced serious enviromental problems.. Parks and green areas that allow breathing in the city can prevent these problems to some extent. In our study, the city of Şanlıurfa, which has desert areas and alluvial fields in its close vicinity and reached peak values in certain periods in terms of the amount of particulate matter, was used. Green areas and parks with different characteristics have been preferred in the central districts (Haliliye-Eyyübiye-Karaköprü). Particulate matter measurements were carried out at 09:00 in the morning and 15:00 in the afternoon in these areas. The measurements were made with CEM DT-9880 device in 6 dimensions. As a result of the measurements the highest amount of particulate matter was experienced in the Ottoman promenade area of Eyyübiye district at 09.00 and 15.00. It has been determined that the lowest amount of particulate matter is in the Karaköprü recreation area in Karaköprü district. In addition, it has been found that the amount of particulate matter is high in the parks and green areas along the main road.

Anahtar Kelimeler:
Şehir,
Yeşil Alanlar,
Hava Kalitesi,
Partikül Madde,
Şanlıurfa.

ÖZ

İnsan ve diğer canlıların yaşamlarını sürdürebilmeleri için hayati öneme sahip olan havanın belirli bir kalitede olması gerekmektedir. Çeşitli nedenlere bağlı olarak farklı yer ve zamanlarda hava kalitesi düşmekte ve hava kirlenebilmektedir. Özellikle sanayi devrimiyle birlikte önce lokal anlamda sonrada küresel anlamda hava kirliliği sorunu insanları etkilemeye başlamıştır. Sanayi devriminin gerçekleşmesi ve teknolojinin gelişmesiyle birlikte yaşanan hızlı nüfus artışı, yoğun ve plansız şehirleşme, motorlu taşıt sayısında yaşanan büyük artış ve arazi kullanımlarında meydana gelen gelişmeler ve değişmeler insanların hayatlarını kolaylaştırmasına imkan tanırken, bunlara bağlı olarak ortaya çıkan çevre sorunları da insanların ve doğanın ciddi sorunlarla karşı karşıya kalmasına neden olmuştur. Şehir içinde nefes alınmasını sağlayan parklar ve yeşil alanlar bu sorunlara bir nebze olsun engel olabilmektedir. Çalışmamızda yakın çevresinde çöl alanları ile alüvyon sahalar bulunan ve partikül madde miktarı bakımından belirli dönemlerde zirve değerlere ulaşan Şanlıurfa şehri kullanılmıştır. Şanlıurfa şehrinde merkez ilçelerde (Haliliye-Eyyübiye-Karaköprü) farklı karakteristik özelliklere sahip yeşil alanlar ve parklar tercih edilmiştir. Bu alanlarda sabah 09.00 ile öğleden sonra 15.00'da partikül madde ölçümü gerçekleştirilmiştir. Partikül madde ölçümü CEM DT-9880 cihazı ile 6 boyut olarak yapılmıştır. Yapılan ölçümler sonucunda

09.00 ve 15.00'da yapılan ölçümlerde en yüksek partikül madde miktarının Eyyübiye ilçesi Osmanlı mesire alanında yaşandığı tespit edilmiştir. En düşük partikül madde miktarının da Karaköprü ilçesinde yer alan Karaköprü mesire alanında olduğu tespit edilmiştir. Ayrıca anayol kenarında yer alan parklarda ve yeşil alanlarda da partikül madde miktarının yüksek olduğu tespit edilmiştir.

1. Introduction

Air, which is vital for humans and other living creatures to survive, must have a certain quality. Depending on various reasons, the air quality decreases in different places and times and the air can be polluted. The concept of air pollution emerged with the industrial revolution, as a result of rapid population growth, excessive use of natural resources and urbanization as a problem affecting humanity [1]. Air pollution, especially in cities and industrial areas, has been a serious problem for human health for years [2]. Half of the world's population [3] and 2/3 of the population of European countries live in cities [4-5]. In this respect, the majority of the population living in cities on a global scale is affected by air pollution.

The rapid population growth, industrialization and increases in the number of motor vehicles, especially in cities, have led to a rise in air pollution values [6]. Apart from these, pollutants released into the atmosphere as a result of natural and human resources can adversely affect every environment, especially living things. After the pollutants in the air exceed a certain threshold, they become harmful for living and non-living beings [7]. The pollutants in the air cause people to get sick or even lose their lives. Air pollution is an important environmental health problem affecting all countries. According to estimates, more than 3 million people die each year from air pollution [8] or are negatively affected by this pollution.

Among the most important air pollutants are particulate matter (PM), sulfur dioxide (SO2), carbon monoxide (CO), ozone (O3), azotoxides (NOx) and hydrocarbons (HC) [9]. Particulate matter, present in different sizes as a result of natural and human processes, is also very dangerous among these pollutants. Exposure to particulate matter of various sizes can adversely affect human health, plants, animals and human structures especially. PM10 (coarse particles) and PM2.5 (fine particles) refer to the masses of particles with an aerodynamic diameter less than 10 and 2.5 μm, respectively [10]. Particulate matter settles in different regions of the human lung according to their size. Particulate matter smaller than roughly 2.5 μm can accumulate in the capillaries of the lung, while those with an aerodynamic diameter greater than 10 μm can accumulate in the upper respiratory tract or directly in the lung. Particulate substances in the atmosphere can also cause various diseases. Some of these diseases are COPD, lung cancer, asthma, cough, upper respiratory tract infection, bronchitis, etc.

Sources of particulate matter in the atmosphere are divided into two as natural and human. Some of the natural resource examples are soil, desert, sea and volcanic activities; human resources are fossil fuels, industrial facilities, agricultural activities, transportation activities, etc. The biggest factor in the formation of air pollution is human activities. The effects of air pollution resulting from human activities may vary regionally [11]. Cities are at the forefront of places where the impact of human activities is intense. Areas with industrial, residential and central business areas in the city are generally highly sensitive areas in terms of air pollution. In case the necessary precautions are not taken, a significant degree of air pollution occurs in industrial production processes, heating of houses and daily activities in the central business area. There are also some areas that absorb this pollution in the city. The most important of these areas are wooded and green areas. Generally, in the green areas in the city, the most intensive areas where plants are used are roadsides and parks. The green areas seen and used in cities today have emerged as a solution to environmental problems caused by industry [12]. These areas are used in different ways by many people with the thought of high air cleaning effect [13]. The green areas where human activities are intensely seen, housing gardens, children's playgrounds, neighborhood and district parks, cemeteries, botanical gardens, exhibition and fair areas, food production areas, such areas are resting, sitting, picnicking, running, and walking In addition to recreational and sportive activities such as making, products, plants and tree cultivation, and many other activities such as education [14]. These areas make a great contribution to the reduction of air pollution in the city and the protection of human health [15] and are also extremely important and effective in reducing carbon dioxide and other pollutants [16]. However, the green areas in the city are gradually decreasing as a result of the rapid increase in population and construction [17-18]. The level of air pollution is low in cities with large forest areas and large amounts of green areas [19]. However, in general, little importance is given to green areas in urban areas and in planning, they have very little competencies to meet the needs of cities [20].

In this study, it was aimed to determine the air quality in terms of particulate matter pollution in some green areas in Sanliurfa city. For this purpose, particulate matter measurements in 6 different sizes were carried out at certain times during the day. The results were evaluated and interpreted with their causes and results.

2. Material and Method

To determine measurement locations, the size of the area and the district difference were taken into account. In addition to these, the proximity to the main roads was also taken into account. Measurements were made in 9 green areas which are 4 in Haliliye, 3 in Karaköprü and 2 in Eyyübiye (Table 1 and Figure 1). Measurements at the locations in Table 1 were made in December 2020, 2021, January and February. Periodic measurements were performed for 3 months, 2 days on weekdays and 2 days on weekends in December, January and February. The altitude of the locations varies between 500 and 680 m. In addition, particulate matter measurements were carried out at different points of the measurement areas. Measurements were carried out with the CEM DT-9880 6-channel particulate matter meter. The device gives measurement values in dimensions of 0.3, 0.5, 1.0, 2.5, 5.0 and 10 µg / m³. The particulate matter meter shows the particulate matter amount in µg / m³ by passing the air flow through it for 21 seconds. The measurements were carried out at 09.00 and 15.00. The values obtained were averaged and processed in graphics and tables. The processed values were analyzed and interpreted.

Table 1. General Characteristics of the Study Area

Location	District	Attribute Status	Tree Presence	Area (m^2)	Altitude	Latitude	Longitude
Cumhuriyet Park (CP)	Haliliye	Promenade Area/Park	Low	120.000	500	37° 9' 51''	38° 50' 41''
Çamlık Park (ÇP)	Haliliye	Park	High	21.494	580	37° 10' 28''	38° 48' 18''
Fatih Sultan Mehmet Park (FSMP)	Haliliye	Park	High	66.140	581	37° 10' 39''	38° 48' 16''
Selahaddin Eyyübi Park (SEP)	Haliliye	Park	Low	80.000	583	37° 10' 43''	38° 46' 45''
Karaköprü Mesire Alanı (KMA)	Karaköprü	Alanı	High	115.000	624	37° 13' 48''	38° 48' 01''
Çocuk Oyun Dünyası (ÇOD)	Karaköprü	Play Ground	Low	30.000	654	37° 11' 53''	38° 48' 55''
İbrahim Tatlıses Park (İTP)	Karaköprü	Park	Low	14.423	595	37° 12' 45''	38° 47' 52''
Halepli Bahçe (HB)	Eyyübiye	Park	Low	120.000	530	37° 9' 11''	38° 46' 58''
Osmanlı Mesire Alanı (OMA)	Eyyübiye	Promenade Area	High	220.000	526	37° 6' 59''	38° 47' 42''

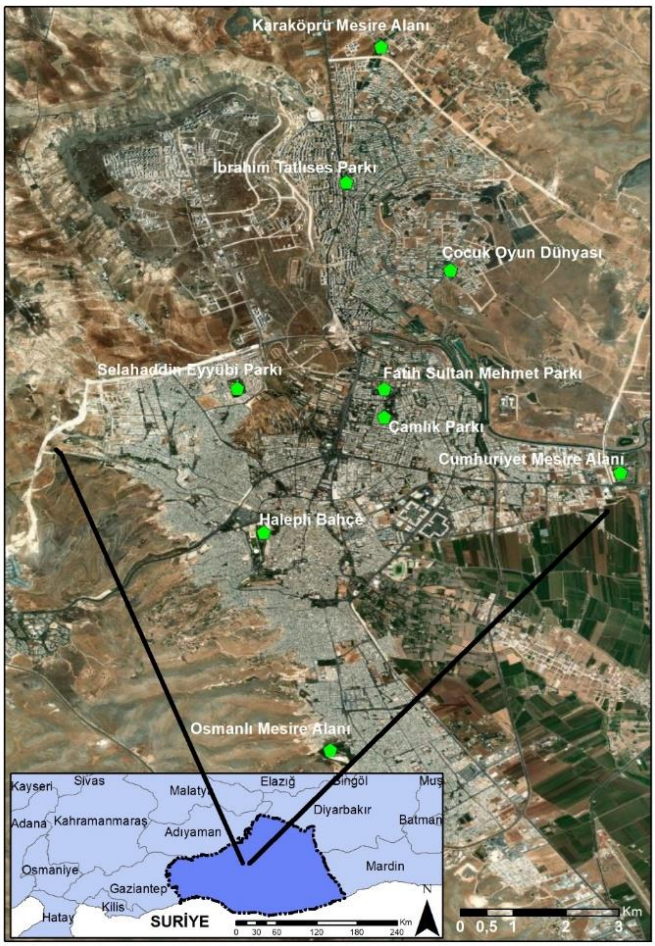

Figure 1. Sanliurfa City Measurement Points

3. Results

When the measurements of the particulate matter and meteorological data taken in the morning and afternoon in some selected green areas in the city of Sanliurfa were evaluated, it was seen that the amount of particulate matter in six dimensions in the Ottoman promenade area was quite high in both measurements compared to other areas. (Table 2, Figure 2).

When it is listed according to the lowest in the size of 0.3 µm in morning measurement, OMA> CP> HB> ITP> SEP> ÇOD> FSMP> KMA. While the highest value is OMA 82256, this value decreases to 8998 in KMA. In the afternoon measurement, it was observed that OMA> CP> HB> ITP> SEP> ÇP> ÇOD> FSMP> KMA, respectively. Although the pollution level remained almost the same, only ITP, ÇP and SEP were replaced. Particulate matter pollution with a size of 0.3 µm decreased in ITP and SEP, while it increased in FP.

When the particulate matter values of 0.5 µm in the measurement areas are examined, it is seen that the pollution order is OMA> CP> ÇP> HB> SEP> ITP> FSMP> ÇOD> KMA. Particulate matter was measured in the highest OMA 20453 and in the lowest KMA (Table 2, Figure 2). In the afternoon measurement, the pollution values were reached with the order of OMA> HB> CP> ÇOD> SEP> ITP> FMSP> ÇP> KMA. In the second measurement, the highest particulate matter values were reached in OMA with 28123, and the lowest in KMA with 3201. The stations that change places in the measurements taken in the morning and in the afternoon are CP, HB, ÇOD and ÇP. According to the morning

measurement, while the pollution decreased in CP and FP, the pollution level in ÇOD and HB increased (Table 3, Figure 3).

Table 2. Measurement Point Values (Morning-09.00)

Ölçüm Yeri	0.3 µm	0.5 µm	1.0 µm	2.5 µm	5.0 µm	10 µm
OMA	82256	20453	3386	720	119	42
CP	24001	6461	1306	281	46	12
ÇP	17789	5135	1051	275	57	20
FSMP	12633	3490	769	122	26	16
HB	19730	4688	881	159	25	6
İTP	14408	3895	765	210	66	24
KMA	8998	2344	560	126	6	1
SEP	14374	3927	763	122	16	5
ÇOD	12801	3493	720	213	24	9

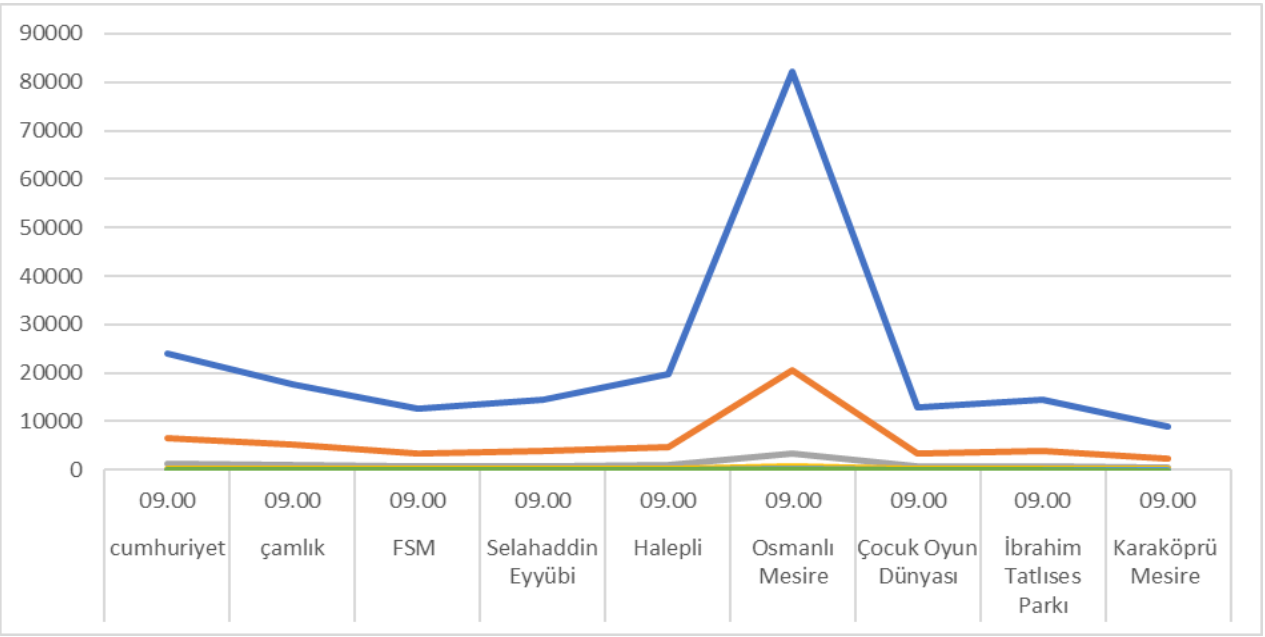

Figure 2. Change of Measurement Points in Morning Time

When the particulate matter values of 1 µm in the measurement areas are examined, it is seen that there is a pollution order of OMA> CP> ÇP> HB> FSMP> ITP> SEP> ÇOD> KMA in the morning measurement. Particulate matter was measured as 3386 in the highest OMA and 560 in the lowest KMA (Table 2, Figure 2). In the afternoon measurements, the pollution order OMA> CP> HB> SEP> ÇP> ÇOD> ITP> FSMP> KMA was formed. Stations varying between morning measurement and afternoon measurements, and all stations except OMA, CP and KMA show a change in pollution level. While the pollution level increased at HB, SEP and ÇOD stations according to the morning measurement, the pollution level decreased relatively at the FP and FSMP stations (Table 3, Figure 3).

Table 3. Measurement Point Values (Afternoon-15.00)

Ölçüm Yeri	0.3 µm	0.5 µm	1.0 µm	2.5 µm	5.0 µm	10 µm
OMA	97632	28123	4500	1250	154	67
CP	25785	4896	1459	156	54	24
ÇP	15789	3569	957	178	40	17
FSMP	12123	3596	787	136	28	16
HB	20159	5698	1236	221	45	36
İTP	16365	4236	830	302	86	35
KMA	9658	3201	657	165	10	5
SEP	15986	4502	1023	159	32	15
ÇOD	13695	4698	854	318	39	15

Looking at the 2.5 µm size particulate matter values of the measurement areas, it is seen that the pollution is listed as OMA> CP> ÇP> ÇOD> ITP> HB> KMA> FSMP = SEP in the morning measurement. The highest value was measured as 720 in OMA and the lowest as 122 in SEP and FSMP (Table 2, Figure 2). In the afternoon measurements, the pollution order was created as OMA> ÇOD> ITP> HB> ÇP> KMA> SEP> CP> FSMP. The highest value was measured as 1250 in OMA and the lowest as 136 in FSMP. The pollution change took place at all stations except the OMA station. According to the morning measurement, while the pollution due to particulate matter increased in the ÇOD, ITP, HB, KMA and SEP, the pollution values decreased at the FP and CP stations. FSMP remained in the same order (Table 3, Figure 3).

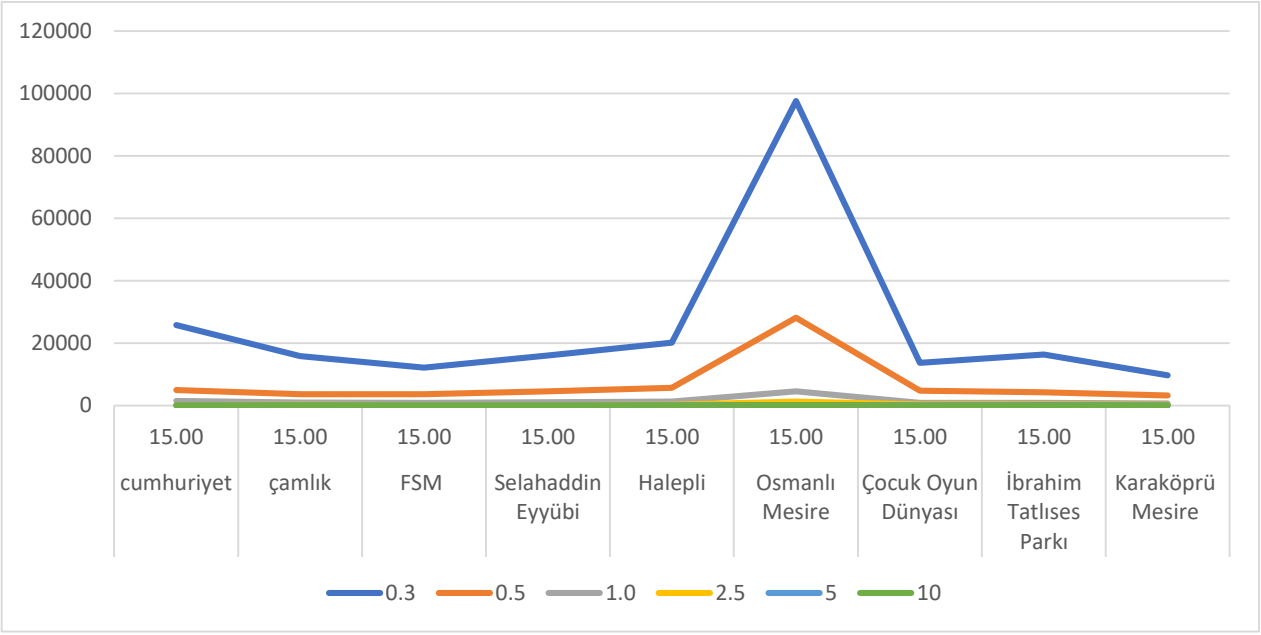

Figure 3. Change of Measurement Points in the Afternoon

When looking at the 5 µm size particulate matter values of the measurement areas, the order is OMA> ITP> ÇP> CP> HB> FSMP> CHOD> SEP> KMA. In the morning measurement, the highest value was measured as 119 in OMA, while the lowest value was measured as 9 in KMA (Table 2, Figure 2). In the afternoon measurement, the order has changed as OMA> ITP> CP> HB> ÇP> ÇOD> SEP> FSMP> KMA. It was measured as 154 in the highest OMA and 10 in the KMA. The pollution change took place at stations CP, HB, ÇP, ÇOD, SEP and FSMP. While the pollution level increased in CP, HB, ÇOD and SEP, it decreased in FP and FSMP (Table 3, Figure 3).

Finally, looking at the particulate matter values of 10 µm in the measurement areas, the pollution order in the morning measurement is OMA> ITP> ÇP> FSMP> CP> ÇOD> HB> SEP> KMA. It was measured as 42 in the highest OMA and

1 in the KMA (Table 2, Figure 2). In the afternoon measurement, the pollution order was formed as OMA> HB> ITP> CP> ÇP> FSMP> SEP = ÇOD> KMA. It was measured as 67 in the highest OMA and 5 in the KMA. When looking at the change of pollution, it is seen that it changes in ITP, ÇP, CP, FSMP, ÇOD, SEP and HB. Comparing the measurements in the morning and in the afternoon, while the pollution increased in HB and CP, the pollution level decreased in ITP, FP, FSMP, SEP and ÇOD (Table 3, Figure 3).

4. Discussion and Conclusion

The selection of measurement points from different areas has been an important factor in determining the source of particulate matter contamination. In this respect, it is of great importance that the measurement points are located on the main road, close to the Harran plain, which is an important alluvial deposit for Şanlıurfa, and selected from areas where human circulation is intense, and the source of particulate matter pollution in these areas has been tried to be determined.

As a result of the measurements made in the field, maximum pollution was detected in the morning and afternoon measurements of all sizes, especially in the OMA located in the south of the city. Minimum pollution in six dimensions was detected in the morning and afternoon at KMA. The high number of people in OMA located in Eyyübiye district indicates that more people are affected by particulate matter compared to other districts, and the lower population in KMA indicates that less people are affected by particulate matter. In addition to these, the fact that Eyyübiye is close to the Harran plain causes the pollution to remain longer because it is morphologically surrounded by high areas, while the relatively high areas of Haliliye and Karaköprü affect the duration of the pollution. In general, the pollution level is expected to decrease under normal conditions as we move from south to north in the study area. However, it has been observed that the pollution level is high in the green areas on the main road route.

Exposure to particulate matter for a long time can cause serious lung diseases (asthma, chronic bronchitis, lung cancer, etc.), respiratory tract infections, and even premature deaths. Dust particles coming from the deserts in the near and far surroundings of Şanlıurfa province cause significant particulate matter pollution, especially in the spring and autumn seasons. Especially in these seasons, it is of great importance for people living in the settlements around the Harran plain to wear masks in protection from particulate matter pollution. In addition, on days when particulate matter pollution is intense, local governments should be periodically reminded that people should not go out except to meet their basic needs and do not open doors and windows of their houses.

Competing Interest / Conflict of Interest
The authors declare that they no conflict of interest. None of the authors have any competing interests in the manuscript.

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Population Change in Yalova Province

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ABSTRACT

Yalova is the province of Turkey with the smallest area. Yalova became a province in 1995. The Population change in Yalova Province was determined by taking in to account the results of the Population Census (1935-2020) and Address Based Population Registration System (ABPRS) that has been carried out since 2007. Statistical data has been interpreted by converting it into various tables and graphs in a computer environment. The aim of the research is to analyze the population change in Yalova Province with in a spatial framework. The research area receives intense internal and international migration. The population of Yalova Province has continuously increased from 1990 (135.121) until 2020 (276.050). The population of Yalova Province increased by 16.4 times between 1935-2020. It is estimated that it will continue to increase according to population projections. The main factors causing population change are birth, death and migration. It has been determined that international migration and internal migration play an important role in the change of population in Yalova Province. Since the rural population increases are less than the urban population and the ratio of the rural population is decreasing, projects supporting rural development should be increased so that the rural population should be protected and the continuation of agricultural production should be ensured. Population growth has always had a negative impact on area. As the population increases in the research area, agricultural areas are declining, and it is seen that the pressure on agricultural areas will continue.

Anahtar Kelimeler:
Beşeri Coğrafya,
Nüfus,
Göç.

ÖZ

Yalova Türkiye'nin en küçük yüzölçümüne sahip ilidir. Yalova 1995 yılında il olmuştur. Yalova İlinde nüfusun değişimi Genel Nüfus Sayımı sonuçları (1935-2000) ile 2007 yılından itibaren gerçekleştirilen Adrese Dayalı Nüfus Kayıt Sistemi sonuçları dikkate alınarak tespit edilmiştir. İstatistiki veriler bilgisayar ortamında çeşitli tablo ve grafiklere dönüştürülerek yorumlanmıştır. Araştırmanın amacı, Yalova İlinde nüfusun değişiminin mekânsal çerçeve içerisinde analiz edilmesidir. Araştırma sahası yoğun iç ve dış göç almaktadır. Yalova İli nüfusu 1990 yılından (135.121), 2020 yılına kadar (276.050) sürekli olarak artış göstermiştir. Yalova İli nüfusu 1935-2020 yılları arasında 16,4 kat artış göstermiştir. Nüfus projeksiyonlarına göre de nüfusun artış göstermeye devam edeceği öngörülmektedir. Nüfus değişimine neden olan temel faktörleri doğum, ölüm ve göçler oluşturmaktadır. Yalova İlinde nüfusun değişiminde uluslararası göçler ile iç göçlerin önemli rol oynağı tespit edilmiştir. Kırsal nüfusun şehir nüfusuna göre daha az artış göstermesi, kırsal nüfus oranının azalış göstermesi nedeniyle kırsal kalkınmayı destekleyici projeler artırılmalı böylece kırsal nüfus korunmalı tarımsal üretimin devamı sağlanmalıdır. Nüfus artışının her zaman mekân üzerine olumsuz etkisi olmuştur. Araştırma sahasında nüfusun artması ile birlikte tarım alanları azalmakta olup, tarım alanları üzerindeki baskının devam edeceği görülmektedir.

1. Introduction

General population; refers to the number of people living in a given timeframe and within a certain area. While population censuses across the world focused only on the number/amount of the populace until the 20th century, subsequently, they were subsequently revamped to include the characteristics of the population, migration, changes in population as these factors became important [1].

The population issue constitutes one of the basic study areas of human geography. The distribution of the population on the earth, the factors that cause this distribution, the movement of the population (migration), births and deaths, changes in the various characteristics of the population according to time and place are discussed in the population geography, which is a branch of human geography [2].

Population is an extremely mobile and volatile phenomenon. The increase or decrease of the population in a certain period of time is parallel to the economic, social and political events experienced [3]. The population is determined through censuses. Countries want to have information about the number and characteristics of human resources in order to use their natural, economic and cultural assets effectively, for which census is applied to ensure this. Census can be defined as "collecting demographic information in a country at a certain time with information that includes all family members and making them ready for processing, organizing and publishing them in a manner suitable for specific purposes" [4].

Yalova Province is located in Northwestern Turkey and is surrounded by the eastern coast of the Sea of Marmara, Izmit and Gemlik gulfs. The Marmara Sea is located in the north of Yalova Province, and it is adjacent to Karamürsel District of Kocaeli, Orhangazi and Gemlik District of Bursa (Figure 1). Yalova, the smallest province in terms of Turkey, has a surface area of 798 Km2 and accounts for 0.10% of the surface area of Turkey [5].

Figure 1. The location map of Yalova Province

Armutlu sub-district center of Gemlik District of Bursa Province, Altınova small town of Karamürsel District of Kocaeli Province and Yalova District of İstanbul Province and Çınarcık sub-district Center, Termal town and Çiftlikköy town became Districts and were connected to Yalova Province. In Yalova Province, which consists of six districts

together with the Central District; There are 43 villages and 14 municipalities. The municipalities are central and 5 district municipalities and 8 town municipalities (1 of Central District, 3 of Altınova District, 3 of Çınarcık District and 1 of Çiftlikköy District).

Yalova is located on the northwest coasts of Samanlı Mountains and on the northern coasts of Armutlu Peninsula and has the potential of being an important tourism area of the Marmara Region. Yalova is surrounded by the Marmara Sea to the north and west, Gemlik Bay and Gemlik and Orhangazi Districts of Bursa Province to the south, and Karamürsel District of Kocaeli Province to the east. Apart from the plains formed by the coastal plains and delta plains on the eastern shores of Yalova, it generally has a rugged terrain.

The thermal springs, ornamental plants and flower cultivation are other factors that affect the economy of the city. Yalova is a coastal city and the land conditions are suitable positively and affect the settlement and agricultural economy. The diversity and richness of Yalova can be attributed to the internal migrations from many regions of Turkey to Yalova Province, as well as the presence of Balkan and Caucasian immigrants in the region [6]. In the Province of Yalova, the population has shown a balanced increase in recent years.

Yalova is located in an area where some of Turkey's most important industrial and transport networks are concentrated. With the development of transportation systems day by day, the importance of Yalova is increasing. The fact that it is located on main routes such as Balıkesir, İzmir and Bursa and its proximity to a metropolis like İstanbul has ensured that Yalova's importance has been preserved throughout history. The fact that Yalova is located in an area with suitable settlement and many attractive factors caused the population and settlement movements to increase in this area [6, 7].

The construction of 5 Organized Industrial Zones (OIZs) in a total area of 12,667 decares in Yalova Province continues. It is expected that 6 OIZs will be operational in the Yalova Province by 2023. With the activation of the other 5 OIZs, excluding Yalova Composite and Chemical Specialization OIZ, approximately 57,000 people are expected to be employed [8, 9].

The Turkish Shipbuilders'Association (GISBIR) has 100 members and 6 of the 69 companies are headquartered in Yalova Province. There are 84 active shipyards in Turkey that perform ship and yacht construction and maintenance and repair activities. The largest number of shipyards are located in the Tuzla shipyards region of İstanbul, and the second is located in the Altınova shipyards region of Yalova Province. In 2017, there were 12 thousand employees in the Altınova shipyards region of Yalova Province, reaching 17 thousand in 2019 and 23 thousand in 2020. The number of jobs is expected to reach 40 thousand by 2023 [10-15].

The population of Yalova Province has increased steadily from 1990 (135,121) to 2020 (276,050). The population of Yalova Province increased by 16.4 times between 1935-2020.

2. Material and Method

The aim of the research is to analyze the change of the population in Yalova Province within a spatial framework. With the population growth of Yalova, the population density that intensifies in the city centers in the coming years will further increase the pressures on the place.

A detailed national and international literature review was carried out within the scope of the research. According to the subject of the study, general censuses and the Address Based Population Registration System (ABPRS) statistics produced by the Turkish Statistical Institute (TUIK) were used as second data due to the fact that the population change will be analyzed in the Province of Yalova. Statistical data has been interpreted by converting it in to various tables and graphs in a computer environment.

The observation and analysis of documents determined as qualitative research methods were interpreted descriptively and systematically. In this study, the result was reached from the geographical point of view.

3. Results

3.1. Total Population of Yalova Province

In this chapter; The total population of Yalova Province and the change of population, population growth rate are taken into account.

Due to the fact that Yalova was a province in 1995, detailed information about Yalova Province and its districts can be obtained since the 1990 general population census. Before Yalova became a province, the population of Yalova District increased to 16,840 in 1935, 22,225 in 1950, and 37,090 in 1965. Industrialization and migration from the countryside to the city accelerated this increase. At the same time, the NATO base established in Karamürsel District of Izmit in 1960 contributed to the increase of the population of Yalova District [16]. While the population of Yalova, which is a District of İstanbul Province, was taken into account in the 1985 census, and in the 1990 census, Armutlu sub-district center of Gemlik District of Bursa Province, Altınova small town of Karamürsel District of Kocaeli Province gained the status of the district and was added to the population of Yalova province, the population of Yalova Province in 1985 increased by 50% from 90,228 in 1990 to 135,121. The annual population growth rate of Yalova Province was also realized as 80.8‰. In the general population census of 1990, Yalova was actually counted only as a district, and according to the administrative structure in 2000, its population was recalculated by considering other districts. In fact, Yalova's population was found to be 113,417 people in the 1990 general census. When the annual population growth rate is calculated considering this population, it will be seen that this rate is 45.7‰. According to the 1997 General Population Count [17], the population of Yalova was 163,916 according to de facto and the population is 162,190 people according to de jure (Table 1). The annual population growth rate compared to 1990 was 27.6‰ in 1997 and 22.1‰ in 2000.

Table1. Change of Total Population of Yalova Province by Years (1935-2020)

Year	Population	Period	Increase/Decrease	Annual Growth Rate of Population (‰)
1935	16.840	-	-	-
1940	17.078	1935-1940	238	2.8
1945	20.276	1940-1945	3.198	34.3
1950	22.255	1945-1950	1.979	18.6
1955	26.671	1950-1955	4.416	32.2
1960	33.101	1955-1960	6.430	43.2
1965	37.090	1960-1965	3.989	22.8
1970	42.689	1965-1970	5.559	28.1
1975	55.036	1970-1975	12.347	50.8
1980	75.787	1975-1980	20.751	64.1
1985	90.228	1980-1985	14.441	34.9
1990	135.121	1985-1990	44.893	80.8
1997	163.916	1990-1997	28.795	27.6
2000	168.593	1990-2000	33.472	22.1
2007	181.758	2000-2007	13.165	10.7
2008	197.412	2007-2008	15,654	82.6
2009	202.531	2008-2009	5.119	25.6
2010	203.741	2009-2010	1.210	6.0
2011	206.535	2010-2011	2.794	13.6
2012	211.799	2011-2012	5.264	25.2
2013	220.122	2012-2013	8.323	38.5
2014	226.514	2013-2014	6.392	28.6
2015	233.009	2014-2015	6.495	28.3
2016	241.665	2015-2016	8.656	36.5
2017	251.203	2016-2017	9.538	38.7
2018	262.234	2017-2018	11.031	43.0
2019	270.976	2018-2019	8.742	32.8

2020	276.050	2019-2020	5.074	18.6

Source: The results of the Population Censuses (1935-2000), the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute. Annual population growth rate is calculated by using (LN(The next census/previous census)/(The time period between the censuses))*1000 [18, 19, 20].

The population growth rate of Yalova Province in 2008 was 82.6‰, and the net migration to be announced in the internal migration section as 10,114 and the net migration rate as 52.6‰ were contributors to the population growth. The population of Yalova Province has increased continuously from 1990 (135,121) until 2020 (276,050). The population of Yalova Province increased 16.4 times between 1935-2020 (Figure 2).

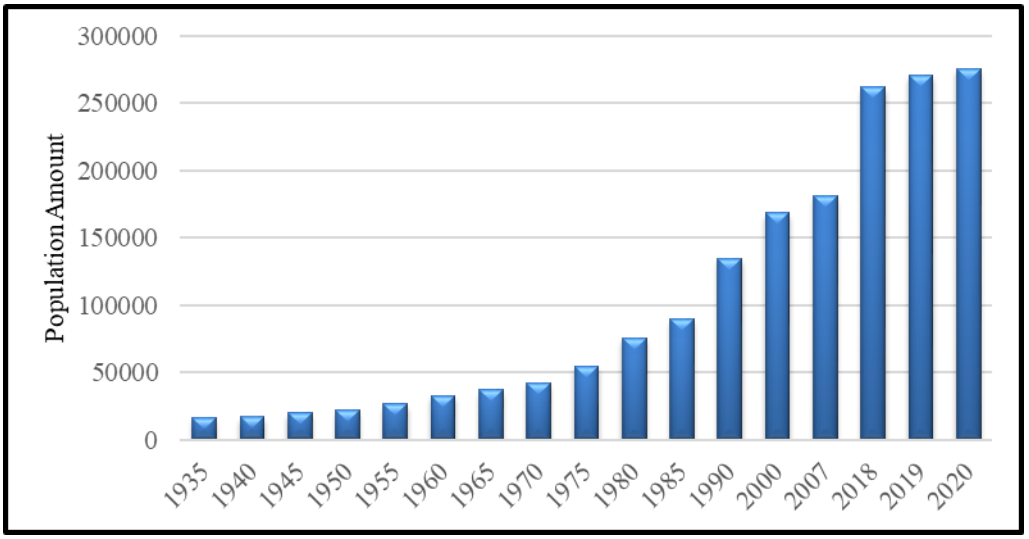

Figure 2. Development of Total Population of Yalova Province by Years (1935-2020)

The total population of Yalova Districts is shown in Table 2. The total population of the districts has been calculated since 1990. The Central District has the highest population, and Çınarcık District, which has the second highest total population, has regressed to the third place since 2009.

Table 2. Change of Total Populations of Yalova Districts by Years (1990-2020)

Year	Central	Altınova	Armutlu	Çınarcık	Çiftlikköy	Termal	Toplam
1990	77.137	15.688	6.016	17.290	14.672	4.318	135.121
2000	86.091	22.801	7.858	21.650	24.789	5.404	168.593
2007	102.871	20.916	7.210	22.085	24.046	4.630	181.758
2008	107.609	23.563	7.821	27.682	25.630	5.107	197.412
2009	114.054	23.235	8.025	25.892	26.239	5.086	202.531
2010	116.471	23.171	7.826	24.488	26.769	5.016	203.741
2011	118.998	22.686	7.823	24.488	27.640	4.900	206.535
2012	121.479	23.148	7.732	25.629	28.854	4.957	211.799
2013	124.018	23.567	8.562	27.384	30.784	5.807	220.122
2014	127.670	24.333	8.619	27.535	32.423	5.934	226.514
2015	132.322	24.140	8.492	28.092	34.094	5.869	233.009
2016	137.007	24.896	8.688	29.417	35.628	6.029	241.665
2017	140.312	26.510	8.848	32.590	36.895	6.048	251.203

2018	144.407	28.232	9.625	34.076	39.110	6.784	262.234
2019	149.068	29.237	9.543	34.343	41.882	6.903	270.976
2020	149.330	30.780	9.901	34.699	44.808	6.532	276.050

Source: The results of the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [19, 20].

The mild climate of Yalova, the availability of tourism opportunities, having important transportation routes, the high rate of education and its cultural diversity, its proximity to important industrial, business and commercial areas such as İstanbul, Bursa, Kocaeli have provided a great advantage in terms of the development of the population of the province [6]. It is also forecasted that this advantage will continue.

3.2. City Population

The first information about the city population of Yalova was described in the 17th century by Evliya Çelebi as a settlement in Yalova with 700 houses, seven mosques, a bath, three khans, forty-fifty shops and the castle were destroyed. It is known that it corresponds to a population of 4000. According to Yalova's census in 1831; there was a total of 3,929 male population, including 918 Islam and 3,011 Reaya [16]. In the 1918 census, which was held for the last time during the Ottoman Empire; The total number of living people, including 795 Muslims, 10,274 Greeks and 3,303 Armenians, was 14,372 [21]. As it is known, Yalova became a province in 1995. For this reason, the change in the city population of the District of Yalova, which was a district between 1935-1995, will be examined first (Table 3, Figure 3). In Turkey, TUIK considers the provincial and district centers as cities and registers the population of the city by administrative arrangement.

Table 3. Change of City Populations of Yalova District by Years (1935-1990)

Year	City Population	Period	Increase/Decrease	Annual Growth Rate of Population (‰)
1935	2.635	-	-	-
1940	2.300	1935-1940	-335	-27.14
1945	3.608	1940-1945	1.308	90.10
1950	3.833	1945-1950	225	12.10
1955	6.610	1950-1955	2.777	100.99
1960	11.318	1955-1960	4.708	107.56
1965	14.241	1960-1965	2.899	45.95
1970	17.689	1965-1970	3.472	43.36
1975	27.289	1970-1975	9.600	86.71
1980	41.823	1975-1980	14.534	85.39
1985	53.857	1980-1985	12.034	50.57
1990	65.823	1985-1990	11.966	40.13

Source: The results of the Population Censuses (1935-2020), the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [18, 19, 20].

Yalova shows the characteristics of a small district consisting of 2,635 people according to the 1935 census. It is known that the city of Yalova was consisted of three neighborhoods (Süleymanbey, Rüstempaşa and Merakuyu) and 461 residences in 1939 [16]. In 1940, the city population of Yalova decreased to 2,300 people, in subsequent censuses, its population increased continuously and continued to expand over the area. The reason for the decrease in the 1940s was the environment created by the World War II and the Turkish War of Independence had an ongoing effect. The effect of the Turkish War of Independence reduced the number of male population, the female population ratio was 59.1% in 1935 and was 59.9% in 1940, in these years the number of women, especially in the 25-44 age, exceeded the number of men. In Turkey, the population growth rate was decreased to 17.03‰ between 1935-1940, was desreased to 10.59‰ between 1940-1945 with the effect of the World War II [18].

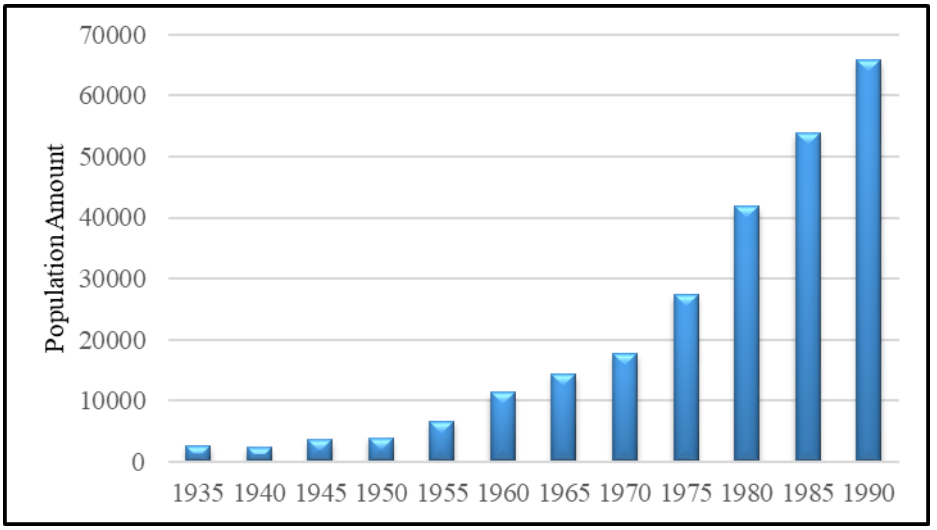

Figure 3. Development of City Population of Yalova District by Years (1935-1990)

In Yalova, the annual population growth rate minus 27.14‰ between 1935-1940. In the following years, a gradual increase is observed in parallel with the development of Yalova city. The industrialization process which began in Turkey After 1950 and therefore affected Yalova as a District of İstanbul, was the most important of the factors that increased Yalova's population growth. However, the migrations from the countryside to the city and the favorable living conditions of Yalova are other important factors. With these factors, the population of Yalova city increased from 3,833 in 1950 to 6,610 in 1955. In the early 1950s, the city of Yalova experienced the highest annual growth rates between 1950 and 1955, with annual growth rates of 100.99‰ and 107.56‰ respectively. The establishment of the NATO base in the east of Yalova in 1952 has been an important factor in the population, economic and social development of the city. For this reason, the population of Yalova city first increased to 11,318 in 1960 and to 14,217 in 1965. The population growth of Yalova has continued since the 1970s, with the acceleration of the industrialization process and the effect of ongoing internal migration. In this period, large industrial facilities started to be established in the east of the city, summer residences increased, floriculture and greenhouse activities developed. Therefore, Yalova city population reached 17,689 in 1970 and 65,823 in 1990. The population growth rate was 86.71‰ in 1975, 85.39‰ in 1980, started to decrease in 1985 and became 50.57‰ and 40.13‰ in 1990.

The change in the city population of Yalova after it became a province is shown in Table 4, taking into account the total of all district centers together with the the General Population Count made in 1997. The increase in the city population of Yalova continued increasingly until the Marmara earthquake on 17 August 1999. According to the results of the General Population Count made on 30 November 1997, the population of Yalova city was 110,106 according to the location and 109,750 according to the residence [19]. The Yalova city was not affected much by the Düzce earthquake on 12 November 1999 [6]. In the Marmara earthquake, the total loss of life of those living in nine neighborhoods in Yalova city was 1,449, and the most casualties were in Bahçelievler (624) and Kâzımkarabekir (595 dead) neighborhoods [16] With the effect of losses and migration after the Marmara earthquake, the population of Yalova city decreased to 98,661 in 2000. In 2007, the population of Yalova city increased again to 122,075. Between 2007-2020, the population of Yalova city has increased continuously. The highest population growth rate was recorded as 75.12‰ in 2008. The Turkish Local Administrations Election held on 29 March 2009 is considered to have had an effect on this increase. Due to the effect of population growth in the previous year, the population of Yalova city increased by only 1,204 people in the next year and the population growth rate was 9.11‰. Likewise, with the effect of The Turkish Local Administrations Election held on March 31, 2019, the population growth rate increased to 60.30‰ in 2018, decreased to 40.69‰ in 2019 and 16.60‰ in 2020.

Table 4. Change of City Populations of Yalova Province by Years (1997-2020)

Year	Population	Period	Increase/Decrease	Annual Growth Rate of Population (‰)
1997	110.106	-	-	-
2000	98.661	1997-2000	-11.445	-36.59
2007	122.075	2000-2007	23.414	30.42
2008	131.599	2007-2008	9.524	75.12
2009	132.803	2008-2009	1.204	9.11
2010	139.388	2009-2010	6.585	48.39
2011	142.881	2010-2011	3.493	24.75
2012	149.421	2011-2012	6.540	44.76
2013	155.016	2012-2013	5.595	36.76
2014	160.803	2013-2014	5.787	36.65
2015	167.558	2014-2015	6.755	41.15
2016	175.319	2015-2016	7.761	45.28
2017	181.036	2016-2017	5.717	32.09
2018	192.288	2017-2018	11.252	60.30
2019	200.274	2019-2018	7.986	40.69
2020	203.628	2020-2019	3.354	16.60

Source: The results of the Population Censuses (1935-2020), the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [18, 19, 20].

Due to the fact that Yalova was a province in 1995, detailed information about Yalova Provence and its districts can be obtained since the 1990 general population census. The change in the total city population of the Central District and other Districts of Yalova in the years 1990, 2000 and 2007 and the city population of Yalova at the district level are shown in Table 5 and Figure 4.

Table 5. Change of City Populations of Yalova Districts (1990-2000-2007)

Districts	1990	2000	2007
Central	65.823	70.118	87.372
Altınova	2.176	3.231	3.429
Armutlu	3.201	4.221	4.633
Çınarcık	7.629	8.953	9.170
Çiftlikköy	5.750	9.622	15.290
Termal	2.453	2.516	2.181
Total	87.032	98.661	122.075

Source: The results of the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [19, 20].

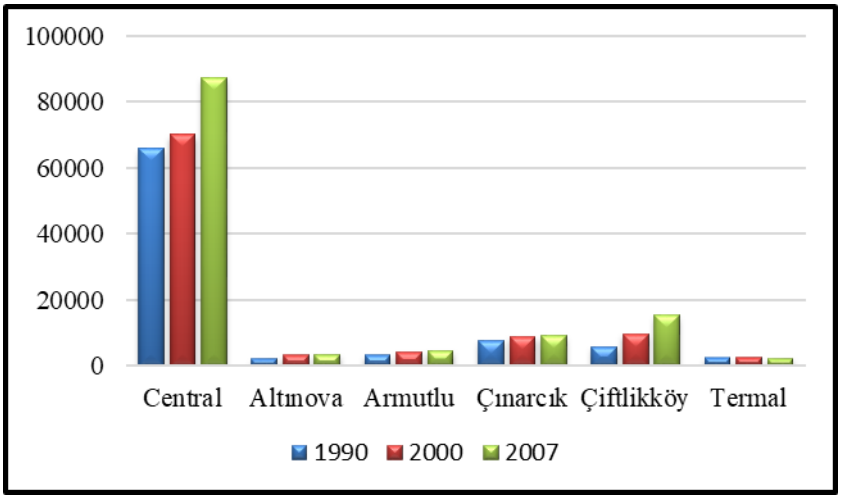

Figure 4. Change of City Populations of Yalova Districts (1990, 2000, 2007)

Except for Termal District of Yalova Province, the city population of other districts has increased, and when the total population amount is compared, Yalova Central District continues to have the highest population.

It is seen that the Central District of Yalova has the highest city population. The concentration of facilities belonging to the service sector such as schools, hospitals, shopping areas, cinemas and theaters in the Central District and the fact that the city is the administrative center of the province constituted the reasons that increased its population [7].

When the annual growth rate of population of Yalova Province between 1990-2000, 2000-2007 was examined (Table 6), Çiftlikköy, Altınova and Armutlu cities were the Districts with the highest annual growth rates of population between 1990 and 2000. The population growth rate of the Central District was low due to the Marmara earthquake. Between 2000 and 2007, Çiftlikköy, Central and Armutlu cities formed the Districts with the highest annual population growth rates.

Table 6. Average Annual Population Growth Rates of City Populations of Yalova Districts (‰) (1990-2000 and 2000-2007)

Place Name	**1990-2000**	**2000-2007**
Central	6.32	31.43
Altınova	39.52	8.50
Armutlu	27.65	13.30
Çınarcık	16.00	3.42
Çiftlikköy	51.47	66.16
Termal	2.54	-20.41
Total	**12.54**	**30.42**
Turkey	**26.81**	**17.52**

Source: The results of the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [19, 20].

Between 1990 and 2000, the annual urban growth rate of population of Yalova in general was 12.54‰. The annual urban growth rate of population of Turkey was 26.81‰. While the reason for the low annual urban growth rate of population of Yalova in 1999 Marmara after the earthquake (2000 census results) was due to the decrease to 59% of the total city population. When the annual population growth rate of the cities of Yalova Province is examined (Table 6),

Çiftlikköy, Central and Armutlu are the Districts with the highest population increases. Between 2000 and 2007, the urban population growth in general was 30.42‰. The annual urban growth rate of population of Turkey was 17.52‰.

As can be seen in Table 7, which includes the change in the total city populations of the Central District and other Districts in Yalova in 2007 and 2020, and the city population of Yalova at the District level, the city population of all Districts in Yalova Province has increased and the average annual population growth rate is was performed as 39.36‰. Turkey's overall annual growth rate of urban population was found to be 101.27‰. When the total city population is compared, the Central District continues to have the highest rural population.

Table 7. Change of City Populations and Average Annual Population Growth Rates of Yalova Districts (2007-2020)

Place Name	2007	2020	Annual Growth Rate of Population (‰)
Central	87.372	128.933	29.93
Altınova	3.429	8.217	67.23
Armutlu	4.633	7.265	34.60
Çınarcık	9.170	18.428	53.69
Çiftlikköy	15.290	37.618	69.25
Termal	2.181	3.167	28.69
Total	**122.075**	**203.628**	**39.36**
Turkey	**20.838.397**	**77.736.041**	**101.27**

Source: The results Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [20].

According to the census of 2020, 128,933 people of the total population in Yalova Province live in the city center of Yalova Central District. Apart from the city center of Yalova, the districts with the most crowded city population are respectively Çiftlikköy, Çınarcık and Altınova District. The city population of all Districts of Yalova has increased in 2020 compared to 2007. The reason for this is the effect of natural population growth as well as migration from rural areas and other provinces. The main reasons for the increase in the population of the cities are the tourism opportunities of the Central District, the cultural diversity and the existence of administrative institutions, the effect of thermal spring tourism in Termal District, the effect of spa and sea tourism in Armutlu District, the effect of agricultural activities such as sea tourism, vegetable, fruit, floristry and greenhouse cultivation, and the existence of industrial facilities in Çiftlikköy District, the effect of agricultural activities such as fruit, floristry and greenhouse cultivation and the existence of industrial facilities in Altınova District.

3.3. Rural Population

Due to the fact that Yalova was a province in 1995, detailed information about Yalova Province and its districts could be reached since the general population census of 1990. According to the administrative restructuring in 2000, the population of Yalova Province has been recalculated considering other districts. The rural population of the Central District and other districts and the annual population growth rates were announced in 1990 and 2000. As can be seen in Table 8, which includes the rural population at the district level of Yalova, the rural population has increased in all districts of Yalova Province.

Table 8. Change of Rural Populations and Average Annual Population Growth Rates of Yalova Districts (1990-2000)

Place Name	1990	2000	Annual Growth Rate of Population (‰)
Central	11.314	15.973	34.48
Altınova	13.512	19.570	37.03
Armutlu	2.815	3.637	25.61
Çınarcık	9.661	12.697	27.32
Çiftlikköy	8.922	15.167	53.05
Termal	1.865	2.888	43.72
Total	**48.089**	**69.932**	**37.44**

Turkey	**23.146.684**	**23.797.653**	**4.21**

Source: The results of the Population Censuses (1965-2000) [19].

When the annual growth rate of rural population in Yalova Province between 1990 and 2000 is examined, Çiftlikköy, Termal, Altınova and Central are the Districts with the highest rural population increases. Generally, rural population growth was 37.44‰. The annual growth rate of rural population in Turkey was 4.21‰, the reason for the high growth rate of rural population in Yalova was due to the migration to the rural areas and the increase of the total rural population to 45% after the earthquake in 1999 Marmara (2000 census results).

As can be seen in Table 9 and Figure 5, which includes the rural population of Yalova at the district level with the change of the total rural populations of the Central District and other Districts in 2000 and 2007 of Yalova, the rural population of other Districts except Çınarcık District in Yalova Province has decreased. When the total population numbers are compared, Yalova Central District continues to have the most population.

Table 9. Change of Rural Populations and Average Annual Population Growth Rates of Yalova Districts (2000-2007)

Place Name	**2000**	**2007**	**Annual Growth Rate of Population (‰)**
Central	15.973	15.499	-4.30
Altınova	19.570	17.487	-16.08
Armutlu	3.637	2.577	-49.22
Çınarcık	12.697	12.915	2.43
Çiftlikköy	15.167	8.756	-78.48
Termal	2.888	2.449	-23.55
Total	**69.932**	**59.683**	**-22.64**
Turkey	**23.797.653**	**20.838.397**	**-18.97**

Source: The results of the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [19, 20].

When the rural annual population growth rate of Yalova Province between 2000 and 2007 was examined (Table 9), Çınarcık was the only District with an increase in rural population growth, and the population growth rates of other Districts remained at negative values. Generally, rural population growth was minus 22.64‰. The rural annual population growth rate in Turkey was found to be minus 18.97‰. The rural population of the Central District increased in 2000 compared to 1990, and decreased in 2007 compared to 2000. The annual growth rate of the Central District in 2007 compared to 2000 was minus 4.30‰.

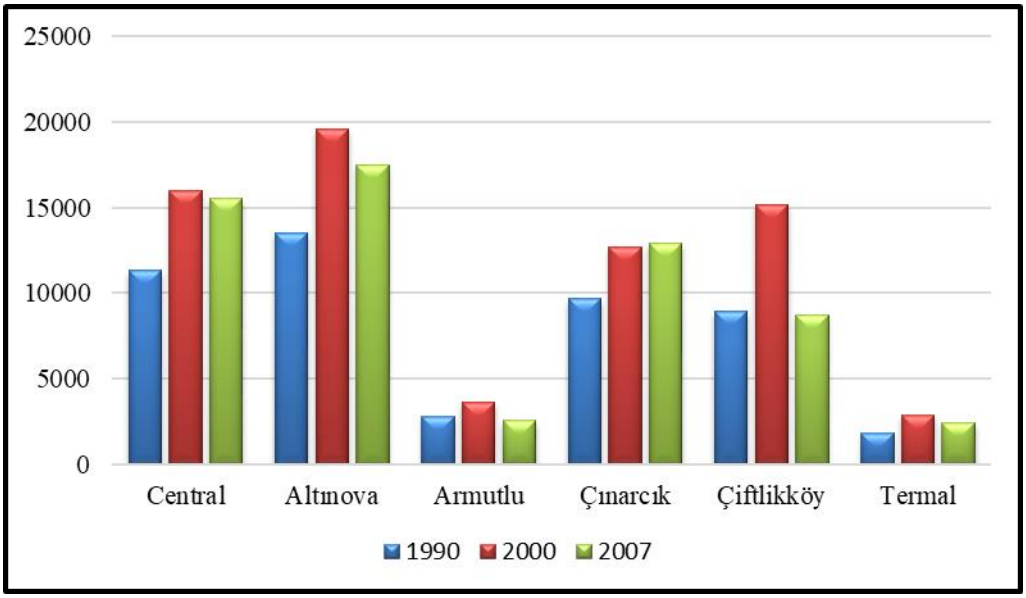

Figure 5. Change of Rural Populations of Yalova Districts (1990, 2000, 2007)

The change of the total rural population of the Central District and other districts in Yalova in 2007 and 2020, as can be seen in Table 10, the rural population of other Districts except Çiftlikköy District in Yalova Province has increased. When the total rural population amounts are compared, Altınova District continues to have the highest rural population.

Table 10. Change of Rural Populations and Average Annual Population Growth Rates of Yalova Districts (2007-2020)

Place Name	2007	2020	Annual Growth Rate of Population (‰)
Central	15.499	20.397	21.12
Altınova	17.487	22.563	19.60
Armutlu	2.577	2.636	1.74
Çınarcık	12.915	16.271	17.77
Çiftlikköy	8.756	7.190	-15.16
Termal	2.449	3.365	24.44
Total	**59.683**	**72.422**	**14.88**
Turkey	**20.838.397**	**5.878.321**	**-97.35**

Source: The results of Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [20].

When the annual growth rate of the rural population of Yalova in 2007 and 2020 is examined, it is seen that the districts with the highest rural population increases are Termal, Central and Altınova. In general, rural population growth was 14.88‰. The total annual population growth rate of the rural population of Turkey in general was that minus 97.35‰, is seen to Yalova has a higher rate of population growth rate than Turkey. The rural population of Yalova has increased in 2020 compared to 2007.

The share of the urban and rural population of Yalova Province in the total population is examined in this section. As can be seen from Table 11, the share of the urban population of Yalova Province in the total population is 16% in 1935, 65% in 1990, 59% in 2000, 68% in 2007 and 74% in 2020. By 1980, the urban population of Yalova exceeded the rural population.

Table 11. Yalova Urban and Rural Population Ratio to Total Population (1935-2020)

Year	Urban	Rural	Topal	Urban %	Turkey %	Rural %	Turkey %
1935	2.635	14.205	16.840	16	23.5	84	76.5
1940	2.300	14.778	17.078	14	24.4	86	75.6
1945	3.608	16.668	20.276	18	24.9	82	75.1
1950	3.833	18.422	22.255	17	25.0	83	75.0
1955	6.610	20.061	26.661	25	28.8	75	71.2
1960	11.318	21.783	33.101	34	31.9	66	68.1
1965	14.241	22.849	37.090	38	34.4	62	65.6
1970	17.689	25.000	42.689	41	38.5	59	61.5
1975	27.289	27.747	55.036	49	41.8	51	58.2
1980	41.823	33.964	75.787	55	43.9	45	56.1
1985	53.857	36.371	90.228	60	53.0	40	47.0
1990	87.032	48.089	135.121	64	59.0	36	41.0
2000	98.661	69.932	168.539	59	64.9	41	35.1
2007	122.075	59.683	181.758	68	70.5	32	29.5
2017	181.036	70.167	251.203	72	92.5	28	7.5
2018	192.288	69.946	262.234	73	92.3	27	7.7
2019	200.274	70.702	270.976	74	92.8	26	7.2
2020	276.050	72.422	203.628	74	93	26	7

Source: The results of the Population Censuses (1935-2000), the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [18, 19, 20].

The Metropolitan Municipality Law No. 5216 was enacted on 23 July 2004 in Turkey. With this law, the administrative borders of the province were determined as the borders of the Metropolitan. With the Law No. 6360 on 06 December 2012, the number of metropolitan cities increased to 14. Today, the number of Metropolitan Municipalities has increased to 30. All settlements of metropolitan cities constitute the city population. In Table 11, this is the main reason why Turkey's urban population increased from 70.5% in 2007 to 92.5% in 2017. Since Yalova does not reach a certain population, it is not in the metropolitan status.

3.4. Change in Birth Indicators

As it is known, the main factors that cause population change are birth, death and migration. Births and deaths and migrating population; determines the age and gender distribution of the population. Within the scope of birth indicators; overall fertility rate, crude birth rate, total fertility rate and maternal median age were examined.

The overall fertility rate in Turkey was 83.9‰ in 2001 to 73.3‰ in 2009, fell in 2019 to 57.8‰. While the overall fertility rate in Yalova Province was 60.4‰ in 2009, it decreased to 54.3‰ in 2019. The crude birth rate in Turkey was 20.3‰ in 2001, it decreased to 11.6‰ in 2019. While the crude birth rate in Yalova Province was 14.1‰ in 2009, it decreased to 11.6‰ in 2019. "As the economic and social development increased in the world and in our country, therefore, as the welfare level increased, the birth rate decreased. Increasing the age of becoming a mother also plays an important role in decreasing the birth rates" [22]. While the average age of being a mother in Yalova Province was 27.11 in 2000, this age increased to 29.5 in 2019 (Table 12).

Table 12. Birth Indicators of Yalova Province (2000-2019)

Year	Total Fertility Rate	Overall Fertility Rate (‰)	Crude Birth Rate (‰)	Maternal Median Age

2000	1.93	-	-	27.11
2009	1.78	60.4	14.1	28.0
2010	1.64	55.4	12.8	28.2
2011	1.62	54.6	12.5	28.4
2012	1.72	57.9	13.1	28.9
2013	1.69	56.3	12.7	28.9
2014	1.81	60.0	13.4	29.2
2015	1.78	59.0	13.1	29.0
2016	1.89	62.3	13.8	29.2
2017	1.82	60.3	13.2	29.4
2018	1.75	57.8	12.5	29.3
2019	1.65	54.3	11.6	29.5

Source:2000 Census of Population: Social and Economic Characteristics of the Population and the results of the Vital Statistics: Births and Deaths Statistics in Turkish Statistical Institute [23, 24].

The total number of children that a woman between the ages of 15-49, that is, a woman of reproductive age, can have, is called the total fertility rate [1]. The total fertility rate in Turkey was 6.3 in 1963, was 4.7 in 1973, while was 4.33 in 1978, to 2.65 in 1993, to 2.23 in 2003, and 1.88 in 2019 [25, 26]. While the total fertility rate of Yalova Province in 2000 was 1.93 as can be seen, it decreased to 1.62 in 2011, then increased to 1.89 in 2016, and decreased again to 1.65 in 2019 (Table 12).

The birth data are published by TURKSTAT between 2001-2008 according to "place of birth" and since 2009 according to "place of residence of the mother" [24]. 2,619 births took place in Yalova Province in 2000, and the total number of births in Yalova is shown in Table 13. The number of births varied between 2001 and 2005, with an increase between 2006 and 2008. Between 2009 and 2019, although the number of births decreased slightly in some years, it increased in general. The crude birth rate (CBR) has been shown since 2009, although the number of births in Yalova has increased, It can be seen in Table 13 that considering the effect of general population growth, the crude birth rates have it decreased.

Table 13. Births and Crude Birth Rates by Gender (2000-2019)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Male	-	1.149	1.016	1.033	1.077	1.043	1.085	1.127	1.234
Female	-	1.069	984	1.037	1.041	971	1.017	1.131	1.147
Total	2.619	2.218	2.000	2.070	2.118	2.014	2.102	2.258	2.381
Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2019**
Male	1.421	1.366	1.347	1.397	1.381	1.491	1.542	1.670	1.498
Female	1.396	1.234	1.217	1.345	1.358	1.509	1.471	1.601	1.601
Total	2.817	2.600	2.564	2.742	2.739	3.000	3.013	3.271	3.099
CBR	14.1	12.8	12.5	13.1	12.7	13.4	13.1	13.8	11.6

Source: 2000 Census of Population: Social and Economic Characteristics of the Population and the results of the Vital Statistics: Births and Deaths Statistics in Turkish Statistical Institute [23, 24].

20-24 age group was the most fertile group in Turkey before 2006, it increased to 25-29 since 2006 [24]. In Yalova, since 2009, the 25-29 age group has been the age group with the highest number of births in the last ten years. Along

with this age group, the 30-34 age group continues to rise (the ratio which was 21.1% in 2009 increased to 25.8% in 2019). Births under the age of 15 are almost nonexistent. The birth rates in the 15-19 age group are also decreasing (the rate which was 5.5% in 2009 decreased to 2.5% in 2019). This situation can be considered as one of the most important indicators of the socio-cultural change that occurs in the demographic structure with the increase in the general education level, participation of women in active business life at a higher rate and their effect [27]. As in the demographic transformation process of Western Europe, the age group with the highest fertility rate will shift to the 30-34 age group in Yalova in the future. This situation will lead to a decrease in the number of births in the future [28].

3.5. Change in Death Indicators

Another factor that causes population growth or decline is death rates. Improvement in health conditions in Turkey, as a result of prevention of epidemics, the reduction of maternal and infant loss and thus has caused a decline in the crude death rate for the year.

The crude death rate in Turkey was 15.3‰ in 1960-65 [29], this number decreased to 5.2‰ in 2018. When the crude death rates of Yalova Province and the East Marmara provinces (Kocaeli, Sakarya, Düzce, Bolu and Yalova), which includes Yalova, as well as Kocaeli, Bursa and İstanbul, Yalova Province has a higher value.

Table 14. Crude Death Rates (2009-2019)

Census Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Yalova	6.3	6.2	6.3	6.1	5.7	6.5	6.3	6.6	6.7	6.6	5.9
Turkey	5.1	5.0	5.1	5.0	4.9	5.1	5.2	5.3	5.3	5.2	5.3
Eastern Marmara TR42	5.3	5.2	5.2	5.2	5.0	5.2	5.4	5.5	5.4	5.4	5.4
Kocaeli	4.4	4.4	4.2	4.3	4.3	4.3	4.4	4.5	4.5	4.6	4.5
İstanbul	4.2	4.0	4.0	4.0	3.9	4.1	4.1	4.2	4.2	4.2	4.1
Bursa	5.6	5.5	5.5	5.4	5.4	5.5	5.6	5.7	5.7	5.6	5.5

Source: The results of the Vital Statistics: Births and Deaths Statistics in Turkish Statistical Institute [24].

The life expectancy at birth, that is, the average life in Turkey, has increased. In 1970, this number was 55 (57 for women, 53 for men), and in 2017 it increased to 78 (80.8 for women, 75.3 for men). The life expectancy at birth is higher in women than in men, as is the case all over the world. The life expectancy at birth in Yalova is 79.4 in 2013 (82.4 in women, 76.6 in men), 78.6 in 2013-2014 (81.9 in women, 75.6 in men), and 78.6 in 2015-2017 (81.5 in women, 75.9 in men), which is higher than the average in Turkey [30].

The information on deaths in Turkey since 1931 began to be compiled and calculated in all provincial centers until the end of 1949 but was only published data for 25 provinces. Since 1 March 1957, it has been collected from all province and district centers [27]. In 1957-2008, the number of deaths was calculated for all provincial and district centers in Turkey, as well as from 2009, the number of deaths was calculated and published for all settlements.

Although it has been requested by the Turkish Statistical Institute to collect the number of deaths according to all settlements since 1982, it has not occurred due to the fact that the data is incomplete. The number of death in Yalova are calculated as the district center from 1999 to 2009, and the number of deaths in 1999 was very high due to the impact of the Marmara earthquake of August 17, 1999. Since 2000, the number of births has steadily increased. The number of deaths increased by 82% in 2009 compared to 2008, as information on death events obtained from the mernis database was compiled and death events occurring outside the health institution (all settlements) were calculated since 2009 [31]. The numbers of death are shown in Table 15, When the death numbers are compared with the crude death rate (CDR)

between 2009 and 2019, it is seen that the crude death rates have also increased in proportion to the increase in the death numbers from 1,200 to 1,400 since 2014.

Table 15. Deaths and Crude Death Rates by Gender (1999-2019)

Year	**1999**	**2000**	**2003**	**2004**	**2006**	**2007**	**2008**	**2009**
Total	1.702	358	406	510	597	684	687	1.252
Male	810	199	230	300	298	397	407	694
Famale	892	159	176	210	299	287	280	558
Year	**2010**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total	1.252	1.226	1.447	1.455	1.576	1.641	1.690	1.571
Male	678	703	840	816	890	897	946	884
Famale	574	523	607	639	686	744	744	687
CDR	6.2	5.7	6.5	6.3	6.6	6.7	6.6	5.9

Source: 2008 Death Statistics and the results of the Vital Statistics: Births and Deaths in Turkish Statistical Institute [24, 31].

As it can be seen in Table 16 between 2000 and 2019, as a result of the removal of death numbers from the birth numbers, which are the natural population growth of Yalova Province, it has always been of added value. In summary, it is seen that the population of Yalova naturally increased without taking into account the migrations experienced during this period.

Table 16: Difference in Birth and Death Numbers (1999-2019)

Year	**1999**	**2000**	**2003**	**2004**	**2006**	**2007**	**2008**	**2009**
Birth	-	2.619	2.070	2.118	2.102	2.258	2.381	2.817
Death	1.702	358	406	510	597	684	687	1.252
Difference	-	2.261	1.664	1.608	1.505	1.574	1.694	1.565
Year	**2010**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Birth	2.600	2.739	3.000	3.013	3.271	3.250	3.207	3.099
Death	1.252	1.226	1.447	1.455	1.576	1.641	1.690	1.571
Difference	1.348	1.513	1.553	1.558	1.695	1.609	1.517	1.528

Source: 2008 Death Statistics and the results of the Vital Statistics: Births and Deaths in Turkish Statistical Institute [24, 31].

Since the deaths (all settlements) that occurred outside the health institution since 2009 have been calculated, the effect of births and the Effects of deaths and Births on Yalova's population change in 2009-2019 is shown in Figure 6 and Figure 7.

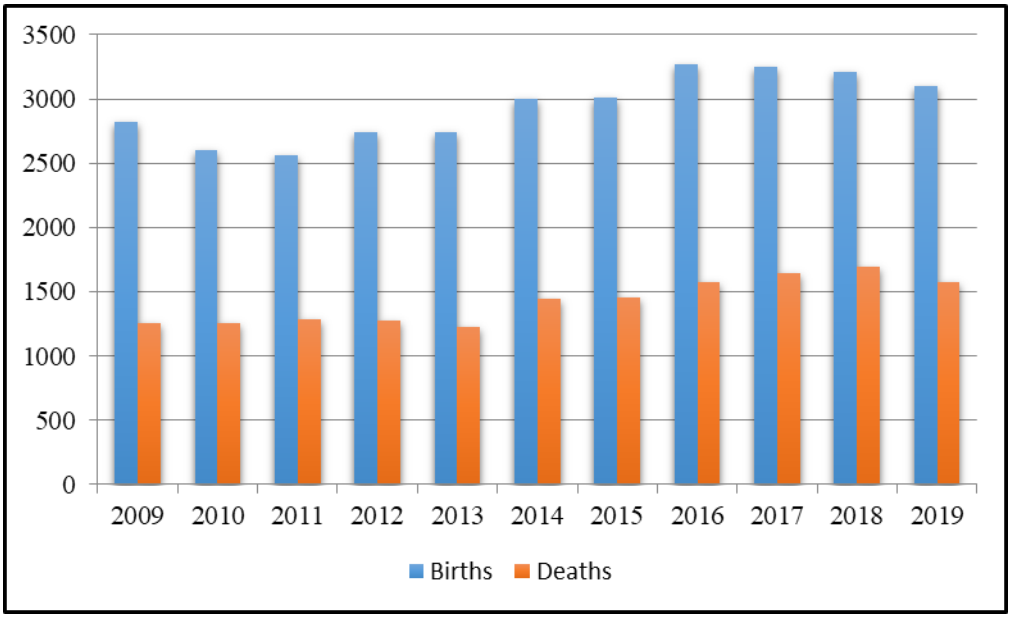

Figure 6. Birth and Death Numbers (2009-2019)

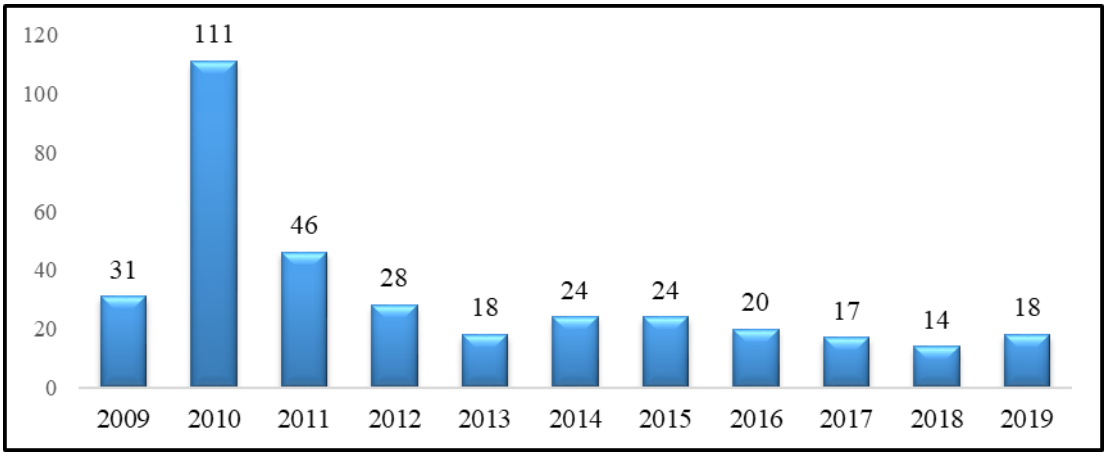

Figure 7. The Effects of Deaths and Births on Yalova's Population Change (%) (2009-2019)

While the population of Yalova was 202,531 in 2009, the population increased continuously and reached 270,976 in 2019, and the general population increased by 68,445 people. Between these years, 16,637 people increased as a result of subtracting the births from the deaths. The effect of births and deaths on population growth was 24.3%.

3.6. Population Movements

3.6.1. Reflections in Yalova of Internal Migration Movements in Turkey

Internal migration from other provinces, is one of the factors causing the population change in Yalova Province, was examined from 1995-2000 until 2020. Because Yalova was a province in 1995. Internal migration in Turkey is evaluated on a provincial basis (Table 17, Figure 8). In fact, Yalova has received internal migration from many provinces of Turkey with internal migrations starting with the 1950s in Turkey. Yalova received more migration than it gave in 1995-2000, and its net migration rate was 3.5‰ despite the acceleration of its out-migration after the 1999 Marmara earthquake. Yalova has become the 19th province in Turkey to increase the rate of migration. Internal migration in the Address Based Population Registration System (ABPRS); is defined as “permanent residence address changes in certain areas (region, province, district, etc.) within the borders of the country within the last one year” [32]. Yalova received more in-migration than out-migration in 2007-2008 (rate of net migration 52.6‰), and the number of

people who came to 8.4% of the population of Yalova Province migrated to Yalova Province. In 2009-2010, Yalova Province gave more out-migration than in-migration (net migration rate minus 2.6‰), and in the following years the net migration rate has increased continuously.

Table 17. Migration, Net Migration and Net Migration Rate of Yalova Province (1995-2020)

Period	In-migration	Out-migration	Net Migration	Rate of Net Migration (‰)
1995-2000	22.774	22.260	514	3.5
2007-2008	16.656	6.542	10.114	52.6
2008-2009	12.269	10.233	2.036	10.1
2009-2010	10.455	10.984	- 529	-2.6
2010-2011	10.267	9.782	485	2.4
2011-2012	11.353	9.199	2.154	10.2
2012-2013	14.670	9.808	4.862	22.3
2013-2014	14.680	11.064	3.616	16.1
2014-2015	13.834	11.497	2.337	10.1
2015-2016	12.825	10.493	2.332	9.7
2016-2017	15.754	10.719	5.035	20.2
2017-2018	16.232	12.905	3.327	12.8
2018-2019	14.531	12.824	1.707	6.3
2019-2020	14.661	10.281	4.380	16.0

Source: Migration Statistics in Turkish Statistical Institute [32].

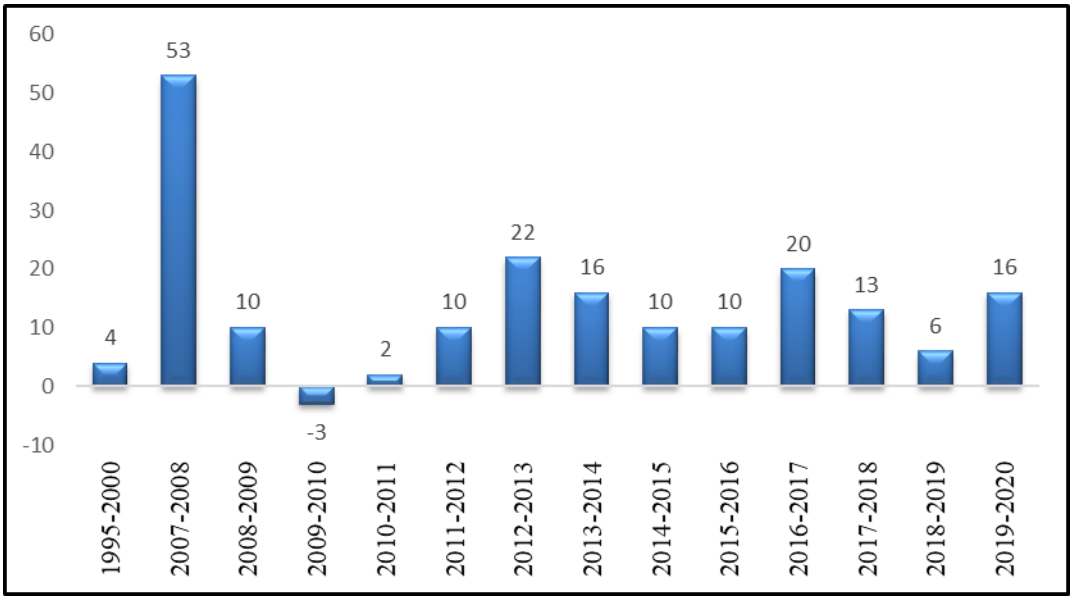

Figure 8. Net Migration Rate of Yalova Province (‰) (1995-2020)

According to the results of the 2000 General Population Census, in-migration data received by Yalova Province by places of residence are examined, a total of 29,226 people (15,636 males, 13,590 females) migrated in Yalova, and the highest migration was made from city to city with 14,185 people (7,406 males, 6,779 females). In the second place, 11,717 (6,309 men, 5,408 women) from city to village, in the third place from village to city with 1,738 people (925 men, 813 women), and finally from village to village with 1,586 people (996 men, 590 women). Due to the 17 August 1999 Marmara Earthquake, migrations mostly took place from city to city and from city to village.

According to the results of the Population and Housing Census in 2011, Yalova Province received 10,140 in-migration, gave 8,441 out-migrantion, and net migration was 1,699 people. The rate of net migration was 8.4‰. Similarly, the rate of net migration of Yalova was 10.2‰ in 2011-2012 [33].

Between 2008 and 2020, Yalova received 178,187 in-migrants and gave 136,331 out-migrants, while the net migration was 41,856. While the population of Yalova was 181,758 in 2007, it has increased continuously and reached 276,050 in 2020. During this period, the population of Yalova has increased by 94,292. The impact of internal migration on population growth between 2008 and 2020 was 44.4% (Figure 9). The rate of those born abroad in Yalova Province increased from 11.5% in 2019 to 11.2% in 2020, the number of foreigners residing in Yalova Province decreased from 23,912 in 2019 to 22,926 in 2020 (Table 22). Since the international migration statistics for 2020 have not been published yet, the effect of international migration on the population could not be calculated. Since it is considered that the effect of international migration on the population growth of Yalova will decrease in 2020, the effect of internal migration on the population in Yalova Province increased by 86% in 2020.

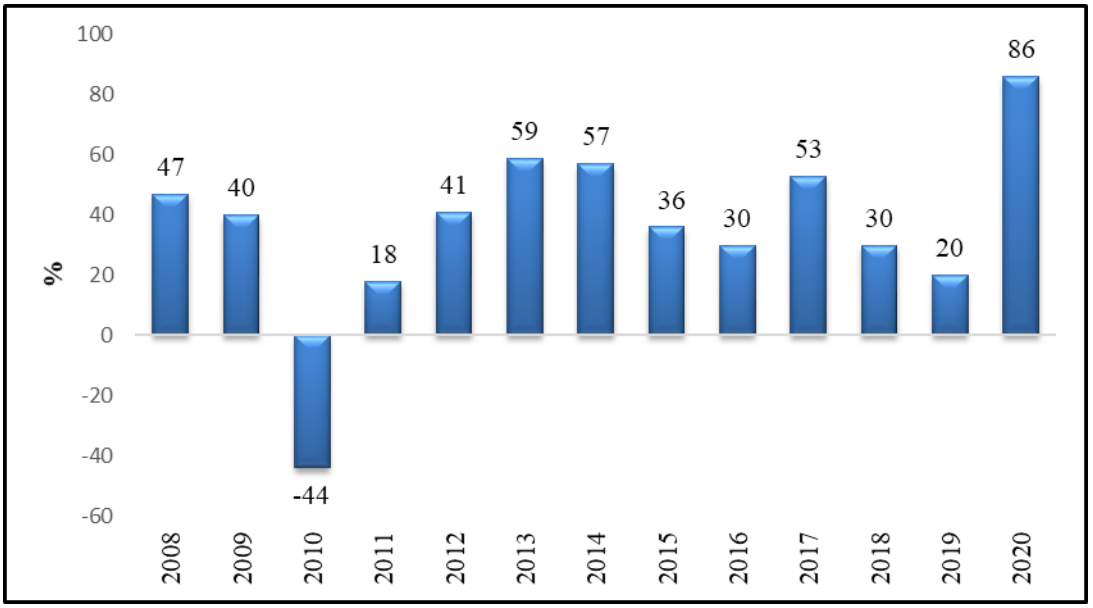

Figure 9. The Effect of Internal Migration on Yalova's Population Change (%) (2008-2020)

Between 2008 and 2020, Yalova received 178,187 in-migrants from 81 provinces, from Kilis with at least 113, and İstanbul with a maximum of 60,332. When the provinces of in-migration are listed from the highest number down; The top ten provinces are İstanbul (60,332), Bursa (14,683), Kocaeli (12,180), Ankara (5,741), Erzurum (4,468), İzmir (4,269), Balıkesir (3,118), Diyarbakır (2,971), Sakarya (2,826) and Şanlıurfa (2,785). The ratio of ten provinces to the total number is 63.6%.

Between 2008 and 2020, Yalova gave 136,331 out-migrants to 81 provinces people, to Kilis with at least 52 people and İstanbul with a maximum of 44,169. When the provinces of out-migration are listed from the highest number down; The top ten provinces are İstanbul (44,169), Bursa (14,987), Kocaeli (13,250), Ankara (5,374), İzmir (4,643), Sakarya (2,794), Balıkesir (2,686), Antalya (2,644), Muğla (1,763) and Eskişehir (1,755). The ratio of ten provinces to the total number is 69%. The net migration of Yalova between 2007 and 2020 was 41,856. In other words, the population of Yalova has increased by 41,856 due to internal migration.

According to the survey results conducted with 200 people corresponding to 2% of those who migrated to Yalova Province in 2011; It was determined that 62% of those who migrated to Yalova Province had relatives and friends in Yalova Province [34]. Considering the migrant networks theory and the result of this research, it is estimated that a similar situation was experienced in previous years. In the coming years, the increasing population growth in the city centers and therefore the population density will further increase the pressures on the area. In a study carried out in 2005, citizens of good financial condition who came from İstanbul to Tevfikiye (Çavuş) village of Altınova District of

Yalova Province and built new houses on the land called "İstanbul Houses" were determined [35]. Migration from cities to villages is called "reverse migration". On the other hand, Tekeli [36] defined these migrations as “return” migrations: “The motives of those who have reached the end of their life cycle and have entered the retirement stage will change. Their migration will be directed to places with good climate and natural conditions rather than places with intense job opportunities. In some cases, return migrations will occur”. Although it is considered that some villages of Yalova may be preferred as a place to stay permanently as a result of retirement, projects should also be produced in order to keep the rural population in place.

Population statistics according to the province of residence and place of birth have been produced since 2014 according to ABPRS results. The population rates according to the birthplace of those who live in Yalova between 2014 and 2020 are shown in Table 18 together with the years 1985, 1990 and 2000 in order to compare. According to the General Population Census results of 1985 and 1990, the rate of those born in Yalova District was considered the rate of those born in İstanbul, since Yalova was not a province. While those born in İstanbul in 1985 were 49.48%, it decreased to 44.60% in 1990. The rate of those born in Yalova in 2000 was 34.59%, and when the rate of those born in İstanbul was added to 6.49%, this rate increased to 41.06%.

Table 18. Population by Yalova Province of residence and place of birth status (1985-2020)

Year	**Born in İstanbul (%)**	**Born in a different province (%)**	**Born abroad (%)**	**Birthplace unknown (%)**
1985	49.48	43.91	6.60	0.004
1990	44.60	47.97	7.38	0.05
Year	**Born in Yalova (%)**	**Born in a different province (%)**	**Born abroad (%)**	**Birthplace unknown (%)**
2000	34.59	60.17	5.22	0.02
2014	29.9	62.6	4.9	2.7
2015	29.8	61.8	6.0	2.5
2016	29.5	60.6	7.5	2.4
2017	29.1	60.5	8.1	2.3
2018	28.5	59.4	9.8	2.2
2019	28.3	58.1	11.5	2.2
2020	28.7	58.4	11.2	1.7

Source: The results of the Population Censuses (1965-2000) and Address Based Population Registration System (ABPRS) in Turkish Statistical Institute [19, 20].

The foreigners were also taken into account in the calculation of those residing in Yalova, and as the number of foreigners increased, the rate of those born abroad increased continuously. While the number of people born in Yalova was 34.59% in 2000, this number decreased further to 28.3% in 2019. In 2020, the rate of those born in the province they reside in Turkey is the lowest (28.7%) province of Yalova. Yalova is followed by the provinces of Tekirdağ (41.4%), Kocaeli (43%) and İstanbul (46.2%), where the industrial sector is concentrated and at the same time receiving heavy internal migration.

Considering the provinces where Yalova residents are registered in the population registry, the rate of those registered to the population of Yalova Province decreased from 42.5% in 2008 to 33.6% in 2020 by decreasing by 8.9% (Figure 10). This situation shows us the impact of the internal migration of Yalova Province in the last twelve years.

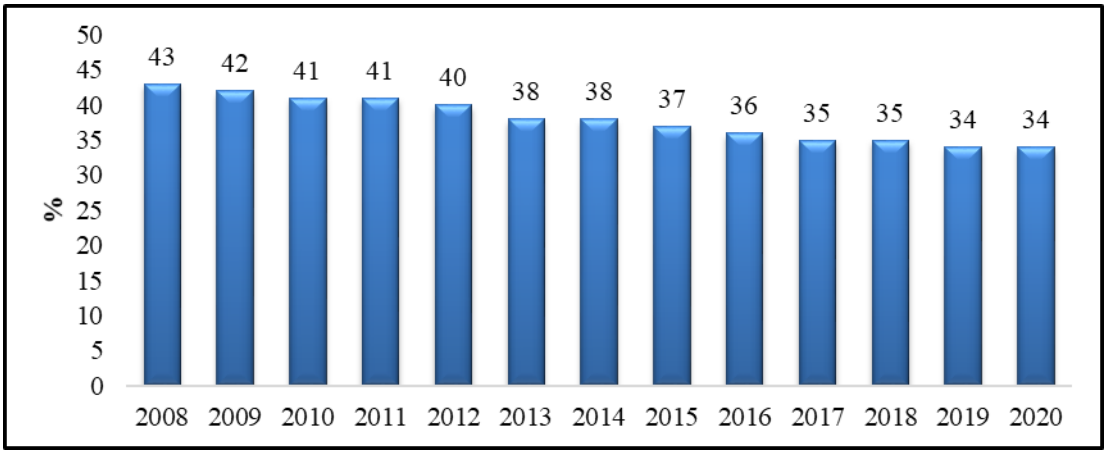

Figure 10. Percentage of Persons Residing and Registered in Yalova Province (%) (2008-2020)

3.6.2. International Migrations

In this section, international migration, one of the factors causing population change in Yalova Province, has been examined. Yalova Province has received massive immigration from both the Balkans and the Caucasus; beginning before the Republic of Turkey and continuing after the Republic. Therefore, Yalova Province has a rich cultural structure where people from many different cultures live.

Before Yalova was a district in the İzmit Sanjak in 1901, it was a town connected to the Karamürsel District. Due to the fact that Yalova is connected to İzmit Sandjak, it is considered that some of the immigrants settled in Yalova as a result of the migrations made to the İzmit Sanjak. Cihan Yalvar explained this in detail in his article titled "Migrations from the Balkans and the Caucasus to Yalova between 1877-1924" [37]. The first international migration to the İzmit region occurred due to the Ottoman-Russian wars between 1806-1812 and 1828-1829. During this period, settlements of Crimea, Dagestan, Nogai and Circassian immigrants were carried out. After the 1877-1878 Ottoman-Russian War, a total of 25,823 immigrants, including 9,425 Batumi, 8,574 Sukhum, 1,527 Rumelia, 377 Tatar-Nogai and 5,920 Circassian immigrants, were settled in İzmit until 1881. With immigrants from the Balkans in 1893, this number increased to 46,463, and with 6,771 immigrants from 1912-1920, to 53,234 [37].

After the Republic of Turkey, some of the immigrants from Bulgaria and Yugoslavia in 1953 were settled in Yalova [16]. Tanoğlu [38] stated that 358 immigrants from Bulgaria were settled in Yalova and its surroundings in 1953.

According to the 2000 General Census results, a total of 1,401 people, 759 men and 642 women, immigrated to Yalova from the previous census in 1990 until 2000. Between 2016 and 2019, international migration statistics started to be produced on the basis of provinces, and the number of immigrants to Yalova from abroad, the number of emigrants from Yalova to abroad and net migration are shown in Table 19. Yalova has increased its population in the last four years (2016-2019) with a net migration of 18,128. The impact of international migration on Yalova's population growth was 47.5% in 2016, 39.7% in 2017, 45.6% in 2018, and 59.4% in 2019.

Table 19. Immigrants and emigrants by citizenship and Yalova Province (2016-2019)

Year	Total Population	Immigrats			Emigrants			Net Migration
		Total	Male	Female	Total	Male	Female	
2016	241.665	5.484	2.911	2.573	1.374	817	557	4.110
2017	251.203	5.805	2.961	2.844	2.014	1.113	901	3.791
2018	262.234	8.122	4.191	3.931	3.091	1.561	1.530	5.031
2019	270.976	9.673	5.006	4.667	4.477	2.309	2.168	5.196

Source: Migration Statistics in Turkish Statistical Institute [32].

The number of immigrants to Yalova from abroad and the number of emigrants from Yalova to abroad in 2016 and 2019, namely the number of international immigrants, are shown in Tables 20 and 21. The immigrants; includes T.R. citizens and foreign nationals. "Foreigners coming from Syria under temporary protection status are not covered in the population" [32].

Table 20. Immigrants by citizenship and Yalova Province (2016-2019)

Year	Total Population			Immigrants		
	Total	Turkish Republic citizens	Foreign nationals	Total	Turkish Republic citizens	Foreign nationals
2016	241.665	230.538	11.127	5.484	372	5.112
2017	251.203	238.043	13.160	5.805	409	5.396
2018	262.234	243.677	18.557	8.122	495	7.627
2019	270.976	247.064	23.912	9.673	333	9.340

Source: Migration Statistics in Turkish Statistical Institute [32].

Yalova received the most of immigrants in 2019 and 2016. 93.9% of immigrants in 2016, 93% in 2017, 93.2% in 2018, and 96.6% in 2019 were foreign nationals.

Table 20. Emigrants by citizenship and Yalova Province (2016-2019)

Year	Total Population			Emigrants		
	Total	Turkish Republic citizens	Foreign nationals	Total	Turkish Republic citizens	Foreign nationals
2016	241.665	230.538	11.127	3.091	388	2.703
2017	251.203	238.043	13.160	2.014	368	1.646
2018	262.234	243.677	18.557	1.274	244	1.130
2019	270.976	247.064	23.912	4 477	281	4 196

Source: Migration Statistics in Turkish Statistical Institute [32].

Yalova also had the most emigrants in 2019. 87.4% of emigrants in 2016, 81.7% in 2017, 88.7% in 2018 and 93.7% in 2019 are foreign nationals. While 9,471 (51.03%) of the total 18,557 foreigners were male and 8,086 (48.97%) of the foreigners were female in 2018, 12,272 (51.32%) of the total 23,912 foreigners were male and 11,640 (48%) of the foreigners were female in 2019. A small proportion of men are more than women.

The numbers and rates of those who live in Yalova and those born abroad are shown in Table 22. While those born abroad were 6.60% in 1985, it increased to 11.5% in 2019. While the number of those born abroad was 5,959 in 1985, this number increased to 8,367 in 1990 and 8,822 in 2000. The nationalities of 908 foreigners residing in Yalova in 2000; 290 (146 men, 144 women) Bulgaria, 331 (182 men, 159 women) Kazakhstan, 79 (20 men, 59 women) Russia, 65 (33 men, 32 women) Greece, 145 other states.

Table 22. Population by Yalova Province of residence and born abroad (1985-2020)

Year	Born abroad	Born abroad (%)	Foreign nationals
1985	5.959	6.60	-

1990	8.367	7.38	-
2000	8.822	5.22	908
2014	11.035	4.9	-
2015	13.934	6.0	-
2016	18.203	7.5	11.127
2017	20.256	8.1	13.160
2018	25.696	9.8	18.557
2019	31.114	11.5	23.912
2020	31.037	11.2	22.926

Source: Migration Statistics in Turkish Statistical Institute [32].

When the number of foreigners (908) is subtracted from those born abroad (8,822) in 2000, the remaining 7,914 people are T.R. citizens and born abroad. The number of foreigners in 2014 and 2015 is not known, and when the number of foreigners in 2016, 2017, 2018, 2019 and 2020 is subtracted from the number of those born abroad, the remaining 7,076 in 2016, 7,096 in 2017, 7,139 in 2018, 7,202 in 2019 and 8,111 in 2020 are T.R. citizens and born abroad. Citizen ones and those born abroad, Evaluating where foreigners were born abroad has been reached that conclusion, though very little when a portion of the foreign born in Turkey can be considered that these numbers can be increased.

In the postgraduate research conducted within the scope of employment of foreign nationals in Yalova Province, a survey was conducted with 105 foreign nationals. 61% of the foreigners were men (64 people) and 39% (41 people) were women. Foreigners are citizens of 22 countries, and citizens of Syria (32), Georgia (9) and Iraq (8) are the most employed foreigners. 95% of the foreigners are in the 15-45 age range, their education level is low (58.1% are high school graduates and below) and the problems they have detected; It has been determined that they are discriminated against by Turkish employees because they are in unqualified, short-term jobs and most of them in an uninsured job. Despite all of these, it has been determined that foreigners are satisfied with living in Turkey and do not want to leave [39].

In 2019, 23,912 (8.8%) of the total population of Yalova Province (270,976) are foreign nationals. This rate was 4.6% in 2016 and the rate of foreigners nationals in Yalova has increased by 4.2% in the last four years (22,926 foreign nationals reside in Yalova in 2020). This is due to the fact that foreigners prefer to live in Yalova, especially those who have good financial means, want to make their investments in Yalova and therefore buy houses. In 2013, 12,181 houses were sold to foreigners in Turkey, and 284 houses were sold in Yalova Province, which ranks seventh. In Yalova, which ranked fifth in 2020, 1,321 houses were sold to foreigners, with an increase of 4.7 times compared to 2013. A total of 9,455 houses were sold to foreigners in Yalova between 2013 and 2020 [40]. In addition, the increasing number of foreign students studying at Yalova University is another important factor. The first five provinces most provinces by the ratio of the total population of the province in which they reside of foreign nationals in Turkey to 2019; Yalova (8.8%), Kırşehir (5.4%), Antalya (4.1%), İstanbul (3.8%) and Karabük (3.8%), for 2020; Yalova (8.3%), Kırşehir (5.6%), Karabük (3.9%), Antalya (3.7%) and Aksaray (3.5%).

3.7. Population Projections

According to the population projection prepared by taking into account the ABPRS results of 2017, the population of Yalova Province and the population growth rates are shown between 2018 and 2025 in Table 23. Although the population of Yalova Province is expected to increase every year, it is predicted that the population growth rate will decrease over the years. It is predicted that the annual average population growth rate of Yalova Province will be 34.1‰ between 2017-2023 and 33.7‰ between 2017-2025. The average annual population growth rate between the years of 2017-2023 in Turkey, the highest province of Yalova (34.1‰) that is expected, this province is respectively followed by Tekirdag (32.1‰) and Kocaeli (27.1‰) Province.

Table 23. Population Estimation de Yalova Province par Population Projection (2017-2025)

Year	Total Population	Period	Population Growth Number	Population Growth Rate (‰)
2017	251.203	2016-2017	9.538	38.7
2018	259.871	2017-2018	8.668	33.9
2019	269.072	2018-2019	9.201	34.8
2020	278.499	2019-2020	8.628	34.4
2021	288.172	2020-2021	9.673	34.1
2022	298.084	2021-2022	9.912	33.8
2023	308.249	2022-2023	10.165	33.5
2024	318.557	2023-2024	10.308	32.9
2025	329.001	2024-2025	10.444	32.3

Source: Population Projection Statistics in Turkish Statistical Institute [41].

The population growth rate of Yalova Province in 2018 was higher than expected (33.9‰) according to the population projection (43.0‰), and the population growth rate in 2019 (32.8‰) was lower than expected (34.8‰). Although the population of Yalova Province was predicted to be 269,072 in 2019, 1,904 people increased to 270,976. In 2020, the population growth rate (18.6‰) was less than the projected (34.4‰). In 2020, the population growth rate (18.6‰) was less than the projected (34.4‰). In 2020, the decrease in the number of foreigners residing in Turkey was also observed in Yalova Province. For this reason, the expected increase in the population of Yalova Province in 2020 did not occur. It is considered that the covid-19 pandemic experienced all over the world caused this decrease.

4. Conclusions

While Yalova Province was a District of İstanbul Province, it gained the status of a province in 1995. Even though the 1999 Marmara earthquake had a negative impact on the population of Yalova Province, it overcame the negative effects of the earthquake in a short time and its population increased continuously.

While the population of Yalova was 202.531 in 2009, the population increased continuously and reached 270.976 in 2019, and the general population increased by 68,445 people. The natural population growth between these years has been 16,637 people. The effect of births and deaths on population growth was 24.3%.

Between 2008 and 2020, 178,187 people migrated from other provinces and 136,331 people migrated to other provinces in Yalova, while its net migration was 41,856 people. During this period, the population of Yalova has increased by 94,292 people. Between 2008 and 2020, the effect of internal migration on population growth was 44.4%.

Between 2016 and 2019, international migration statistics started to be produced on a provincial basis. Yalova has increased its population in the last four years (2016-2019) with 18,128 net migrations. The effect of international migration on Yalova's population growth was 47.5% in 2016, 39.7% in 2017, 45.6% in 2018, and 59.4% in 2019.

When the change of the total city populations of the Central district and other districts in Yalova in 2007 and 2020 is examined, the city population of all districts in Yalova Province has increased and the average annual population growth rate has been realized as 39.36‰. When the total rural population of the Central District and other districts between the same years is examined, the rural population of other districts except Çiftlikköy has increased. The average annual population growth rate was realized as 14.88‰. When the total rural population amounts are compared, Altınova District continues to have the highest rural population.

It is considered that some villages of Yalova can be preferred to stay permanently as a result of retirement. Particularly, some of those living in high-rise villages are migrating to urban centers due to factors such as urbanization, the desire to work in the industrial areas that are formed, and the decline of livestock. Therefore “urban development and industrial areas create pressure on fertile agricultural lands and cause these areas to be lost in time” [42]. Since the rural population increases less than the urban population and the ratio of the rural population is decreasing, projects supporting rural development should be increased so that the rural population should be protected and the continuation of agricultural production should be ensured.

It is seen that the share of the city population of Yalova Province in the total population was 16% in 1935, 65% in 1990, 59% in 2000, 68% in 2007 and 74% in 2020. By 1980, the urban population exceeded the rural population. According to the population projections of Yalova Province, it is predicted that it will increase continuously every year and reach 329,001 people in 2025 and It will increase by 53,000 people in 2025 compared to 2020. Even if at least 74% of this population will live in the city, it is seen that the city population will increase by approximately 39,000 people. With the increase of the city population, the active green areas in the cities are decreasing. The existing green areas in urban areas should be protected and empty spaces should be turned into green spaces [43].

As is known, the main factors causing population change are birth, death and migration. It is seen that international migrations and internal migrations play an important role in the change of population in Yalova Province. Especially in the last decade, the formation of the Shipyards Zone established in Altınova District and companies such as Aksa and Akkim have accelerated the increase of the population in Yalova Province. In addition, with the activation of the OIZs in Yalova, the need for labor to work in these regions will cause the population of Yalova to increase with the effect of internal migrationb

Competing Interest / Conflict of Interest

The authors declare that they have no competing interests.

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Author contribution

We declare that all Authors equally contribute.

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Determining Bioclimatic Comfort Areas in Summer with The Heat Index Method

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ABSTRACT

From past to present, human beings are striving to live following climatic conditions. With the increase in urbanization, these conditions have become more difficult, and especially in the summer months, some settlements have become unbearable. One of these settlements is the Adana-Çukurova district. This study aims to determine the temperature areas felt by the Heat Index method in the Adana-Çukurova district and its surroundings. Bioclimatic comfort zones of the summer months were determined with the climate data obtained from the General Directorate of Meteorology, and these comfort zones and thermal stress levels were classified according to PET.

Anahtar Kelimeler:
Biyoklimatik Konfor,
CBS,
Heat Index,
Çukurova,
Yaz Mevsimi.

ÖZ

Geçmişten günümüze kadar insanoğlu iklim şartlarına uygun yaşama çabasındadır. Şehirleşmenin artmasıyla birlikte bu şartlar daha zorlaşmış ve özellikle yaz aylarında bazı yerleşmelerde çekilmez duruma gelmiştir. Bu yerleşmelerden biri de Adana-Çukurova ilçesidir.

Bu çalışmanın amacı da Adana-Çukurova ilçesi ve çevresinde Heat Indexsi metoduyla hissedilen sıcaklık alanlarını belirlemektir. Meteorloji Genel Müdürlüğünden alınan iklim verileri ile yaz aylarının biyoklimatik konfor alanları belirlenmiştir ve bu konfor alanları ve termal stres seviyeleri PET'e göre sınıflandırılmıştır.

1. Introduction

Human beings have made many scientific developments to improve their living conditions in the historical process. In this context, especially individuals want to have a comfortable life in every sense. Comfort is a dynamic cultural and social structure that has different meanings related to many different areas (work, entertainment, home, school, etc.) in daily life [1-10]. Geographical conditions and especially climate are known to have a multidimensional effect on people's comfort standards. However, when we evaluate it in terms of climate, it has psychological and physiological effects on the individual, as well as economic and social effects. It is a fact that climate is among the main factors controlling the daily life of the individual, clothing and food styles, behaviors and lifestyles, and even health conditions [8-23]. Another situation is that the factors affecting or controlling the climate should not be forgotten in this process. When the climate is considered as a whole, there is the control of mechanisms of various scales and dimensions on similar climatic elements such as pressure, wind, precipitation, humidity, or temperature [11-29]. Today, most people live in cities. In this process,

urbanization has increased more rapidly, especially with the progress of the industrial field in the world. However, with this rapid urbanization, various problems have arisen, especially in terms of planning, cities have developed negatively [23-29]. In the world, more people live in urban areas than rural areas, 55% of the world's population live in urban areas in 2018, while this situation was 30% in 1950, but it is estimated that 68% will live in urban areas in 2050 depending United Nations (UN, 2019) [30]. Since there are very deep and complex relationships in unplanned developing cities, it has left many negative effects on human comfort. As cities change the environmental structure and topography of nature in their location, they have effects on many other natural parameters that have an effect in that area with the increasing population [1-10,23-29, 31-35]. For this reason, it has a great effect on the climate as well as on many natural elements in cities. Thus, the comfort of people living in cities is directly affected. When looking at many studies on human comfort, the climate affects a large part of the life of the individual, and thus, humidity, wind, and temperature must be at certain intervals for the individual to be comfortable in his / her environment [31-41]. In other words, people's stress levels increase considerably when they are above or below these desired values. In this context, in cases where stress increases, firstly its effect is observed on psychology, while it affects daily life negatively. However, it is possible to see these problems on the physical glaze, and this includes a process that goes up to the death of a person. For many such reasons, academic studies in this field have increased gradually. It is increasing with studies on various subjects, especially global warming, urban heat island, and bioclimatic comfort areas.

This study aims to determine and map the bioclimatic comfort areas of Çukurova and its surrounding region. Also to evaluate the human settlement activities in terms of bioclimatic comfort and to determine the stress conditions of the individuals living in the region depending on the temperature. The study took place at various stages in line with such purposes. In this context, climate data such as temperature and relative humidity from 18 meteorology stations covering the study area were obtained by request from the General Directorate of Meteorology. With these data taken in 12 months, it was prepared as general average and monthly average. With these data obtained from a total of 18 meteorology stations, the relative humidity and temperature were transferred to the Geographical Information Systems environment, and the model was created with the co-kriking method, and pixel-based humidity and temperature maps were created. The scale was produced by using the temperature values felt with these produced maps over the "Heat Index" standard. Thus, the temperature values felt on the map were classified.

2. Material and Method

The study area covers the province of Adana, Çukurova district, and its wider environment. It is located between the districts of Pozantı and Çamlıyayla in the northwest and Mersin province in the west and İmamoğlu in the northeast (Figure 1). The altitude of the study area starts from 4 meters and goes up to 2848 meters.

Graphs were prepared for various purposes with the help of climate data obtained from the MGM excel program. Subsequently, with the ArcGIS 10.8.1 program, humidity and temperature maps of the study area and its surroundings were created with the co-kriging method included in the interpolation methods. "Heat index" calculation has been made with the help of the ArcGIS Pro program.

HI = -42.379 + 2.04901523*T + 10.14333127*RH - .22475541*T*RH - .00683783*T*T - .05481717*RH*RH + .00122874*T*T*RH + .00085282*T*RH*RH - .00000199*T*T*RH*RH [42]

Classification of thermal sensation and stress levels of the PET index was used to show the bioclimatic comfort conditions of the study area and its environment (PET Table). However, the heat index map of the district created as a result of mobile measurements and modeling was not subjected to PET index classification, and the felt temperature values were shown (Table 1).

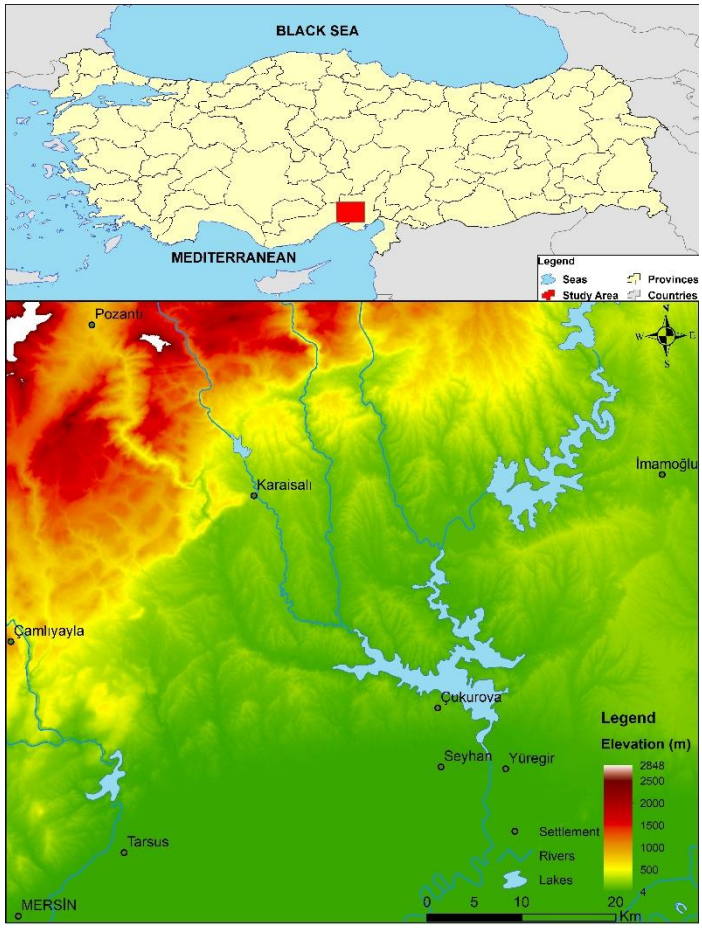

Figure 1. Study Area Location Map

Table 1. The values of PET [43]

PET (°C)	The feeling of warmth	Thermal stress level
< 4	Very cold	Extreme cold stress
4,1 – 8,0	Cold	Strong cold stress
8,1 – 13,0	Cool	Moderate cold stress
13,1 – 18,0	Light cool	Mild cold stress
18,1 – 23,0	Comfortable	No thermal stress
23,1 – 29,0	Slightly warm	Mild heat stress
29,1 – 35,0	Marrow	Medium temperature stress
35,1 – 41,0	Hot	Strong heat stress
> 41,0	Very hot	Extreme temperature stress

3. Result and Discussion

3.1.Spatial Distribution of Temperature and Bioclimatic Comfort Conditions

Temperature (average, maximum and minimum) and bioclimatic comfort conditions of the working area and its environment; The monthly average temperature, the monthly average of the daily maximum temperatures, and the monthly average of the daily minimum temperatures were obtained, and the distribution of temperature and bioclimatic comfort values were made monthly.

In this study, Heat Index was used in index calculations, but PET values were used in thermal detection classes.

3.1.1.June

When the average temperature properties of the study area and its surroundings are examined, it is seen that the lowest temperature is 19 ° C and the highest temperature is 26.83 ° C. The places where the lowest temperatures (19 ° C-22 ° C) are observed are in the north and northwest of the area. The highest temperatures (26 ° C-26.83 ° C) are found in the south of the study area. When looking at the work area, the average temperature is between 24.5 ° C-25 ° C (Figure 2).

For many years, according to the daily maximum temperature monthly averages, the temperatures in the study area and its surroundings hover between 25.88 ° C -33.08 ºC. The areas where the temperatures are the lowest are the Pozantı district and its surroundings located in the northeast of the region. When the study area is examined, it is seen that the maximum temperatures are between 30 ° C-31 ° C, while the values located further south are 33 ° C.

For many years, the daily minimum temperature monthly averages hover between 13.83 ° C-16 ° C in Pozantı, Çamlıyayla, and its vicinity, while the temperature in the study area is around 18 ° C, and in the southern areas, it is 21 ° C and above.

When examining the spatial distributions of bioclimatic comfort conditions according to the June Heat Index values, the average, maximum and minimum temperatures of the work area and its surroundings indicate that "Cool", "Slightly Cool", "Comfortable", "Slightly Cool", "Warm", "Warm" and "Very Hot "thermal detections are seen.

Average temperature values are between 19ºC and 26.83ºC. According to the heat index, these values are between 18.5 ° C-29.45 ° C and indicate the perceived temperature values. The working area is around 20 ° C and in the "Comfortable" range. The north and west of the study area are between 24.8 ° C-25.2 ° C, "Slightly Warm", the south is 29 ° C and above and is in the "Slightly Warm" range.

Maximum temperature values are between 25.88 º C and 33.08 º C. According to the heat index, these values are between 26.03 °-42.58 ° and are in the range of "Comfortable", "Slightly Warm", "Warm", "Warm" and "Very Hot". is located. The working area and its surroundings are around 36 º C and in the "Hot" range. The south of the study area is between 38 ° C-42.58 ° C and is in the "Very Hot" range. The temperature values of Pozantı and Çamlıyayla districts are between 25.88 ° C-30 ° C and are between "Slightly Warm" and "Warm".

Minimum temperature values are between 13.83 ° C and 21.18 ° C. According to the heat index, these values are between 12.81 ° C-21.47 ° C and are in the range of "Cool", "Slightly Cool" and "Comfortable". The area around the work area is "Slightly Cool" and "Comfortable", the north and northwest are generally "Slightly Cool", but a narrow area with high altitude is in the "Cool" range.

The participants' profile has been determined according to gender, age, education, employment and their origin (from Perşembe or come from another city). According to survey data the gender of respondents is % 35,90 female and %64,10 male. The ages of the respondents are % 4,3 (0-18 age), % 25,3 (19-30 age), % 30,3 (31-40), % 36,5 (41-65) and % 3,6 (>65).

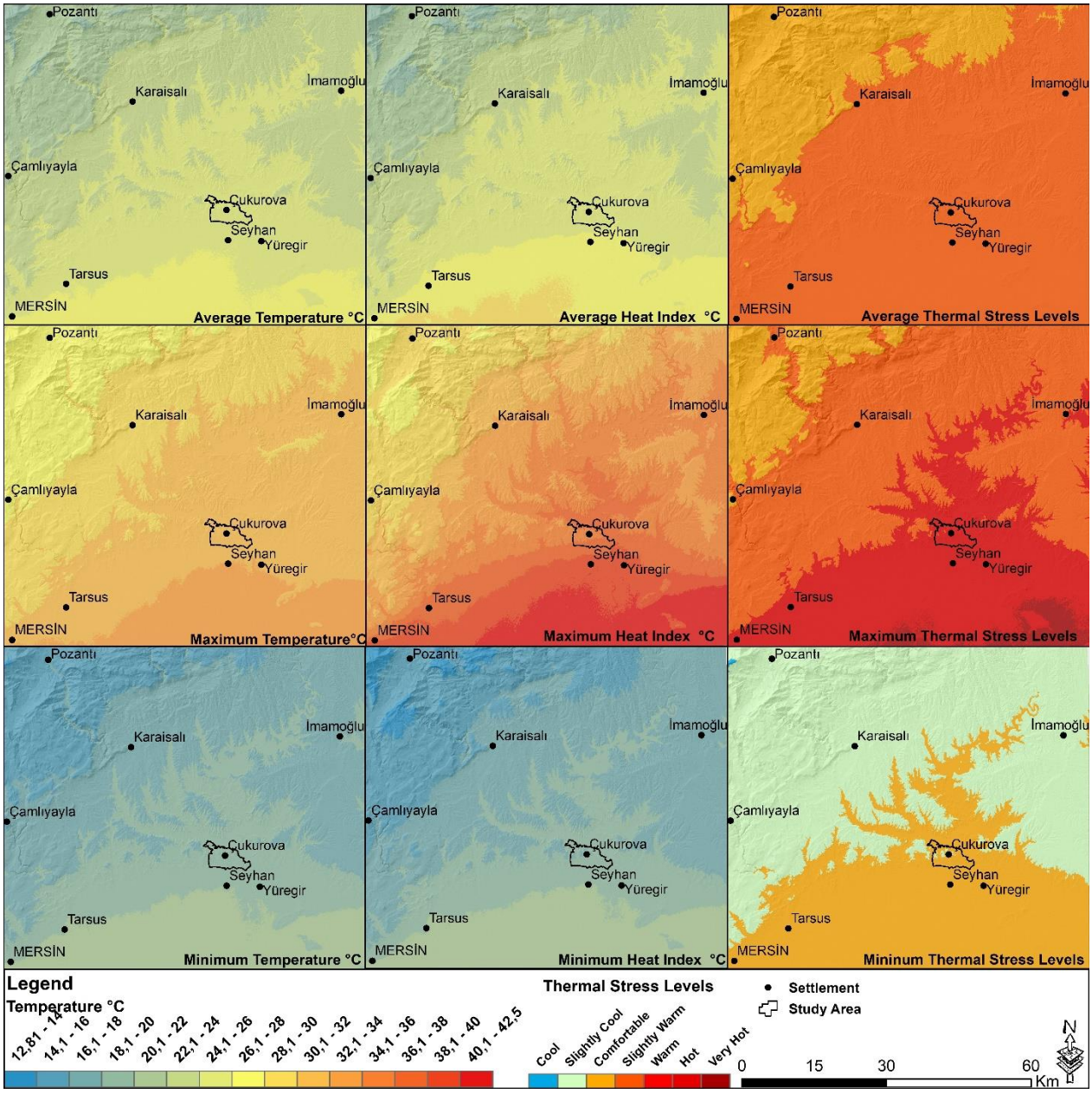

Figure 2: Bioclimatic Comfort Maps of June

3.1.2.July

When the average temperature characteristics of the study area and its surroundings are examined, it is seen that the lowest temperature is 24.79 ° C and the highest temperature is 28.82 ° C. The places where the lowest temperatures (24.79 ° C-26.5 ° C) are observed are located in the north and northwest of the area. The highest temperatures (28 ° C-28.82 ° C) are found in the south of the study area. In terms of the working area, the average temperature is around 27 ° C (Figure 3)

For many years, according to the daily maximum temperature monthly averages, the temperatures in the working area and its surroundings range between 30.35 ° C -34.95 ° C. The areas where the temperatures are the lowest are the Pozantı

district and its surroundings located in the northeast of the region. When the study area is examined, it is seen that the maximum temperatures are around 33 ° C, while the values in the further south are 34 ° C and above.

For many years, the daily minimum temperature monthly averages are between 17.28 ° C-19.4 ° C in Pozantı, Çamlıyayla, and its vicinity, while the temperature in the study area is between 21.5 ° C-22.5 ° C, and in the southern areas it is 24 ° C and above.

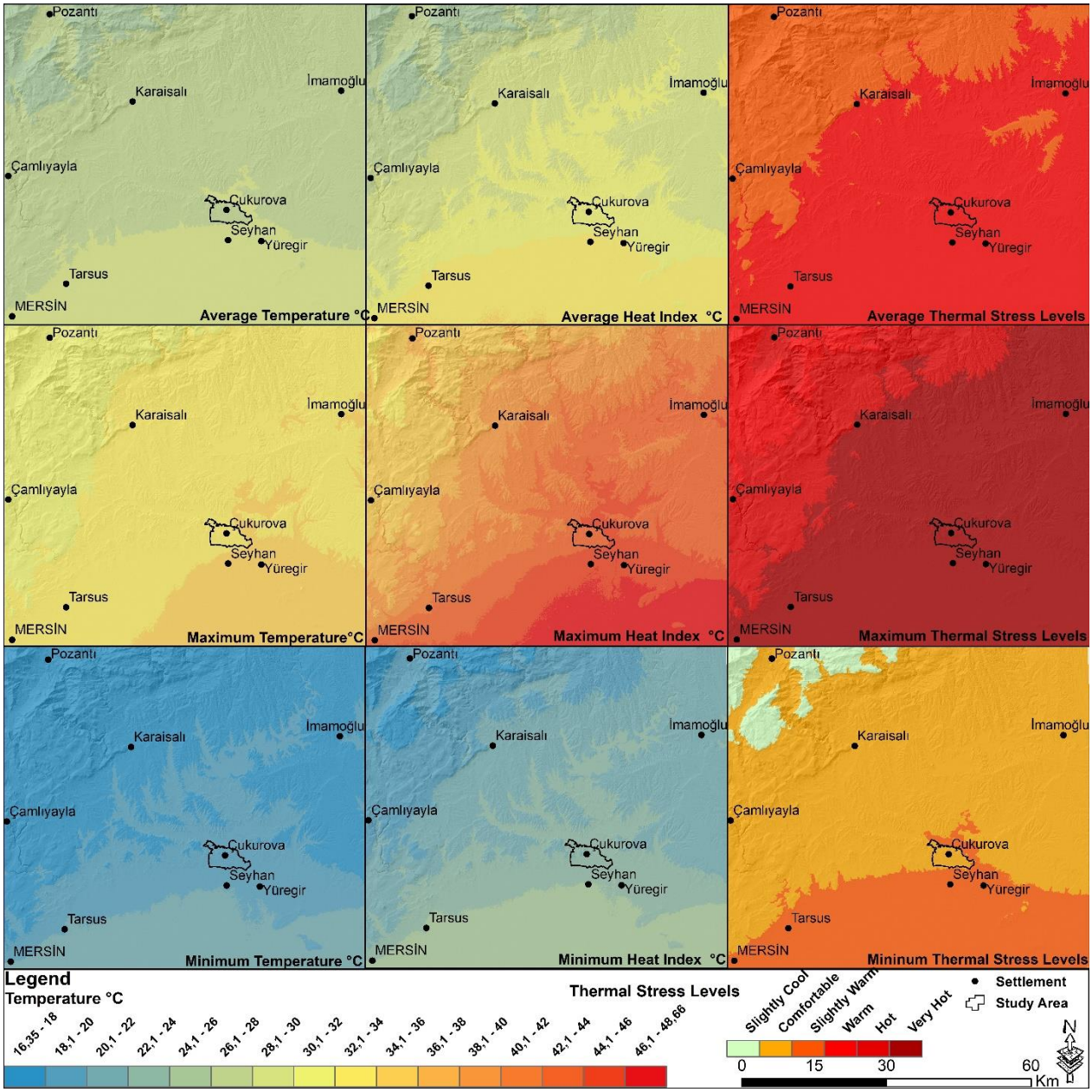

Figure 3: Bioclimatic Comfort Maps of July

When examining the spatial distributions of bioclimatic comfort conditions according to the average, maximum and minimum temperatures of the workplace and its environment, according to the July Heat Index values, "Slightly Cool", "Comfortable", "Slightly Warm", "Warm", "Hot" and "Very Hot" thermal perceptions is seen.

Average temperature values are between 24.79 º C and 28.82 º C. According to the heat index, these values are between 24.6 ° C-34.72 ° C and indicate the perceived temperature values. The working area is around 31 ° C and in the "Warm" range. The north and west of the study area are between 24.6 ° C-26.5 ° C, "Slightly Warm", the south is 33 ° C and above, and is in the "Slightly Warm" range.

Maximum temperature values are between 30.35 ° C and 34.95 ° C. According to the heat index, these values are between 333.04 °C-48.66 ° C and are in the range of "Warm", "Hot" and "Very Hot". The working area and its surroundings are around 43 and in the "Very Hot" range. The south of the study area is between 40 ° C-48.66 ° C and is in the "Very Hot" range. The temperature values of Pozantı and Çamlıyayla districts are between 31.46 ° C-36 ° C and are between "Warm" and "Hot".

Minimum temperature values are between 17.28 ° C and 24.95 ° C. According to the heat index, these values are between 16.15 ° C-25.64 ° C and are in the range of "Slightly Cool", "Comfortable" and "Light Warm". The study area and the west and north of the "Comfortable" study area, in general, are "Slightly Warm" but a narrow area with high elevation is in the "Slightly Cool" range.

3.1.3.August

When the average temperature characteristics of the study area and its surroundings are examined, it is seen that the lowest temperature is 23.92 ° C and the highest temperature is 29.59 ° C. The places where the lowest temperatures (23.92 ° C-26 ° C) are observed are located in the north and northwest of the area. The highest temperatures (28.5 ° C-29.59 ° C) are found in the south of the study area. When looking at the work area, the average temperature is between 27.5 ° C-28 ° C (Figure 4).

For many years, according to the daily maximum temperature monthly averages, the temperatures in the working area and its surroundings range between 30.65 ° C -35.92 ° C. The areas where the temperatures are the lowest are the Pozantı district and its surroundings located in the northeast of the region. When the study area is examined, it is seen that the maximum temperatures are around 34 ° C, while the values in the further south are 35 ° C and above.

For many years, the daily minimum temperature monthly averages hover between 17.36 ° C-19.5 ° C in Pozantı, Çamlıyayla, and its surroundings, while the temperature is around 22.5 ° C in the study area, and 25 ° C and above in the southern areas.

When examining the spatial distributions of bioclimatic comfort conditions according to the average, maximum and minimum temperatures of the work area and its environment according to the August Heat Index values, "Slightly Cool", "Comfortable", "Slightly Warm", "Warm", "Hot" and "Very Hot" thermal perceptions is seen.

Average temperature values are between 23.92 º C and 29.59 º C. According to the heat index, these values are between 23.63 ° -36.98 ° C and indicate the perceived temperature values. The working area is between 30 ° C-31.5 ° C and in the "Warm" range. The north and west of the study area are between 23.63 ° C-26 ° C, "Slightly Warm", the south is 35 ° C and above, and is in the "Hot" range.

Maximum temperature values are between 30.65 º C and 35.92 º C. According to the heat index, these values are between 31.74 ° C-52.12 ° C and are in the range of "Warm", "Hot" and "Very Hot". The working area and its surroundings are between 45 º C-48 ° C and in the "Very Hot" range. The south of the study area rises above 50 ° C and is in the "Very Hot" range. The temperature values of Pozantı and Çamlıyayla districts are between 31.74 ° C-37 ° C and are between "Warm" and "Hot". Minimum temperature values are between 17.34 ° C and 25.49 ° C. According to the heat index, these values are between 16.41 ° C-26.23 ° C and are in the range of "Slightly Cool", "Comfortable" and "Light Warm". The study area and the west and north of the "Comfortable" study area, in general, are "Slightly Warm" but a narrow area with high elevation is in the "Slightly Cool" range.

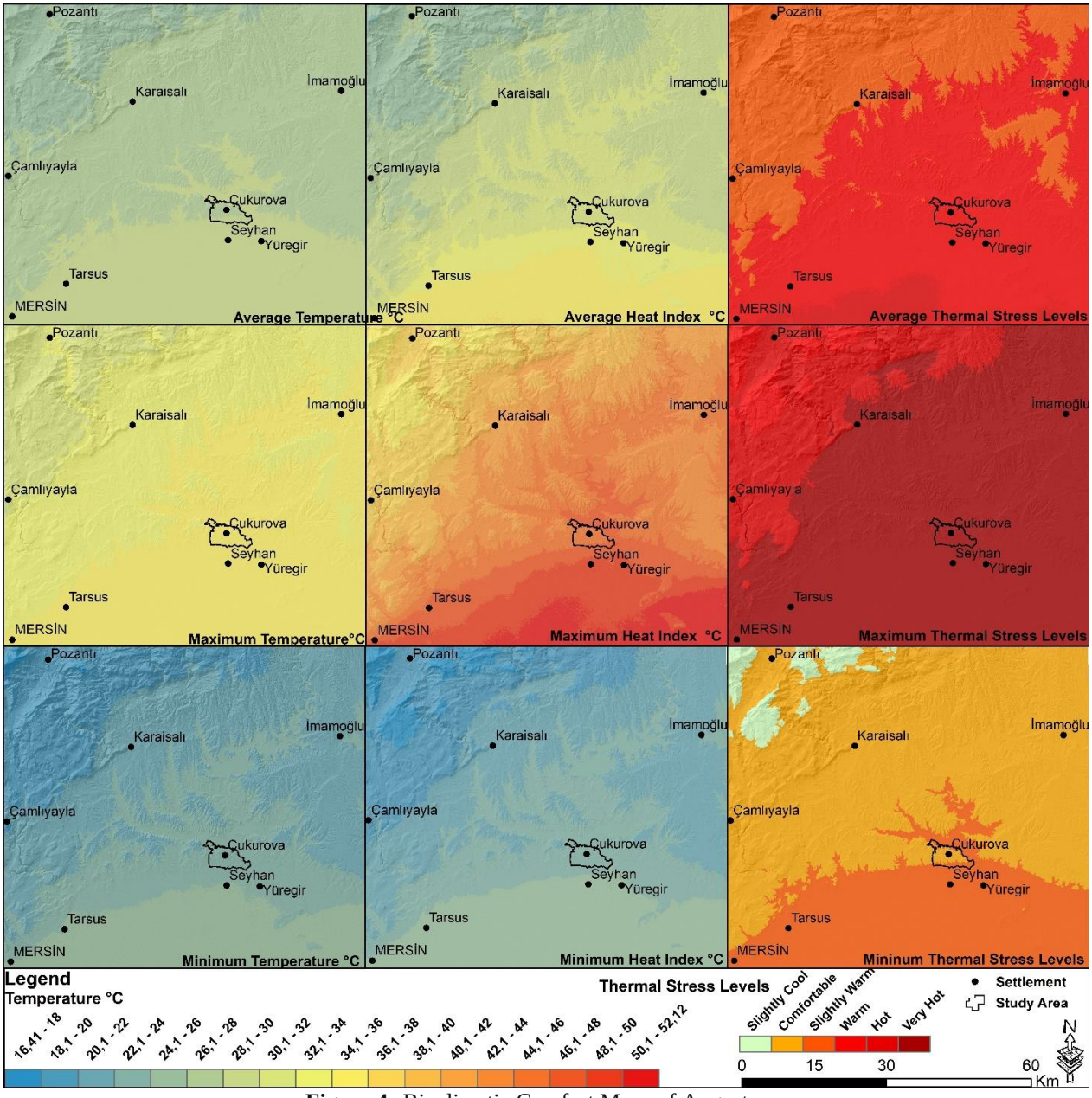

Figure 4: Bioclimatic Comfort Maps of August

4. Conclusion and Recommendation

In this study, the bioclimatic comfort areas of the Çukurova district and its surroundings calculated according to the heat index in the summer months were examined.

Temperature and relative humidity maps were created by interpolating the climate data obtained from MGM and heat index values of these data were revealed through ArcGIS Pro software.

It is observed that the temperatures felt in Çukurova district during the summer months are extremely high according to the maximum heat index and according to the thermal stress level, it is in the hot and very hot class in June and in the very hot class in July and August. This makes the city uninhabitable and causes people to use air conditioners excessively.

According to the minimum heat index calculation, Çukurova district is generally classified as comfortable in the summer months. However, it is classified as warm according to the average heat index.

Since the study area is a hot and humid place, and the urbanization is intense, the urban heat island effect is more common. For this reason, it is necessary to increase the green areas and to carry out activities that will increase the effectiveness of natural ventilation.

Competing Interest / Conflict of Interest

The authors declare that they no conflict of interest. None of the authors have any competing interest in the manuscript

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An Assessment on Shopping Centers as Consumption Places

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ABSTRACT

Consumption was a phenomenon that occurred to meet basic needs in ancient times. It is no longer basic essential for individuals with changing times and technology. Urban consumption places also included commercial products accessible within walking distance in the city in the past. Today, it has turned into shopping malls that have multiple functions individually and gain an image of the city as well as consumption. Within the scope of the study, the historical development process of the shopping centers, which are common in today's cities, has been examined. Markets, agoras, forums, passages, bazaars, multi-storey stores, and today's shopping centers and the missions of these places in the city are dealt with temporally. In the research, the change of the concept of consumption in the historical process has been evaluated. The study will contribute significantly to the literature with the introduction of the temporal change process. It is thought to be a reference for future studies.

Anahtar Kelimeler:
Tüketim,
Kentsel tüketim mekanları,
Alışveriş merkezleri.

ÖZ

Tüketim, eski dönemlerde temel ihtiyaçların karşılanması için gerçekleşen bir olguyken değişen zaman ve teknoloji ile bireyler için bir gereklilik olmaktan çıkmıştır. Kentsel tüketim mekanları da geçmişte kentte yürüme mesafesinde erişilebilen ticari ürünleri kapsarken günümüzde tekil olarak birden çok işlev barındıran ve tüketimin yanı sıra kent imgesi niteliği kazanan alışveriş merkezlerine dönüşmüştür. Çalışma kapsamında günümüz kentlerinde yaygın olarak yer alan alışveriş merkezlerinin tarihsel gelişim süreci incelenmiştir. Geçmiş tüketim mekanlarından olan pazarlar, agoralar, forumlar, pasajlar, çarşılar, çok katlı mağazalar ve günümüz alışveriş merkezlerinin ve bu mekanların kent içindeki misyonları zamansal olarak ele alınmıştır. Araştırmada tüketim kavramının tarihsel süreç içerisindeki değişimi değerlendirilmiştir. Zamansal değişim sürecinin ortaya konması ile çalışmanın literatüre önemli ölçüde katkı sağlayacağı ve daha sonra yapılacak olan çalışmalar için bir referans olacağı düşünülmektedir.

1. Introduction

Consumption enables existence in life for individuals and it is a concept that has developed on meeting the basic requirements. In addition, consumption has become an indicator of belonging to the place, increasing the sense of satisfaction and self-realization [1]. Consumption perception has changed due to globalization, digitalization, the development of communication instruments and the phenomenon of capitalism affecting society. It has been replaced by the understanding of "I consume, therefore I am" rather than meeting the basic requirements [2]. It appears in every point of life as a multifaceted concept. Moreover, to the concepts of trade and economy, supports the concept of shopping and enable individuals to access the services offered. Besides, it has become the main element of socialization by transferring and sharing social-cultural values [1-3]. It contributes significantly to the formation of urban communication, urban and social identity with these concepts [1-4].

The place is the main element of consumption, shopping, and city concepts. It is defined as “delimited by gaps” according to Scott, “place, location” for Turkish Language Society, “a space that separates the person from the environment to a certain extent and is conducive to realizing various actions within” for Hasol, “index of states that allows objects to follow each other” for Leibniz and “the success of the unity of all the facts that contain each other with all the details from general to specific” for Aristo. When these definitions in the literature are examined, it is possible to define space as a means of interaction that enables consumers to be handled with other concepts (economy, trade, religion, social, social) and physically identifies with these concepts with the design fiction[5-7].

Urban consumption places; affect the space in the urban area with its social, physical and economic features. It guides today's designs in urban, architectural, and landscape areas. The aim of the study; to examine the places that shape the formation of today with its structure from past to present in a multifaceted concept.

2. From past to present formation of shopping centers as consumption places

Shopping places have indicated differences with the changing and developing social behaviors, consumption tools, and consumption perception in the process of time. These places appear as bazaars, agoras, forums, inns, caravanserais, arastas, passages, markets in the historical process [8-9]. Also, the places contributed to the formation of the city with the construction that will serve socialization and consumption [10]. At a present time, shopping malls appear as common consumption places with the different possibilities and designs it offers.

The earliest discoveries about trade were found in Egypt before the invention of money. With the start of production from the early ages, the concept of trade through barter came in view [8-9]. Barter is a method in which individuals can meet their requirements by exchanging the goods; they produce with other products they want, displaying products in the spaces. The formation of consumption spaces in cities first occurred by barter [10]. The concept of market has emerged by improving sales by barter method. Then, with the invention of money, trade was developed and the need to create and construct special spaces the need to for this has arisen [8-9].

When the historical process is examined, BC. In the 7th century, Agoras appear as the first form of shopping malls (Figure 1). Agoras serve the city with concepts such as religion, education, military and trade. It also offers the opportunity to socialize by using it for shopping, festivals, and sports activities [11]. Agoras, like at present shopping malls, have shaped modern consumption spaces by offering a colorful, living, interactive and dynamic environment [12].

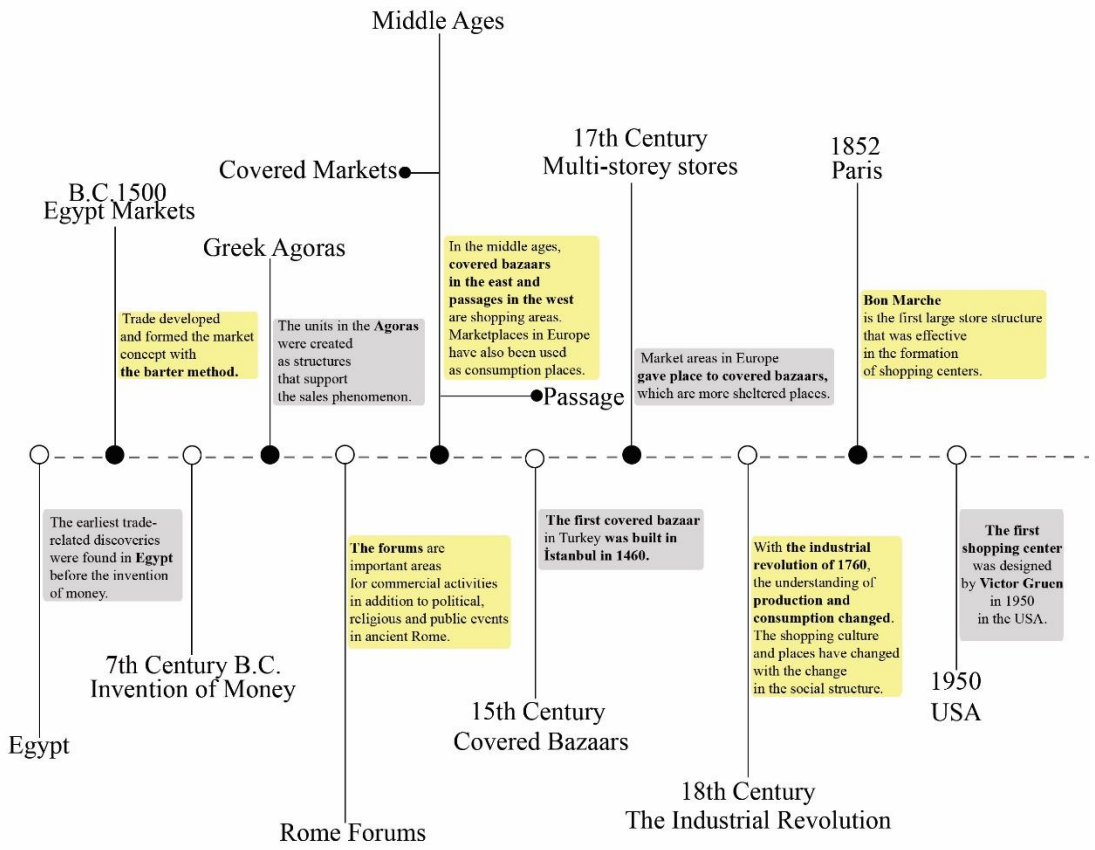

Figure 1: Timewise Breakpoints in the Development of Shopping Spaces

Agoras pioneered multifaceted functions, and these places, which were especially places for shopping and socializing, have historically continued as Roman Forums [10]. Forums in Rome; It is located as an architectural structure serving political, religious, commercial, and social events. It appears as structures that contribute to the formation of today's shopping centers by being a gathering area, including social activities such as festivals, sports, and meeting shopping needs [13]. Then, inns and caravanserais were designed as social service structures to support intercity trade [10-14].

13th-century bazaars and covered bazaars as a product of Ottoman civilization, have also occurred in Anatolia. Covered bazaars are architectural structures that serve as closed shopping centers. Arastas can be defined as architectural structures created in the form of shops that can be designed as open, closed, or semi-open [10]. Covered bazaars took the name of passage in the west, in the Middle Ages, and continued the shopping phenomenon [9]. Passages supported the concept of retail in Europe and created a new consumption understanding [15]. At the present, some of the inns, caravanserais, covered bazaars, and passages continue their existence as historical places with their current functions.

Another consumption place is covered bazaars. The first of the place was built in Istanbul in the 15th century. In the same period, market areas in Europe gave way to covered bazaars. In the 17th century, much more shopping areas were built and they started to be designed multi-storey.

18th century, when the start of the Industrial Revolution, the mass production model developed, the production accelerated, the consumption culture and consequently the consumption places changed. As one of the examples of change, the first department store structure and also the first capitalist consumption place is Bon Marche, which was created in Paris in 1852 (Figure 2). This feature of Bon Marche has pioneered shopping mall designs by supporting social activities such as reading and writing halls, special areas for children, food and beverage and

exhibition areas, as well as sales style and shopping service. Furthermore, the architectural design and general structure of the building have been an aesthetically important and present-day, has shaped the shopping center design and structure [1-16].

19th century, globalization, urbanization, and the rise in capitalism had caused the multi-storey design of new consumption spaces. North America was the region most affected by this multi-storey building. Shopping areas have started to take up large areas in the cities with the introduction of safe, climate-controlled, and advanced new circulation elements for the users. Following, Victor Gruen introduced the concept of "mall" in the USA. The first aim of this design was to create a simulation of the city away from urban problems (traffic, population density, environmental pollution, etc.) [1-17].

The consumption places used could not meet the expected socialization and entertainment demands as well as the westernization and shopping phenomenon, so ungave its place to shopping malls in the 20th century[10-18]. Because of the process, shopping malls have developed in order to meet the increasing consumption need and the expectations of the population living in the urban area. When the development process is examined, it is seen that different functions are shaped on a square in the agoras, which are the first consumption places. With the change in the concept of consumption, agoras have turned into covered markets.

At the beginning of the process, it was seen that different functions were shaped on a square in the agoras, at the present, shopping centers are designed to involve different functions in a monolithic space (Figure 2). It is possible to interpret this development process as combining the first created consumption places (agoras, forums, covered bazaars, etc.) as different layers. With this design concept, focal points suitable are designed within shopping malls and at different levels for different functions (sports, performing arts, entertainment, gathering, seating areas, etc.). These spaces are designed as a complex to allow functions such as residences, offices, performance arts centers, open spaces and playgrounds associated with the increasing preference of consumption places and the changing consumption perception.

Shaped by column designs especially in agoras, were developed with architectural elements such as domes and vaults in Roman forums. In the process of change that continues with covered bazaars, semi-open and closed areas were designed with vaults, developing structural system and architectural elements and then multi-storey stores and today's shopping centers started to be designed as multi-storey and multi-functional with these developments.

In the first consumption areas, functions were design in mutual open areas. In spaces that change over time, these common areas have been enhanced with flooring differences, lighting elements, natural and artificial landscaping, different shading elements, and when considered as a building complex, green areas are applied as floor gardens. The first consumption areas are designed to be more open to users. In time with the change seen in these areas, the private space planning has become widespread and limiting factors (security guards, X-ray devices, etc.) have taken place to the entrances of consumption areas, and again more private shopping places have been designed with different services, brands, and products.

The shopping areas which starting with the agoras and forums, provide the main circulation for the city during the time, and occur form where the axes are connected and located in the center of the city. Today, the existing transportation lines (Metro, metrobus, etc.) are constructed and designed to involve the planned shopping centers.

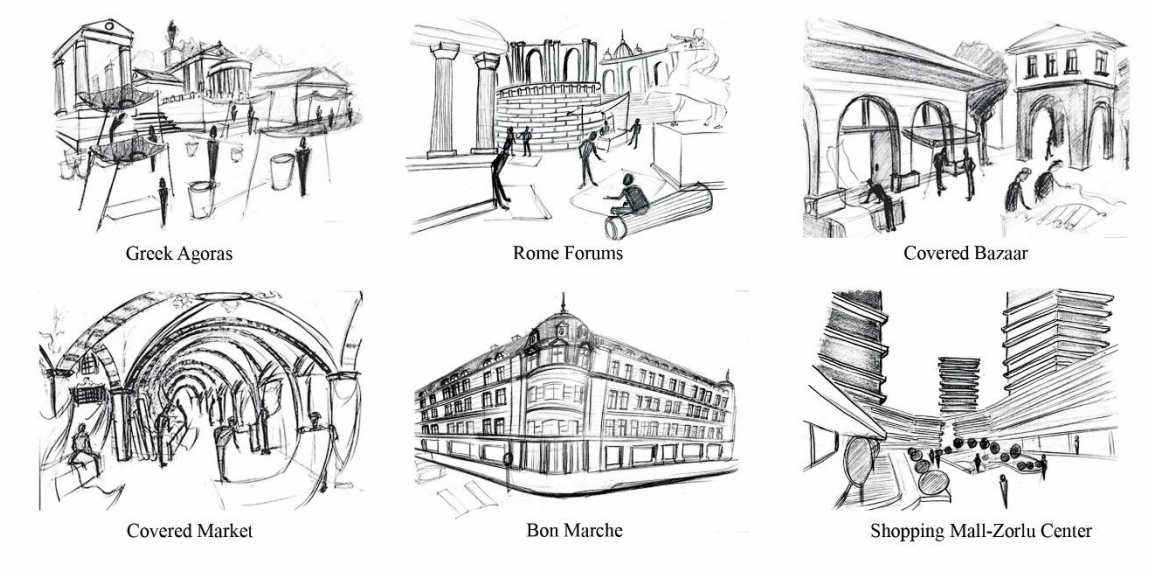

Figure 2: Sketches of Developing Shopping Spaces

According to the International Shopping Council of Shopping Centers (ICSI), the definition of shopping malls is open or closed independent bazaars that consist of a single building or group of structures and contain more of different retail types [19]. The first purpose of designing shopping centers is to create a social space by removing people from the ongoing problems of the city [9]. At present, shopping centers are defined as;

- Planned as a city simulation,
- Providing its users with the opportunity to meet and socialize,
- Allowing entertainment activities,
- The basic needs and recreational activities can be met,
- Contributes to the city economically by supporting the urban identity and branding of the city,
- Contributing to tourism activities by supporting the concept of belonging with purchasing activities,
- Able to transfer urban features to users and tourists with architectural criteria,
- Public spaces that accessible, safe, climate-controlled physical environment based on quality and brand access [9-20].

The first shopping mall was designed in 1950 in the United States (Figure 3). The building designed by Gruen is Northland Shopping Center in Detroit [9]. There have been shopping malls in developed countries for more than half a century. In Turkey, the development process of shopping malls started after the 1980s.

Figure 3: Northland Shopping Mall [21]

3. Development Process of Shopping Centers in Turkey

The emergence of the grocery store chain is the first development that started the formation process of shopping centers in Turkey (Figure 4). In 1954, with the support of foreign capital investments, the "Swiss Migros Cooperatives Association" was invited and as a result, "Migros" took its place as the first grocery store chain [22]. In 1956, with the opening of Gima and the entry of different brands into the market, the number of chain stores increased. Tansaş started operations in Izmir in 1976. In 1988, the first shopping mall was established the name of 'Galeria' in Ataköy, İstanbul [23].

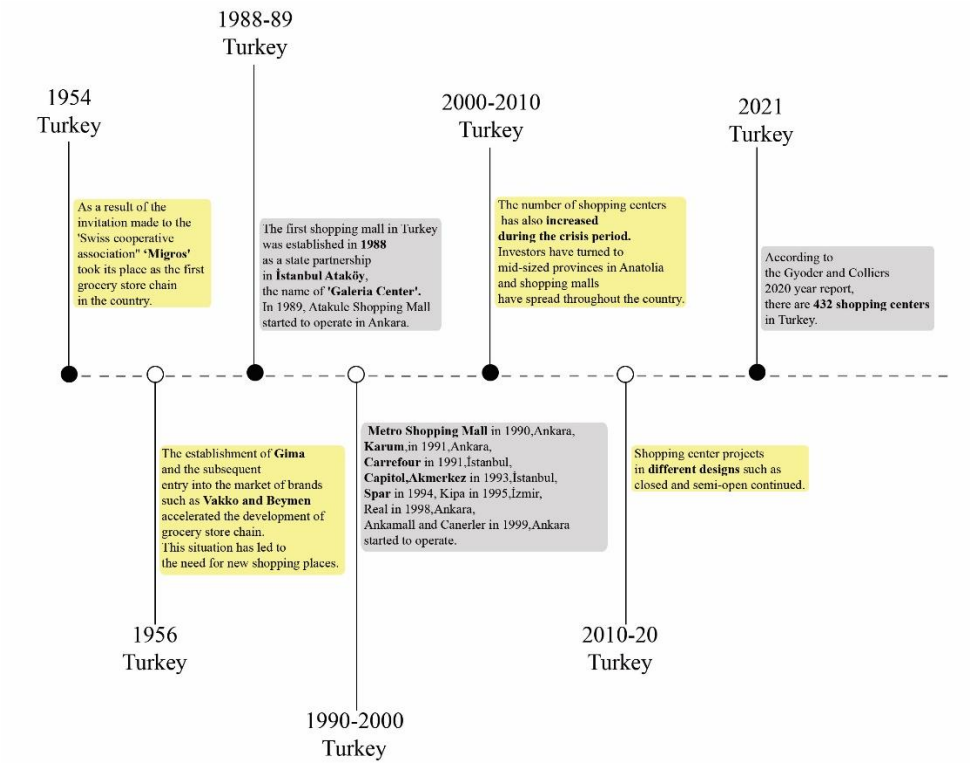

Figure 4: Development Process of Shopping Centers in Turkey

After Galeria Shopping Mall was opened, in 1989 Atakule Shopping Mall is activated in Ankara and also in 1990 Metro Shopping Mall became operational in Ankara. With the opening of Carrefour Shopping Mall in Istanbul, Karum Shopping Mall in Ankara, and Capitol Shopping Mall and Akmerkez Shopping Mall shopping centers in Istanbul in 1993, the number of shopping centers has increased consistently in the country. Spar was opened in Istanbul in 1994 and Kipa Shopping Mall in Izmir in 1995. Then, Real in 1998 in Ankara and Ankamall in 1999, Canerler started to [1]. In 2007, by means of the increase in the number of shopping centers, it reached a coverage that constitutes 38% of the retail sector [19]. In the following years, even the economic crises experienced did not stop the increase of shopping centers. On the contrary, due to increasing construction costs, investors turned to Anatolia and shopping malls started to be planned in medium-sized cities [24].

Nowadays, especially in Istanbul, shopping center projects in different concepts such as fully closed, semi-closed, open space design continue like in the historical consumption places. Kanyon Shopping Mall (2006), İstinyepark Shopping Mall (2007), Ümraniye Meydan Shopping Mall (2007), Viaport Asia Outlet Shopping Mall (2008), Tuzla Viaport Marina Shopping Mall (2015) can be given as examples of shopping malls for different concepts [25].

There are 432 shopping centers serving in Turkey and the leasable shopping area per 1000 people is determined to be 159 m^2 [26].

4. Conclusion

The concept of consumption has changed from the past to the present with the change of time-space perception, the disappearance of space boundaries and technological developments. Apart from being an action to meet the needs, consumption has gained different social, social and commercial dimensions in time. With the important events experienced in the changing consumption understanding, the variety of products consumed has increased and the demands have also changed. Because of the paradigm change regarding consumption, places started to be designed in this direction.

In the research, the paradigm shift regarding consumption has been discussed within the framework of the temporal change of consumption places. These places, which were called as market, agora, forum, covered bazaar, passage and bazaar in the first days of their emergence, were designed to support other public spaces during the period when they were created. Nowadays, due to factors such as technological developments, rapid urbanization and population growth, consumption places are designed as shopping centers, which are a high simulation of interaction with the city.

In the study, consumption-shopping space constructions in the historical process were revealed and it was concluded that these spaces were created by inspiring from past designs. It has been observed that the shopping centers mentioned within the scope of the study add a different vision to the urban development and at the same time, these places play a major role in today's shopping center constructions.

Within the scope of the study, the change in the concept of consumption in the historical process and the differentiation of consumption places accordingly have been evaluated comprehensively. The shopping center areas, which are an important part of social life today, are very substantial. Thence, it is a significant necessity to consider their changes in the historical process.

Competing Interest / Conflict of Interest

The authors declare that they no conflict of interest. The none of the authors have any competing interests in the manuscript.

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Investigation of Traffic Accidents in The City Center of Sanliurfa by Using GIS

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ABSTRACT

The loss of life and material caused by traffic accidents all over the world are important problems. Research and studies conducted for the solution of the problem affecting the society reveal the results of urban planning, increasing and improving the divided roads, the use of traffic signals, improving the awareness level of drivers, pedestrians, and passengers in traffic, and increasing the safety equipment of the vehicles. In recent years, the black spots of traffic accidents have been determined by interpreting the spatial analysis of the accidents with the use of GIS. Thus, it was possible to take preventive measures by identifying the points where accidents were concentrated.

In this study, accident blackspots were determined using hot spot analysis of traffic accidents that occurred in 2019 in Eyyubiye, Haliliye, and Karakopru districts of Sanlıurfa city center, and it was aimed to develop solutions to reduce accidents. In this direction, traffic accident reports for the year 2019 of Eyyubiye, Haliliye and Karakopru districts, which are the central districts of the city of Sanlıurfa, were obtained from the General Directorate of Security to be used in the study. According to the findings obtained in the study, 1626 traffic accidents occurred at the study site in 2019. While most of these accidents occurred in October, the most common day was Thursday. The time zone between 16:00 and 17:59 during the day is the period with the highest accident density. Looking at the accident blackspots; Abide Junction, D-400 (east-west), E-99 (north-south) highways, and Bamyasuyu and Bahcelievler neighborhoods were seen as the areas where the black spots of the accident were concentrated. As a result of the study, it is understood that traffic accidents are concentrated in certain regions and a certain period. To reduce traffic accidents in Eyyubiye, Haliliye and Karakopru districts, which are the central districts of the city of Sanlıurfa, measures should be taken to reduce accidents at these time intervals. However, increasing the traffic signaling systems on the roads in the regions where accidents are determined to be intense, maintenance and widening of the roads are very important in reducing the number of accident black spots.

ÖZ

Anahtar Kelimeler:
Şanlıurfa,
Kaza,
Kaza Analizi.

Tüm dünyada meydana gelen trafik kazaları sonucunda oluşan can ve maddi kayıp önemli bir sorundur. Toplumu etkileyen sorunun çözümü için yapılan araştırma ve çalışmalar, şehirsel planlamanın yapılması, bölünmüş yolların arttırılması ve iyileştirilmesi, trafik sinyalizasyonların kullanımı, trafikte yer alan sürücü, yaya ve yolcularının bilinç seviyelerinin eğitimle geliştirilmesi ile araçların güvenlik donanımlarının artırılması sonucunu ortaya koymaktadır. Son yıllarda, CBS kullanımı ile kazaların mekânsal analizleri yorumlanarak trafik kazalarının kara noktaları belirlenmiştir. Böylece kazaların yoğunlaştığı noktalar belirlenerek önleyici tedbirler alınması mümkün olmuştur. Bu çalışmada Şanlıurfa şehrinin merkez ilçeleri olan Eyyübiye, Haliliye ve Karaköprü ilçelerinde 2019 yılında meydana gelen trafik kazalarının CBS yardımıyla hot spot analizi kullanılarak kaza kara noktaları tespit edilmiş, kazaların azaltılması için çözüm yolları geliştirmek amaçlanmıştır. Bu doğrultuda Emniyet Genel Müdürlüğü'nden, çalışmada kullanılmak üzere Şanlıurfa şehrinin merkez ilçeleri olan Eyyübiye, Haliliye ve Karaköprü ilçelerine ait 2019 yılı trafik kaza tutanakları elde edilmiştir. Çalışmada elde edilen bulgulara göre çalışma sahasında 2019 yılında 1626 trafik kazası meydana gelmiştir. Bu kazalar en çok Ekim ayında gerçekleşirken, en çok gerçekleştiği gün ise perşembe olmuştur. Gün içerisinde 16:00- 17:59 saat dilimi kaza yoğunluğunun en fazla olduğu zaman aralığıdır. Kaza kara noktalarına bakıldığında; Abide Kavşağı, D-400 (doğu-batı), E-99 (kuzey-güney) karayolları ile Bamyasuyu ve Bahçelievler mahallesi kaza kara noktalarının yoğunlaştığı sahalar olarak görülmüştür. Çalışma sonucunda trafik kazalarının belirli bölgelerde ve belirli bir zaman aralığında yoğunlaştığı anlaşılmaktadır. Şanlıurfa şehrinin merkez ilçeleri olan Eyyübiye, Haliliye ve Karaköprü ilçelerinde meydana gelen trafik kazalarını azaltmak için belirlenen bu zaman aralıklarında kazaları azaltacak önlemlerin alınması gerekmektedir. Bununla birlikte kazaların yoğunlaştığı belirlenen bölgelerdeki yollar üzerindeki trafik sinyalizasyon sistemlerinin arttırılması, yolların bakımı ve genişletilmesi, kaza kara noktalarının sayısını azaltmada çok önemlidir.

1. Introduction

Due to the increase in the population over the years in Turkey, the traffic density has also increased. In this context, especially in cities with high population density, the increasing traffic problem and loss of time due to the variety and number of vehicles providing transportation have become one of the most important problems. The reflection of the information and technological developments that have developed in recent years on the transportation process and the development of the welfare level have also been effective in the increase in the number of individual vehicles. According to the March 2021 Turkish Statistical Institute (TUIK) [1] report, the number of Motor Land Vehicles registered to traffic in Turkey was announced as 24,454,396 at the end of March. 54.4% of these vehicles were automobiles, 16.3% van, 14.5% motorcycles, 8.1% tractors, 3.5% trucks, 2.0% minibuses. Busses constitute 0.9% and special purpose vehicles constitute 0.3%. The length of the highway under the responsibility of the General Directorate of Highways is 95279 km as of 01.01.2021 and 26646 km of it consists of divided roads. When we look at the data, due to the high number of vehicles and the length of the highway in Turkey, the most popular transportation choice is the highway. Consequently, the use of the highway made it inevitable to increase the traffic density [2] to the highway traffic law, all incidents that result in injury, loss of life, material and moral damage caused by one or more vehicles in traffic are called traffic accidents. The fact that most of the transportation movements are provided by the highway [3] and the traffic density causes the high number of traffic accidents occurring on the highway.

Due to the high number of traffic accidents, public damages, material damages, injuries, and loss of life are constantly in the memory of the society and the situation reaches extremely worrying results [4]. Accident victims are injured both financially and physically, and the economy of the country is also seriously damaged. Approximately 1 million people die each year in the world, and between 20 and 30 million people are injured [5]. Therefore, it has become a necessity to carry out research and studies to reduce accidents.

Improvement studies on 28 black points determined as a result of the studies carried out by the General Directorate of Highways in the Turkish highways network are continuing [6]. However, black spots obtained due to the results of urban accidents are not shown in the road network because they are within the duties and powers of different units. For this reason, there are deficiencies in transferring the potential accident zones and black spots found as a result of accident studies in urban roads to digital and map environments. Analyzing traffic accident studies across the country, creating a general database that includes urban roads, and analyzing solutions will make an important contribution to the reduction of traffic accidents [7]. Attention is paid to traffic engineering and road planning to solve problems in road networks that are complex to develop. In this context, the lower number of accidents compared to other countries can be shown as traffic success in developed countries [8].

As a result of the increasing technological developments in recent years, the increase in advanced software and programs provides analysis opportunities to eliminate many problems. In this context, Geographical Information Systems (GIS), which enables the application of various analyzes and examine the results, has been used in many service activities. With the geographical information systems, accident areas can be determined in detail and solutions can be produced for taking measures by analyzing the results. For example, Thieman implemented his project for the city of Cheyenne, where he determined black spots using the Geographical Information System (GIS) using accident data [9]. The point to note here is that all accident-related data are as detailed as possible and convenient for interpretation in geographic information systems [10]. Furthermore, as a result of the recent technological advances, the use of software such as GIS plays a role in city planning and the fiction of development aspects. These developments also affect the form and direction of city transportation [11].

Spatial analyzes made with the increasing use of GIS in Turkey have been used in accident analysis in recent years and applications of many disciplines have taken place in the literature. In this context, accident analysis of three districts in Urfa province was conducted to contribute to the literature numerically. In this study, using geographical information systems (GIS) where advanced spatial analyzes can be made and accident data in Eyyubiye, Haliliye, and Karakopru districts of Sanlıurfa central districts, the black spots where traffic accidents occur were determined. With the accident analysis and evaluation of the results, it is aimed to reduce the number of accidents and determine the direction of transportation.

2. Material and Method

Our field of study is the city of Sanliurfa, located in the Middle Firat of the Southeastern Anatolia Region (Map 1). Since the city of Sanliurfa is at the intersection of east-west and north-south roads, there is a constant traffic of vehicles. In the city of Sanliurfa, which is on the transit route of both cars and large tonnage vehicles, it is inevitable to experience traffic jams especially in recent years, and due to this density of vehicles, many accidents with fatalities and injuries occur.

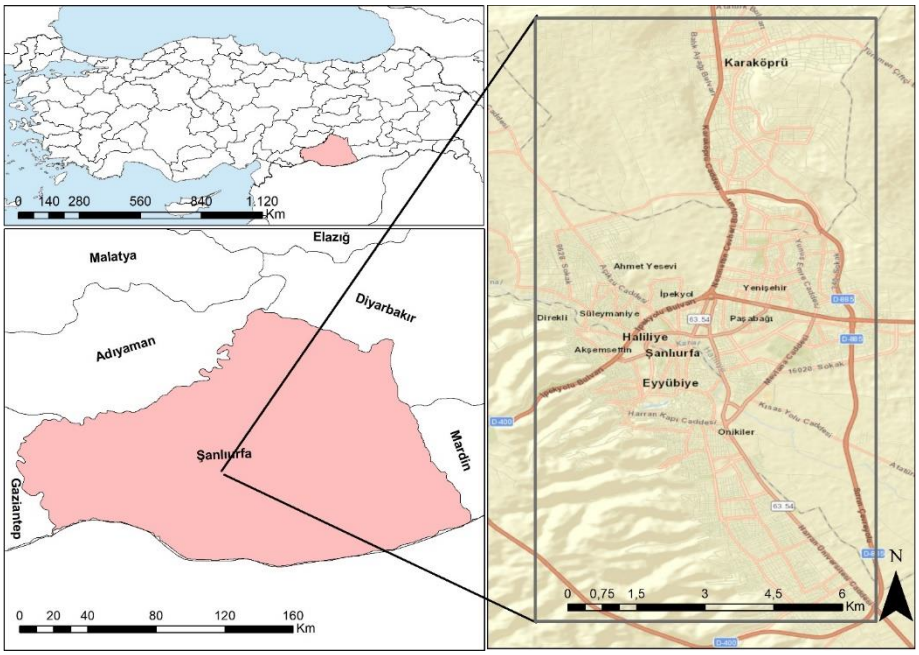


Figure 1. Study Area Location Map

Geographical Information Systems can classify and interpret data with many analyzes made on accidents, as in every field, thanks to its existing analyzes. Many different methods are used for accident analysis. Hot spot analysis is the most used of these methods and gives the most accurate results. In the hot spot analysis, Getis Ord uses G * statistics. Getis Ord G * can detect areas where spatial clustering is high and low. In our study, spatial clustering and densities of accident points were determined with hot spot analysis. If the G * value obtained as a result of the calculations in Getis Ord G * is positive and the z value is greater than the za value, it is accepted that the higher values are aggregated or if the G * value

is negative and the z value is smaller than the za value, the lower values are aggregated [12]. The Getis Ord G * calculation is as follows:

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}.x_i.x_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i.x_j}$$

D: Neighborhood distance

W: Weight matrix

i and j attribute information of its objects

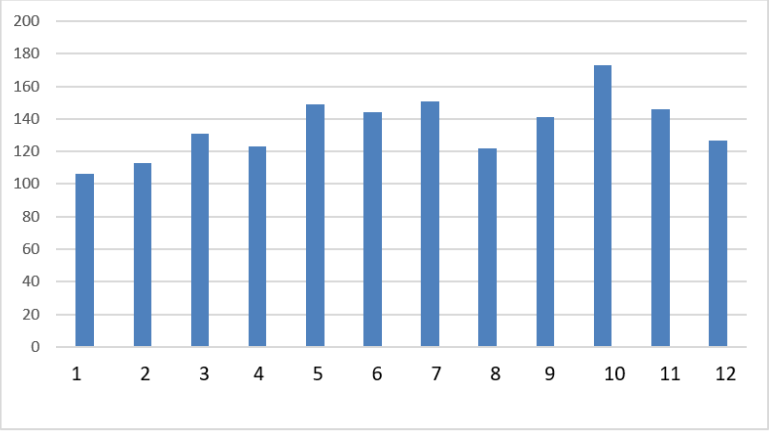
N: It is expressed as the number of objects in the layer.

In the study, the data of fatal and injured traffic accidents taken from the General Directorate of Security Traffic Branch Directorate of 2019 were used. As of 2019, 1626 accidents have occurred in the city of Sanliurfa. In these accidents, the attribute information of the month, day, hour, the result of the accident (fatal or injured), etc. information is included. Interpreting and evaluating this information is very important in analyzing accidents.

3. Findings

When the monthly distribution of the accident data for 2019 in Eyyubiye, Haliliye and Karakopru districts, which are the central districts of Sanliurfa, is examined, the highest number of accidents occurred in October with 173. After October, July is the second month with the highest number of accidents with 150 accidents. It is then ranked with 148 accidents in May and 146 accidents in November. The month in which the least accident occurred is January with 106 accidents. As can be seen, the accidents mostly occurred in the summer and autumn months. The reason for the high rate of traffic accidents in this period was evaluated as the effect of the drivers being overwhelmed by the hot weather and not obeying the traffic rules.

Table 1: Distribution of the accidents that occurred in Sanliurfa in 2019 by months

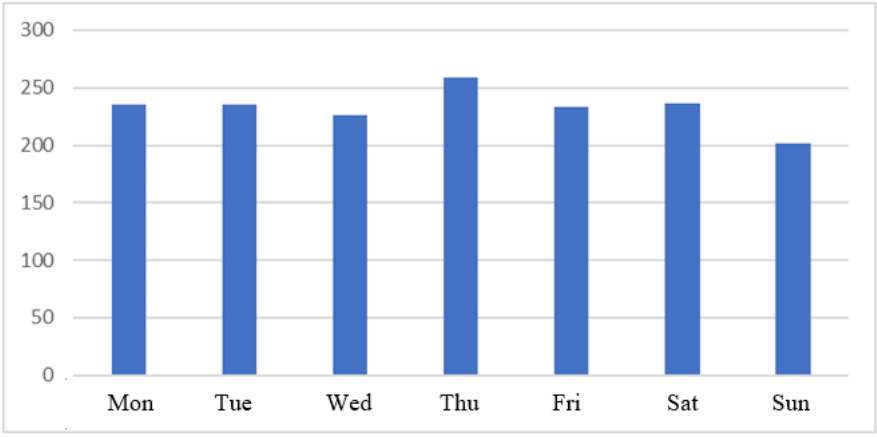


Source: General Directorate of Security Traffic Inspection Branch, 2019.

When we look at the days of traffic accidents, it was seen that the most accidents occurred on Thursday with 259 accidents. Then Saturday with 236 accidents and Monday and Tuesday with 235 accidents each. The day with the lowest number of accidents was on Sunday, with 202 accidents. When we look at the total accident data, it is seen that more

accidents occur on weekdays compared to weekend days. This situation can be interpreted as the traffic is more intense due to the higher number of employees on weekdays.

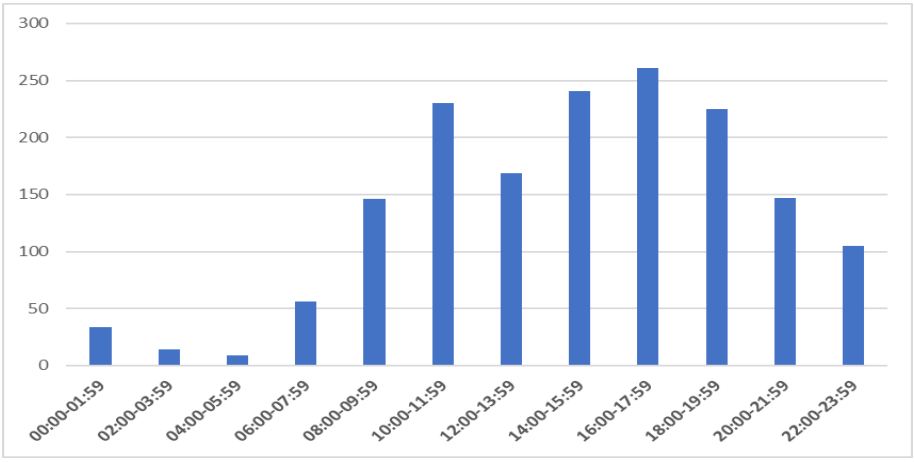
Table 2: Distribution of the accidents that occurred in Sanliurfa in 2019 by days



Source: General Directorate of Security Traffic Inspection Branch, 2019.

Examining the distribution of traffic accidents according to time zones during the day, it was seen that the highest number of accidents occurred between 16:00 and 17:59 with 261 accidents. After this time zone, it occurred in the 14:00-15:59 time zone with a maximum of 241 accidents. The time zone with the least accidents is 04: 00-05: 59 with 9 accidents. When accident data are analyzed, it is observed that traffic accidents in the districts mostly occur in the afternoon. It is seen that the reason for being in this time zone is the effect of the intensity that occurs at the end of work.

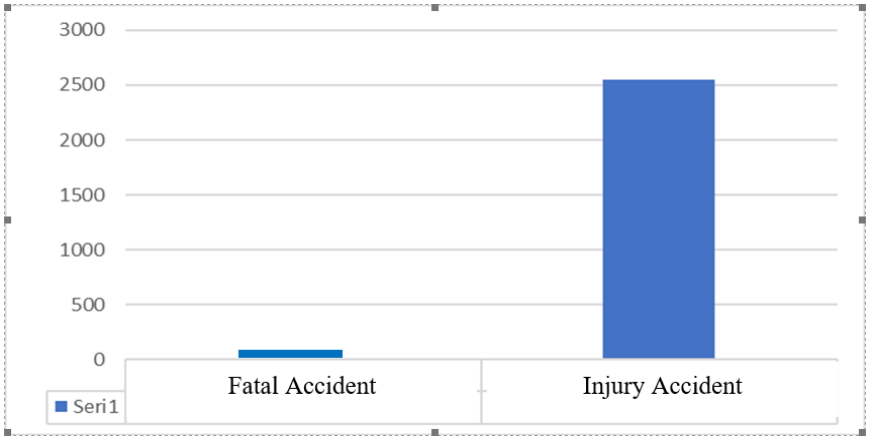
Table 3: Distribution of the accidents that occurred in Sanliurfa in 2019 by periods during the day



Source: General Directorate of Security Traffic Inspection Branch, 2019.

According to traffic accident data, 1616 accidents were injured in 1626 accidents that occurred, resulting in material damage, and 2551 were injured in the accidents that occurred. In 10 accidents, 10 people died in addition to material damage (Table 4).

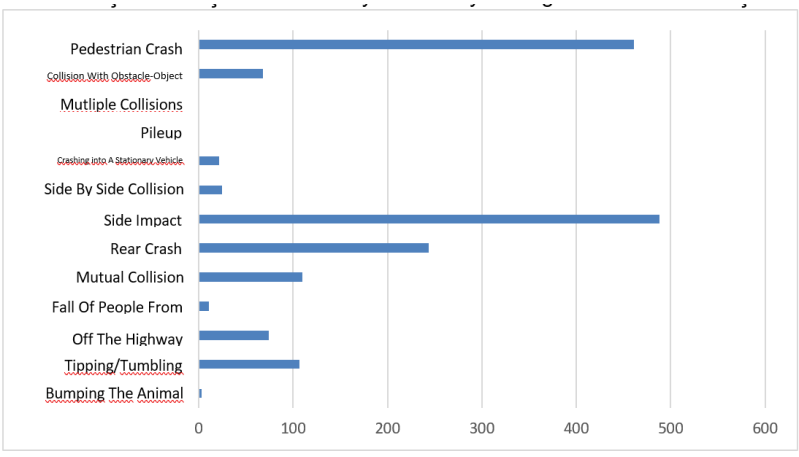
Table 4: Distribution of Sanliurfa City according to the results of the accidents that occurred in 2019



Source: General Directorate of Security Traffic Inspection Branch, 2019.

When the accidents are analyzed according to their occurrence types, it is seen that there are accident types in 13 categories. The highest of these is the side impact. Subsequently, pedestrian collision, rear-end collision, mutual collision, roll-over / overturn, run out of the road, collision with obstacle-object, collision with an obstacle-object, collision with a stationary vehicle, human fall from the vehicle, animal collision, and chain accident-multiple collisions (Table 5).

Table 5: Formation type of the city of Sanliurfa accidents in 2019



Source: General Directorate of Security Traffic Inspection Branch, 2019.

Looking at Map 2, it is seen that the accidents are concentrated on the main roads. Especially at the Abide junction, where the east-west and north-south roads intersect, it is seen that the accidents are very intense. Apart from this, it is seen that the accidents are concentrated at small and large intersections. This, in particular, has a direct link with the number of vehicles and traffic density. It is observed that the accident density from the intersections towards the periphery has decreased. The accidents appear to be concentrated linearly on the D-400 (1) highway (east-west), and E-99 (2) (north-south). Apart from this, it is seen that there are Bamyasuyu (3) and Bahcelievler (4) neighborhoods, which are the areas

where the human circulation is the most intense. The high number of accidents in these areas is due to driver and pedestrian carelessness, violation of traffic rules, and excessive human circulation.

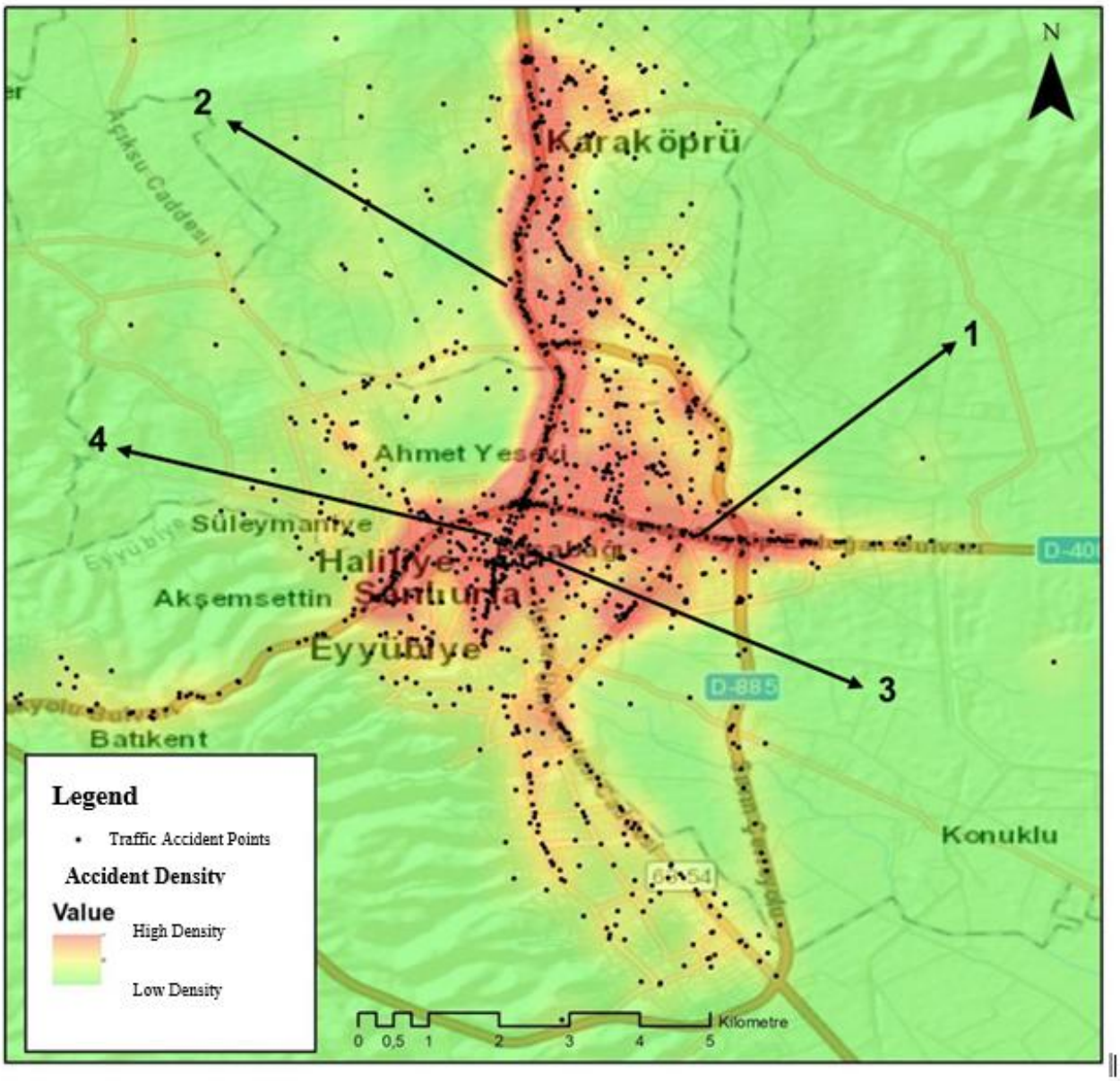


Figure 2. Traffic accident density map that occurred in the city of Sanlurfa in 2019.

4. Results

As a result of the increase in the number of vehicles in traffic due to the increase in population density, the number of traffic accidents has increased both in the world and in Turkey. It has been observed that the number of traffic accidents that occurred has increased quantitatively, according to the data of fatal and injured traffic accidents received from the General Directorate of Security Traffic Branch Directorate of 2019. Even if it is difficult to prevent the occurrence of

traffic accidents, it is aimed to reduce the intensity of traffic accidents as a result of the studies and researches and to reduce the number of accidents to the lowest possible number by raising the awareness of the drivers.

A large number of black spots were determined by hot spot analysis in the study area also concentrated on the roads on the intersections, narrow avenues, and streets. Consequently, taking into account the data and as a result of the interviews with the authorities, driver errors are observed in most traffic accidents. Accordingly, it is seen that drivers' carelessness, rule violations, and excessive speed accidents occur. According to the accident data that occurred in the districts in the study area, vehicles such as automobiles and motorcycles were mainly involved in the accident. When we look at the data in 2019, it is seen that the most accidents occurred in 16: 00-17:59 time zones. Traffic accidents are seen due to the increase in traffic density due to the end of working hours of public and private institution employees. Apart from that, the most intense accidents occurred between 14: 00-15:59 on weekdays. The reason for this can be seen as the departure time of the schools in provincial and district centers after 14:00. The increase in the density of student services causes traffic and accidents to occur. Deformed divided roads and two-way roads in the work area increase the accident rate. In this context, repairing the deformed parts and performing the necessary asphalt works will contribute to the reduction of accidents. Moreover, it is necessary to build sets that will prevent pedestrians from using the vehicle road on the road routes where heavy traffic occurs. Thus, stopping or slowing down of the traffic will be prevented and pedestrian crashes will be prevented. This situation makes it obligatory to construct underpasses or overpasses depending on the building suitability in areas where pedestrians should not use the road. In addition, it should not be forgotten that there should be ramps or elevators in places with underpasses or overpasses for our disabled citizens. During rush hour traffic control points should be established, roundabouts should be enlarged if possible or blind spots should be reduced by placing mirrors. Likewise, the roads that need to be measured can be determined and traffic accidents due to excessive speed can be prevented. Preventing grazing of animals by installing wire fences at points close to highways will prevent loss of life or property in a possible traffic accident. Since giving traffic education lessons starting from the primary education level will increase traffic awareness in students, it will contribute to the reduction of driver errors in the future. On the other hand, depending on the advancing technology, the use of devices such as drones will allow traffic teams to intervene quickly and prevent loss of time.

Competing Interest / Conflict of Interest

The authors declare that they no conflict of interest. None of the authors have competing interests in the manuscript.

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