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An analysis of spatial development tendency of Istanbul

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Abstract:
Urban spatial structure is increasingly characterized by decentralization, dispersion, concentration, and multiple centers. In Istanbul, dual development processes have been observed in the course of time. The first process is continuous urban expansion with low density development which was triggered mainly by squatter settlements at the periphery and recently occurring high density mass housing development due to low land values. The second process is the intensification and/or renewal process within built-up areas in the central parts of Istanbul.

In this paper, density and land value gradient analysis has been used to analyze urban structural change in terms of core-peripheral relationship in Istanbul. A GIS database is set up to obtain density, land value, distance measures, visualize spatial patterns, and calculate density and land value gradient. In general, standard urban models predict a pattern of negative exponential density gradients within cities, where there is a gradual decline in population density and land value from the center of the city to its outskirts. In the Istanbul case, negative exponential density and land value gradients is observed even though Istanbul has the changing urban structure from monocentric to polycentric. Furthermore, the fact that the change in land value at peripheries has been higher than that of the central zones and the increase in density changes at peripheries shows that the macro-form of Istanbul has demonstrated both urban expansion and urban intensification characteristics from past to present.

Keywords: *Urban spatial structure; change; density gradients; land value gradients.*

Introduction

A number of studies on multi-center urban development process have been conducted and various aspects of this process have been well-documented. Spatial variables such as population or employment density, land values, commuting, and firm locations, have been widely used in empirical studies (Gordon and Wong, 1985; McDonald and McMillen, 1990; Davoudi, 2003; Gordon and Richardson, 1996; Parr, 2008; Yue et al, 2010) to explore the evolution of polycentric urban structure and to analyze urban spatial structure. In this studies, land value and population density have been selected to analyze the change in urban space in Istanbul.

Some researchers have attempted to explain land values change by the bid-rent curve (Alonso, 1964; Muth, 1969). Bid rent curve shows how the rent function change based on potential users' distance from central points. In the central points, transportation cost for a land use is the lowest where the rent is the highest. Therefore, location is a key factor in determining the price and the demand for land and other real estate properties. Here, the location means the distances to the work, to the urban amenities and to the other urban facilities. Alonso (1964) and Evans (1973, 1985), examined the effects of the distance on land values and housing prices. In this context, specific models which consider various households with different preferences were developed. These models, on the one hand, took into account the travel time, travel cost and distance; on the other hand, the location of land and the size of the land. The household competition has direct effect on determining the land and house price. Some households prefer to live in urban centers, while keeping transportation costs low; some of them prefer to live in peripheral areas while paying high transport costs, but paying less rent (Alonso, 1964; Oxley, 2004). In an urban area of circular form, land supply is limited in urban center compared to urban periphery, leads to an increase in land prices in a competitive environment in the city center (Oxley, 2004).

Robert M. Haig (1926) a land economist, stated that a land with lower transportation cost is more valuable, because households prefer more accessible land. He found that rent, distance to work and transportation cost are the main parameters affected the decision of individuals (Alonso, 1964).

Geltner and Miller (2000), emphasized the importance of understanding spatial formation of city to understand urban land values. The size of the city, land use, income distribution and density are the main factors affecting land values in a city. As they stated that there is a closer relationship between land value and density. Borukhov (1978) pointed out that the trade-off between density and transportation costs are the one of the principal forces which determines the shape of a city. "If a given population lives at a lower density, the residents occupy a larger area of land - so travelling distances and transportation costs increase. Obviously, one way to economize on transportation costs is to crowd the population into a smaller area - that is, to increase the density. This will shorten travelling distances, and thus reduce transportation costs" (Borukhov, 1978).

Yue et al (2010) found out that polycentric development is encouraged by the combined forces of government planning, globalization, and market-oriented reforms. He claimed that market forces have played an increasingly important role in Hangzhou's polycentric development due to low cost of land and more open space which attracted companies to locate or relocate in subcenters.

In this paper, a gradient approach was used to quantify density and/or land value based on the distance from city center. The idea is based on defining the percentage change in density/land value for a small change in distance from an urban centre, which approximates the density/land value gradient of urban development (Batty and Longley, 1994; Malpezzi and Guo, 2001; Torrens and Alberti, 2000). In fact, as Malpezzi and Guo (2001) emphasized, it can be argued that the gradient model, which often assumes that urban form is monocentric, is a good fit to the dynamics of how cities grow and economies develop, although the measure must always be qualified in terms

of the extent to which cities are polycentric. This limits the applicability of such gradient analysis.

Urban development history of Istanbul

As in many other metropolitan areas throughout the world, urban expansion and the associated conversion of rural land have become an important issue facing Istanbul which is the largest city in Turkey where its population increased from 3.904.588 to 12.573.836 between 1975 and 2007 primarily due to migration. Starting from 1950's, Istanbul has faced rapid urban growth and industrialization process, and subsequently, its structure has been constantly changing. The rapid urbanization of the city since the 1950s, has affected urban spatial development and its structure.

In that period of rapid urbanization, the city of Istanbul has been experiencing motorway oriented urban development. With motorway investments, industrialization process has been accelerated and location of industrial areas have become the dominating factor which was affecting the spatial structure of the city in 1950s (Ocakçı,1998; Aysan and Özçevik, 2003). Rapid urbanization process with industrialization caused immigration to Istanbul and the increase in population resulted in an uncontrolled development in different time periods. Due to industrialization, the first migration wave occurred in 1950s, and the immigrants settled around industrial zones around Golden Horn and the first squatter housing (illegal housing) neighborhoods emerged in Kâğıthane and Zeytinburnu (Yenen et al., 2000). The illegal housing areas, which were low density and were located at the periphery, accelerated the expansion of Istanbul. As a consequence of expansion, illegal/informal residential areas have started to invade the water basins, forests and high quality agricultural land.

It was seen in the following years along with industrialization that squatter housing have become the second dominating factor which was affecting the spatial structure of the city (Kaptan, 1994; Sırma et al.,1994). Illegal housing growth continued very fast and the neighborhoods near to the old industrial settlements grew and was intensified until 1970. The city of Istanbul began to expand towards Kâğıthane, Alibeyköy, a part of Gaziosmanpaşa, Esenler, Bahçelievler, Bakırköy, Bağcılar, Güngören, and Avcılar in the West, Maltepe, Kartal, and Pendik and Tuzla in the East, and slightly inner parts in Bosporus. With this urban development, the natural structures of ecologically sensitive areas have started to deteriorate (Kılınçaslan, 1981; Yenen et al., 2000).

In 1980s, illegal housing areas continued in the districts of Güngören, Esenler, Kâğıthane, Şişli, Maltepe, Kartal, and Pendik (Kılınçaslan, 1981). By the year of 2000, two essential development corridors have been emerged in Istanbul relating to illegally growing areas. One of them is the axis of Ümraniye-Sarıgazi-Sultanbeyli in the East part of Istanbul, and the other is the axis of Sultançiftliği-Habibler-Yayla-Arnavutköy in the West part of Istanbul (Yenen et al., 2000). An urban expansion process has been observed in both of these axes towards forests and water basins (Yenen et al., 2000).

Urban spatial development patterns of Istanbul over time have continued until today in a dual process. In this dual process, urban expansion with low density development which was triggered mainly by squatter settlements at

the periphery and recently occurring high density mass housing development due to low land values. The second process is the intensification and/or renewal process within built-up areas in the central parts of Istanbul (Kaptan, 1994). In addition, the construction of the bridges on the Bosphorus and the Golden Horn have changed accessibility of various areas considerably. An increase in accessibility caused an increase in the density of the neighborhoods which were close to the city core, and facilitated spatial transformation in the pattern of land use particularly from housing to commercial or service areas. (Ünal et al., 1994; Yenen et al., 2000).

In 1980, the Law of Mass Housing encouraged mass housing projects (Yenen et al., 2000), and thus, mass housing areas began to play an important role in spatial development pattern of Istanbul. Since 1990s, mass housing projects of high and middle income have become more determinative in urban macro-form (Aysan and Özçevik, 2003). Settlements of high-income group were moved towards peripheries of the city for a new life style, and luxuriously facilitated housing sites which are isolated from the city were established (gated community) (Aysan and Özçevik, 2003; Gülümser, 2005).

Urban spatial development pattern was highly dependent on industrialization at early stage, and it has been continuing in an uncontrolled way characterizing by incremental and low-cost development process (Bölen et al., 2006). In the entire process beginning with rapid industrialization and urbanization, Istanbul has grown by expanding and intensifying beyond control. It is reported that natural structure of the city began to degenerate, and to spread towards drinking water supplies and forests in the north (Kılınçaslan, 1981; Kaptan,1994; Ünal et al., 1994; Sırma et al., 1994; Yenen et al., 2000; Aysan and Özçevik, 2003). In response to this rapid urban growth, metropolitan level master planning efforts have not been sufficient to take the spatial growth under control. This requires that sustainability of spatial development in Istanbul should be re-discussed.

Method

In this paper, density and land value gradient analysis has been used to analyze urban structural change in terms of core-peripheral relationship in Istanbul. The purpose of this analysis is to understand the relationship between change of land values and densities associated with urban spatial development over time. Neighborhoods were assumed as the smallest statistical units making a base for the analysis. However, the built-up areas of the neighborhoods were taken into account rather than its administrative borders.

In the density and land value gradient analysis, gross density (for the years of 1980, 1995 and 2005) and land values (for the years of 1994, 2002, 2006) were associated with the urban form.

Gradient analysis, which was used in this study, measures both ‘the change over time’ and ‘the change in space’. Therefore, data for each time period were made compatible. For example, inflation effect was eliminated in analyzing the change in land values using constant price. Data related to the built-up areas were collected for each neighborhood level within the urbanized area of Istanbul.

Analyzing density change over time

In this section, it was calculated that how density values of the neighborhoods changed over time depending on their distances to the center for the time periods of 1980, 1995 and 2005. Gravity centers of the districts of Şişli, Beyoğlu and Eminönü were assumed as Central Business District.

According to gradient analysis, density gradient is based on defining the percentage change in density for a small change in distance from an urban centre (Batty and Longley, 1994; Torrens and Alberti, 2000; Malpezzi and Guo, 2001).

Gradient is calculated as the following in theoretical studies **(1):**

$$D(x) = D_0 x^{-\alpha} \tag{1}$$

In this equation,

D(x): density value of a neighborhood x units far away from the center,

D_0: density value in the center,

α: coefficient of distance gradient (Torrens and Alberti, 2000).

− α parameter may be described as the ratio of the change in percentage in density $\left[\frac{Dd(x)}{D(x)}\right]$ to the change in percentage in distance from the center $\left(\frac{dx}{x}\right)$. In other words, density decreases by (− α) as moving from the center to the peripheries. Thus, first derivative of $D(x)$ parameter gives the − α value (Torrens and Alberti, 2000) (2 and 3).

$$\frac{dD(x)}{dx} = -\frac{\alpha}{x} D(x) = -\alpha D_0 x^{-\alpha-1} \tag{2}$$

$$\frac{\frac{dD(x)}{D(x)}}{\frac{dx}{x}} = -\alpha \tag{3}$$

A macro, which was able to make iteration calculation in MS Excel program, was written according to this equation (Mutlu, 2006) and α value was calculated by using this macro.

Analyzing land values change over time

In this section, it was calculated how land values changed in the course of time depending on their distances to the center for the time periods of 1994, 2002 and 2006.

Considering effects of external factors such as shift in national currency (TL, YTL) and inflation, land values in all three of the periods were calculated

according to the prices in 1994 to be able to make a comparison. Then, land value gradient was calculated for each period. How these calculations were made was described in the previous chapter relating to density gradient calculation.

Findings

Density gradient

According to the calculations, density gradients (α) were found as 0.029 for the year of 1980, 0.030 for the year of 1995 and 0.0033 for the year of 2005 as a result of the calculations made for 3 periods in Istanbul. The decrease in α value indicates that effect of the center decreases while the increase indicates that its effect increases. Thus, the highest effect of central business district on density increase was seen in the year of 2005 while this value was the lowest in 1980. The effect of central business district on densities increased regularly after 1980.

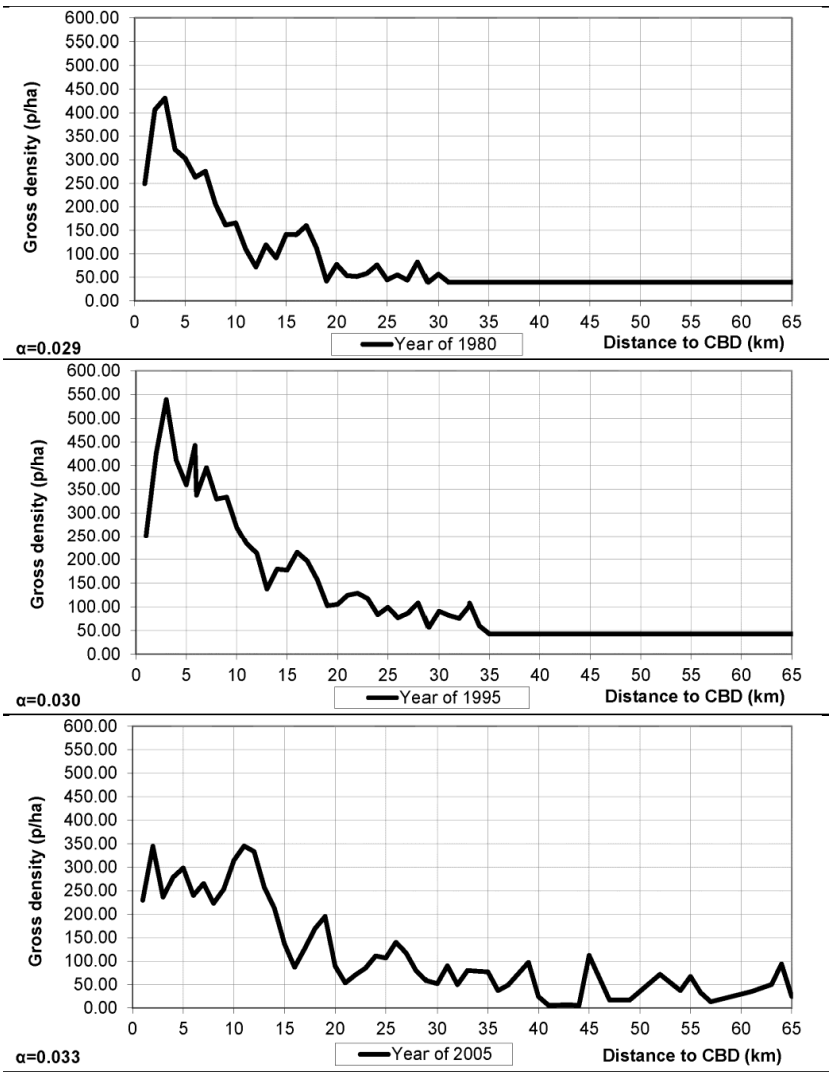

Figure 1. *Gross density vs. distance in Istanbul for the years of 1980, 1995 and 2005 (Terzi, 2009).*

It was determined that, in 1980, urban settlement border ended approximately 30 km away from the central business district and then, rural settlements began having an average density of 39.63 person/ha. In 1995, urban settlement border achieved about 35 km and density of rural settlements increased to approximately 42.28 person/ha while the border went beyond 65 km (with effect of 5216 act law) and average density of rural settlements was 33.20 persons/ha in 2005 (Figures 1-2).

Based on the year of 1980, settlements at peripheries (for example Bakırköy, Pendik) have been intensified since that time and new sub-centers emerged. Intensification and multi-centralization are the most important two key words describing compact development in the literature. Thus, it is evident that rapid urban expansion with low density towards peripheries has affected urban spatial development. Once, there can be a density increase of neighbourhoods, and it turns into a compact pattern due to increasing density and\or emerging new subcentres. This continued in a cyclic way through expansion again (the year of 2005). Characteristic of the expansion, as seen in maps, occurs in the form of low density and/or leapfrog development (Figures 1-2).

Another finding obtained from analyzing density change over time is the fact that the borders of the city expands due to low density settlements in every five-year, while new residential areas emerged in the existing built-up areas of the city. For example, density of housing zones within 20-30 km was around 80 persons/ha in 1980, while this figure increased in 1995. Average density increased over time in the neighborhoods taking place in closer zones to the center. This indicates that the city has been developing by expanding and intensifying (Figure 1).

According to average density of housing areas depending on distance to the center, an increase was observed in the 0–5 and 5–10 km distance ranges in 1995; however, a decrease was seen in 2005. The reason may be the fact that housing areas were transformed into commercial and service areas in central zones. A regular decrease in average density is seen in other distance ranges in general over time except 10-15 km distance range (Table 1, Figure 3).

Table 1. *Change in average gross density over time (Terzi, 2009)*

Distance to CBD (km)	1980 p/ha	1995 p/ha	2005 p/ha	Average change 1980-2005 (%)
0-5	342.24	397.00	277.48	-18.92
5-10	214.18	367.55	259.19	21.02
10-15	106.75	206.14	257.03	140.78
15-20	106.57	169.36	133.45	25.22
20-25	57.04	111.57	85.89	50.58
25-30	55.68	85.26	89.24	60.27
30-35	39.63	91.37	75.07	89.43
35-40	39.63	45.76	51.96	31.11
40 and over	39.63	42.28	37.64	-17.49
Average	89.20	129.65	109.05	-5.02

According to gross density between 1980 and 2005, it was observed that the density increase in the peripheries (20–35 km) is higher than central areas (Table 1).

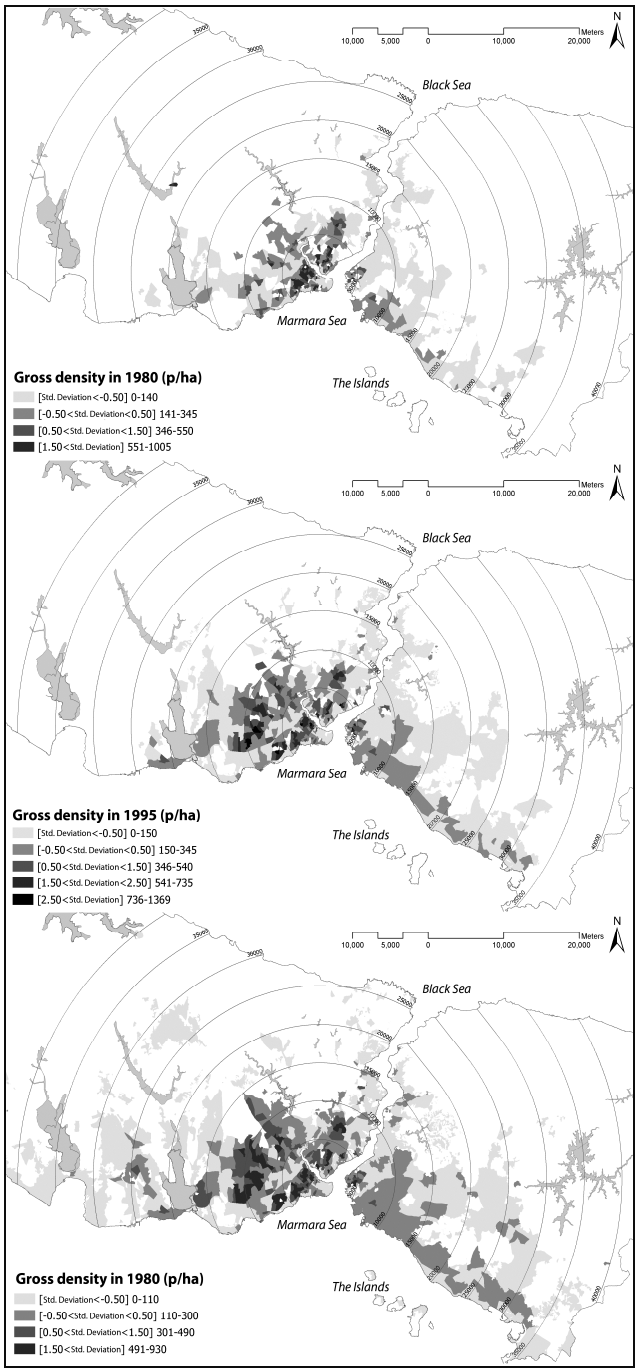

Figure 2. *Spatial distribution of gross densities for the years of 1980, 1995 and 2005 (Terzi,2009).*

Common features seen in all 3 of time periods are that density is decreasing from the center to peripheries, and that the settlement in the peripheries was initially developed as low density and their density gradually increases over time. These characteristics are similar to features of spreading and concentrating growth.

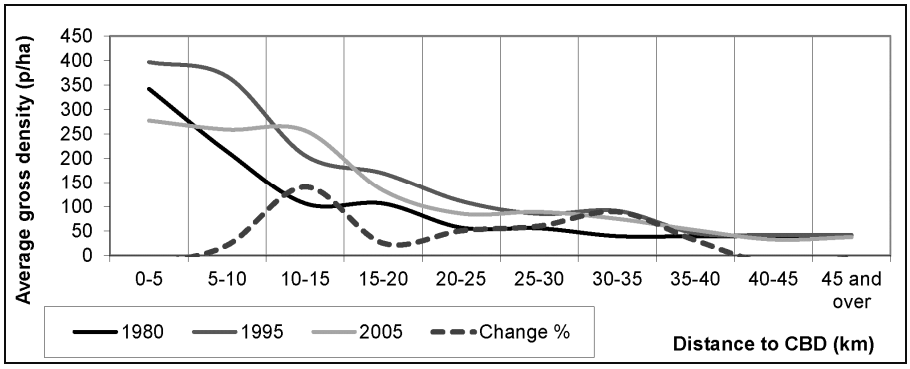

Figure 3. *Distance-dependent change of gross density for the years of 1980, 1995 and 2005 (Terzi, 2009)*

In brief, two conclusions have been drawn from analyzing density change over time. First is that Istanbul has been expanding day by day from 1980 up to 2005, and this expansion occurred with a few neighborhoods at low density in the peripheries at the beginning, and these neighborhoods have grown with new settlements in the course of time. The second is low density development in Istanbul has triggered compact development and this continues in a cyclic way in the course of time.

Land value gradient

According to the calculations, land value gradient coefficient was found 0.179 in 1994, 0.139 in 2002, and 0.163 in 2006. Thus, effect of the factor of proximity to the center on land values decreased in 2002 but increased again in 2006. According to results, average land values decreased as the distance to the center increased, and average land values increased in each neighborhoods compared with previous term in each distance range (Figure 4, Table 2).

Table 2. *Distance-dependent change of average land values over time (with constant prices of 1994) (Terzi,2009)*

Distance to CBD (km)	1994 YTL/m^2	2002 YTL/m^2	2006 YTL/m^2	Average change 1994-2006 (%)
0-5	2.54	3.65	4.42	74.02
5-10	1.51	2.48	2.82	86.75
10-15	0.94	1.43	1.95	107.45
15-20	0.80	1.00	1.25	56.25
20-25	0.47	0.56	0.68	44.68
25-30	0.19	0.48	0.59	210.53
30-35	0.14	0.36	0.44	214.29
35-40	0.23	0.32	0.4	73.91
40 and over	0.32	0.30	0.39	21.88

Average land values increased gradually in 0-5 km distance range in all three time periods. It is observed that this increase continued even in further distance neighborhoods (Figures 4-5-6).

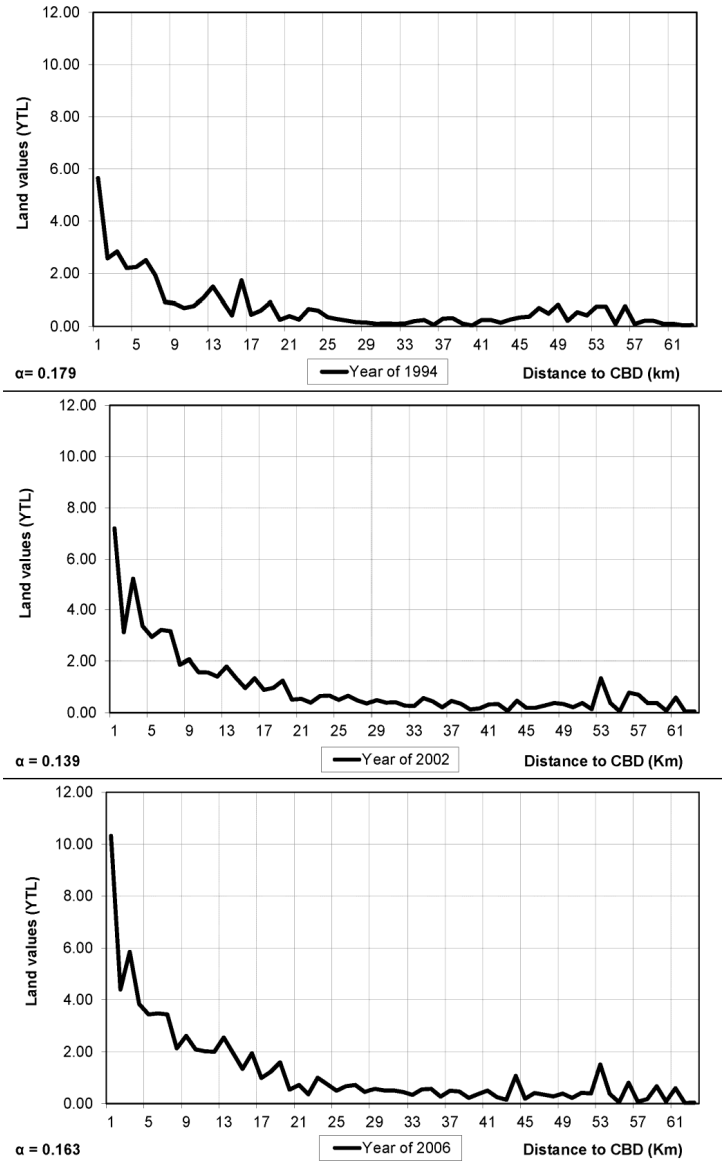

***Figure 4**. Land values vs. distance in Istanbul for the years of 1994, 2002 and 2006 (Terzi,2009)*

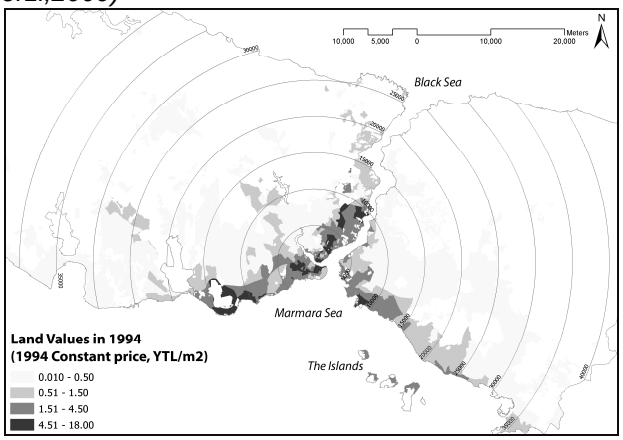

***Figure 5.** Spatial distribution of land values for the years of 1994, 2002 and 2006 (with constant prices of 1994) (Terzi,2009).*

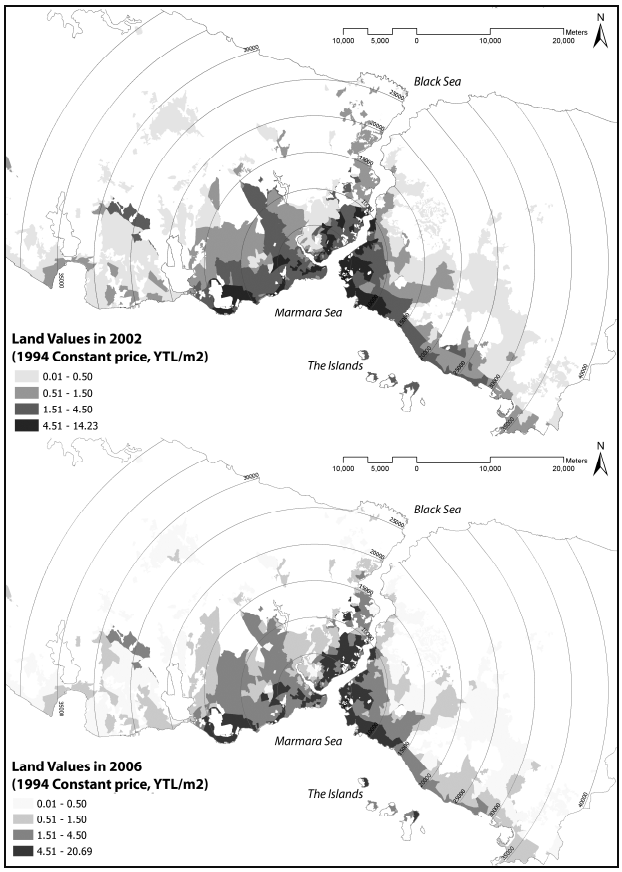

Figure 5. *Continued*

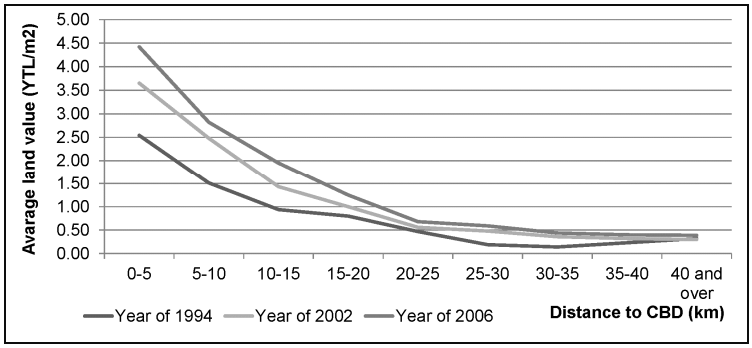

Figure 6. *Distance-dependent change of average land values over time (according to fixed 1994 prices) (Terzi,2009).*

Considering increases in land values change, dramatic increases have been seen especially after 20-25 km (peripheral zone) from 1994 to 2006. The highest increase in land values change occurred in the neighborhoods 25 and 35 km far from the center between 1994 and 2006 (Figure 7).

The reason of land values increase in the neighborhoods at 25 to 35 km far from the center might be explained through the fact that land values in these neighborhoods were low when rural characteristics of these neighborhoods were saved and urbanization pressure was not begin yet; however, with

acceleration of urban growth, density increased in these neighborhoods triggering land value increase.

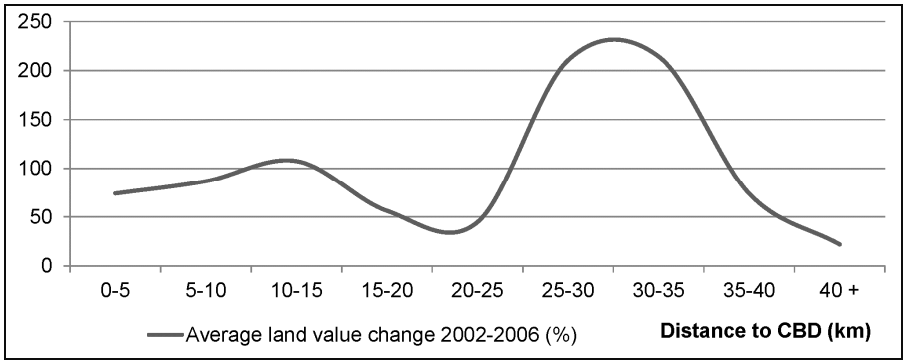

***Figure 7**. The change of average land values between 1994 and 2006 (1994 constant prices) (Terzi,2009).*

Conclusions

This study tries to address how urban structure has changed from the past to the present in Istanbul. The results from gross densities and land values gradient analysis over time can be generalized as the following.

First, Istanbul has spatially been expanded gradually from 1980 to 2005. This urban expansion occurred in a few neighborhoods with low density at the beginning; however, these areas grew with new settlements later. Thus, the low density urban expansion triggers compact development and this continues in the course of time in a cyclic way.

Second, it was observed that average land values decreased as the distance to the center increased in 1994, 2002 and 2006 while land values increased in 5 km distance range in the course of time. The most significant land values change has been observed at the peripheries of the city.

As a result, urban spatial development has been continuing even today in an uncontrolled way. The city has been spreading towards to peripheries and intensifying in the central areas. It is seen that natural resources of the city began to deteriorate along with urban expansion process. And the city began to sprawl through drinking water supplies and forests in the north. This indicates the requirement for certain strategies to be implemented for controlling spatial expansion in planning and for ensuring more sustainable development.

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İstanbul'un mekânsal büyüme eğilimlerinin analizi

Şehirlerin mekânsal biçimlenişinde desantralizasyon-merkezileşme, yoğunlaşma-yayılma, tek merkezli ve çok merkezli gelişme gibi farklı karakteristik özellikler rol oynamaktadır. Mekânsal biçimlenişe etki eden bu gelişmeler İstanbul'da ikili bir süreç içerisinde günümüze kadar devam etmiştir. Bu ikili süreçte, İstanbul, bir yandan gecekondulaşma ile özellikle çeperlerde düşük yoğunluklu olarak yayılmış; diğer taraftan merkez bölgelerine yakın düzenli konut alanlarının devamlı bir yenilenme süreciyle sağlıksız bir biçimde giderek yoğunlaşmıştır.

Bu çalışmanın amacı, mekânsal biçimlenmeye etki eden temel faktörlerden olan arazi değerleri ile yoğunlukların değişiminin analiz edilerek, mekânsal büyüme ile ilişkisinin ortaya konmasıdır. 'Yoğunluk Değer Azalım Eğimi (Density Gradient)' ve 'Arazi Değer Azalım Eğimi (Land Value Gradient)' yöntemi kullanılarak İstanbul'un çekirdek-çeper ilişkisi açısından kentsel yapısal değişimi analiz edilmiştir. İstanbul'un her bir mahallesi için, brüt yoğunluk, arazi değerleri ve kent merkezine olan mesafeler hesaplanarak bir CBS veritabanı oluşturulmuştur. Daha sonra elde edilen yoğunluk ve arazi değerleri için, değer azalım eğimi (density-land value gradient) üç dönem için hesaplanmış ve ArcGIS programı ile görselleştirilmiştir. Genel olarak, standart kentsel modeller, nüfus yoğunluğunun çeperlere doğru gidildikçe mesafe ile ters orantılı olarak azalan bir üstel fonksiyon olarak tahmin etmektedir. Bu çalışmanın sonucunda da, İstanbul'un negatif üstel yoğunluk ve arazi değeri yapısına sahip olduğu görülmüş ve mekânsal biçimlenişin tek merkezli yapıdan çok merkezli yapıya doğru bir değişim gösterdiği görülmüştür. Ayrıca zaman içerisinde çeperlerdeki arazi değerleri değişiminin merkez bölgelerdekinden fazla olması ve yine çeperlerdeki yoğunluk değerlerindeki değişimdeki artış, İstanbul'un geçmişten günümüze doğu olan makroform gelişiminde yayılarak ve yoğunlaşarak geliştiğini göstermektedir.