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The relationship between environmental quality level and housing sale prices in the Istanbul Metropolitan Area

Elif ALKAY
Istanbul Technical University Faculty of Architecture, Istanbul TURKEY

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Abstract
In this study, the relationship between environmental quality level and housing sale prices is examined in the Istanbul Metropolitan Area (IMA). Examination is carried out in two steps. Firstly, the environmental quality index is developed by utilizing principal component analysis. The geographical scope of the index is 32 districts within boundaries of the IMA. The index is achieved related to subjective and objective indicators. It is seen that natural advantages, dissatisfactions based on high density, and some negative externalities resulted from industrial areas have impacts on the environmental quality index levels. Secondly, the relationship between the index levels and housing sale prices is explored. For this reason, correlation coefficient and chi-square goodness-of-fit tests are utilized. Results provide enough evidence that there is a positive and strong linear relationship between the environmental quality and housing sale prices at the district level in the IMA; the index levels and housing sale prices are dependent ranks.

Keywords: *Environmental quality index; housing sale prices; Istanbul*

I. Introduction

Studies focusing on environmental quality go back to the 1960s (Lansing and Marans, 1969). The importance of environmental quality studies is rooted in measuring and comparing the potential of different housing environments. This is why; environmental quality measurements and comparisons among areas attract the attention of not only researches but also residents, workers, business managers, and policymakers (Blomquist et al 2001).

Although it has been widely studied for quite a long time, environmental quality measurement has not yet begun to permeate all practical applications. For instance, the measurement method, geographical scope of the measurement and indicators cannot be generalized. Many researchers have used different methods and indicators to measure the environmental quality and the available evidence has been collected for a disparate range of cities and in a variety of time periods (Kamp et al., 2003). I would expect that introducing new evidence from the Istanbul Metropolitan Area could contribute to this debate.

The literature contains various environmental quality studies. It is remarkable that researchers have been focused on three main topics for examining environmental quality related with housing and its environment. The first topic is examining the relationship between environmental quality of housing areas and users' well-being, the second topic is focusing on housing and its environment via user satisfaction and perception. As a last, the third topic is concerning environmental quality as a factor in housing price structure. Therefore, the related literature is organized according to these three topics.
Relationship between environmental quality of housing areas and users' well-being

Environmental quality of housing areas and users' well-being related studies can be clustered in two sub-groups. In the first subgroup, researchers explore the role of well-being on quality of life indexes. For instance, Royuela et al. (2003) measure the quality of life focusing on individual well-being in small areas. In another study, Bobbitt et al. (2005) discuss the strengths and weaknesses of quality of life indexes, which are based on well-being. Additionally, Turksever and Atalik (2001) identify individual well being as one of the 18 different attributes that define the quality of housing environment. These studies emphasize that well-being is a major variable of quality of life indexes.

The second subgroup examines the relationship between environmental quality of housing areas and well-being. For instance, Marans (2003) demonstrates that the quality of neighborhoods is important to the well being of individuals and families. Likewise, Pacione (2003) assesses the quality of different residential environments and emphasizes that increasing quality in housing environments means increasing well-being of individuals. In another study, Sirgy and Cornwell (2002) evaluate three conceptual models' results and they emphasize that the greater the housing environment satisfaction, the greater the satisfaction and well-being with life in general. Supporting to Sirgy and Cornwell (2002), Kahlmeier et al. (2001) emphasize that an improved health is most strongly associated with an improved satisfaction with environmental housing quality. Galster and Hesser (1981) developed an explanatory model of residential satisfaction which is based on objective characteristics of residents, their dwellings and their neighborhoods. Their findings have supported that objective characteristics of residents, dwellings and surrounding neighborhood have significant, independent correlations with various dimensions of residential satisfaction. Results of all these studies demonstrate that there is a strong and linear relationship between environmental quality of housing areas and well-being of residents.

Relationship between environmental quality of housing areas and user satisfaction and perception

Some of the user satisfaction and perception based studies give remarkable attention to environmental characteristics such as geographical scale and social structure of which increase user satisfaction and perception. For instance, Kellekci and Berkoz (2006) investigate mass housing user satisfaction based on environmental quality of housing areas in Istanbul.

They determine the characteristics of housing environment which increase the level of satisfaction. In a larger geographical scale, Lee and Guest (1983) examine why satisfaction is greater for some metropolitan populations across a sample of 60 standard metropolitan statistical areas. They find out that urban scale is important for user satisfaction with neighborhood quality. Analyzing user satisfaction by perceived neighborhood model, Connerly and Marans (1985) emphasize that social interaction within the neighborhood environment has significant effect on satisfaction. As another example, Greenberg and Crossney (2007) examine the association between the ratings of neighborhood quality and assessment of neighborhood attributes. They find out that perception of neighborhood quality is adjustable across different geographical scales.

On the other side, some of the user satisfaction and perception based studies concern about residential mobility. Fang (2006) examines the interrelationship between residential satisfaction and residential mobility. Greenberg et al. (1994) test the residents' perception on the low environmental quality neighborhoods. They emphasize that resident who moves in the low environmental quality neighborhood from poorer neighborhoods more positively perceive the neighborhood than the others. Hence, they reflect that intra-urban movements drive through higher quality environmental areas. At a larger geographical scale, Rebhun and Raveh (2006) investigate the importance of quality of life in interstate migration rates. Blomquist (1992) addresses the importance of environmental quality for movement decisions within or through the urban area. Additionally, Bender et al. (2000) investigate the environmental preferences of residents focusing on environmental perceptions of them.

Either focusing on environmental characteristics or residential mobility, user satisfaction and perception based studies show that high environmental quality is more decisive on user satisfaction and perception than low environmental quality. Beyond, people always tend to move from relatively poor conditioned environments to wealthy conditioned ones.

Relationship between environmental quality and housing prices

There are various studies investigating the effect of environmental features on housing prices. Almost all of the reviewed studies are explorative and focus on the impact of environmental quality on housing prices. Rosiers et al. (2007) define environmental features as neighborhood attributes and seek these attributes effect on housing prices. They find that all neighborhood and landscaping attributes are significant and they have positive effects on housing prices. Undertaking an analysis of inequality in the spatial distribution of accessibility and environmental quality in the Paris metropolitan region, Palma et al. (2007) recognize that local amenities are generally capitalized into the housing market. Chau et al. (2006) seek residents' environmental perception and evaluate the importance of different environmental attributes associated with housing prices. With their similar studies Cobb (1984) tries to explain varying rent rates in housing areas according to large numbers of housing area-related characteristics. Furthermore, Potepan (1994) shows housing sales prices depend on the neighborhood amenities associated with the residential area and urban migration proceeds toward amenity rich areas despite the higher housing costs there. Rogerson (1999) explores in a more general panorama and investigates how environmental quality level influences patterns of urban growth by attracting new capital and becoming a part of promotional tool to different global capital.

It is clear that characteristics that increase environmental quality are simultaneously significant ones which have positive impact on either housing price or rent. This study is explorative and it focuses on relationship between environmental quality levels and housing prices rather than determine the price effect of environmental quality on housing prices.

In this study, environmental quality is measured on the basis of housing and environmental characteristics, and then, it is searched if there is any relation between environmental quality levels and housing prices are in coincidence. Geographical scale of the study covers 32 administrative municipalities (districts) of the IMA. The scope of the index is environmental quality levels for housing areas. Both objective and subjective indicators of index are based on a panel data. Housing sale prices are for individual households rather than urban aggregates. Hence, this paper examines the environmental quality levels for housing areas that base on objective and subjective indicators; it ranks the environmental quality levels for housing areas with respect to geographical level; it tests the relationship between the environmental quality levels and housing sale prices.

II. Research Methodology

The research methodology is included in two steps. In the first step, it is explained how the environmental quality index is measured. In the second step, it is depicted how the relationship between the index levels and housing sale prices is examined.

The First Step: Environmental quality index

This study focuses on the Istanbul Metropolitan Area (IMA) which is one of the Turkey's most developed metropolitan areas, located in the north-west of the country. It is divided by the Bosphorus Straits into two geographical parts. The IMA bridges two parts -continents- one arm reaching out to Asia the other to Europe. There are 32 districts (administrative municipalities) located on these two parts and therefore within boundary of the IMA.

The coverage of the research is consistent with Eurostat's Nomenclature of Territorial Units for Statistics (NUTS). The research covers Istanbul NUTS 1 region in which 32 districts are located (although districts are not included in NUTS classification, they are the smallest statistical units that the data can be gathered).

The main data source of this step is obtained from a panel data. The panel data is from the household survey which is held by Istanbul Greater Municipality in 2005. The survey is done by using the "multiple stratified random sampling" method. Districts were geographic units that defined the first stratum of the study. The second stratum was based on socio-economic profile of the residents. Therefore, it is representative of socio-economic segments of geographical units; and the sample size is 3862 households.

The survey gives detail in six main topics (1) the socio-demographic structure of households such as age, family size, stage in life cycle (2) the socio-economic structure of households such as income, working people, car ownership (3) the characteristics of dwelling units such as room number, size of the house, bathroom number (4) the intentions to move into another housing area (5) the satisfaction from housing environment such as sufficient public places, green areas, high accessibility to public transportation, and (6) the observed problems related to housing environments such as noise, crime, safety. With these details, survey provides opportunities to design both objective (socio-demographic, socio-economic, and dwelling characteristics) and subjective (perceived and evaluated conditions such as moving intentions, satisfaction and dissatisfaction conditions) indicators in order to develop an environmental quality index.

Considering general conceptual and methodological issues such as the geographical scale of the index, the scope of the index, the identification of indicators, and peculiarity of indicators is essential for developing an index (Pacione, 2003, Bobbitt et al., 2005). Additionally, an index should be reliable, valid and sensitive. It would provide opportunities to separate into components. Moreover, the purpose of the index must be clear to help public policymakers and professionals (Bobbitt et al., 2005). Corresponding with these issues, the Principal Component Analysis (PCA) is utilized as an objective technique to construct the environmental quality index (hereafter, EQI) in this study. PCA is a technique that uses the covariance between a set of variables to create a new set of variables each of which is a linear combination of the original variables yet is uncorrelated with the other, newly created variables. This technique is adopted because it lends itself to abolishing the dependent structure between variables, to separately showing the dimensions that affect changeability in a data set, to numerical determining differences in the environmental quality levels of districts by weighting and determining the independent dimensions of quality. Additionally, it provides opportunity to separate into components.

The Second Step: The relationship between the environmental quality and housing sale prices

For this step, the data is collected from real estate agencies in between 2005-2007. It contains 1155 housing sale prices in 32 districts.

To explore the relationship between the environmental quality and housing sale prices, both correlation coefficient and chi-square goodness-of-fit tests are utilized. The existence and strength of relationship between the environmental quality and housing sale prices, and the direction of this relationship is put forth by correlation coefficient test. Then, by utilizing chi-square test for independence, it is evaluated whether there are statistically significant differences between proportions of the environmental quality and housing sale prices.

III. Constructing the Environmental Quality Index

As emphasized in the second section, the geographical scale of this study is 32 administrative municipalities (districts) of the Istanbul Metropolitan Area (IMA). The environmental quality level defines the scope of the index. Indicators are based on IMA specific panel data set and represent both objective and subjective characteristics that describe the housing environments.

In this study, 28 indicators are designed to construct the environmental quality index. These indicators are classified under six main groups (1) the social indicators, (2) the economic indicators, (3) the accessibility indicators, (4) the perceived problems of the housing environment, (5) the satisfaction from the housing environment, and (6) the dwelling characteristics. The social indicators describe the family size, education level as well as population increase and crime rate of the housing area. The economic indicators give general prosperity of the housing area not only by working people number, income, and car ownership but also land sales prices. Distance to school, and distance to both working and shopping areas are indicators of the accessibility. The perceived problems of the housing environment are included in insufficient technical infrastructure, insufficient green areas, noise, pollution, traffic congestion, crowded, safety, insufficient car park and insufficient public transportation. The satisfaction indicators of the housing environment are designed as satisfaction from municipality services and public facilities such as school quality, cultural facilities, and health facilities. Floor area and number of room represent the two dwelling related indicators.

Although both the data and the constructed index are specific for the IMA, indicators have some similarities with some of the related literature. Liu (1975), Bender et al. (1997), Bender et al. (1999), Evcil and Atalık (2001), Sirgy and Cornwell (2002), Kahlmeier et al. (2001), Chin and Fong (2006), Kellekci and Berköz (2006), Rosiers et al. (2007), Palma et al. (2007), are some researchers who included similar indicators in their neighborhood environmental quality measurement studies or user satisfaction determination studies either in housing or in office areas. General indicators that reflect host city characteristics such as climate, sunny day number, topography and so on are not included in the EQI in this study. All the indicators can be followed from Table 1.

Before applying the principal components analysis (PCA), all these indicators, which have different units of measurement and size, are standardized. In the statistical analysis, standardized 32 x 28 (32 districts and 28 indicators) data matrix is used.

Upon inspection of the analysis, it is seen that the variances in 6 out of 28 principal components are greater than “1”. This means that 6 principal components with a variance greater than “1” are sufficient to determine the basic dimensions of the data and contain an important amount of information. For instance, the 6 components explain 84.24% of the total variance. It is remarkable that the first component explains an overwhelming proportion (35%) of the variation of the 28 original indicators while all components loadings (weights with which original variables enter the factor) are positive. The second component is the combination of original measures that explains the largest amount of the remaining variance (that left unexplained by the first component), and so on. Each of these components is linearly independent of the other components, which allows different dimensions of the data to be observed.

__Table 1.__ Housing unit characteritics and housing environment indicators

	Codes	Definition	Mean	St. D.
Social Indicators	**fmlysz**	Household size (persons per family)	3,639	0,417
	education	Education level (total years in education)	4,244	0,544
	popinc	Population increase per year (%)	29,703	31,689
	crimerate	Crime rate (%)	29,824	24,370
Economic Indicators	**wrkngppl**	Working people in the family (number of working people in each family)	0,313	0,046
	income	Income level of household (in TL)	1064,241	290,542
	carwnrshp	Car ownership (number of cars owned by each family)	1,442	0,189
	lndvl	Land sales price (in TL; logarithmic)	167,156	5,226
Accessibility Indicators	**wrk_schl**	Average travel time to work / school (minutes)	24,895	4,681
	shppng	Average travel time to shopping areas (minutes)	18,232	6,200
Perceived problems of housing environment*	**p_istrctr**	Insufficient infrastructure*	2,172	0,257
	p_green	Insufficient green area*	2,032	0,401
	p_noise	Noise*	1,988	0,362
	p_pollution	Pollution*	2,236	0,373
	p_safety	Safety*	1,801	0,315
	p_traffic	Traffic*	2,031	0,417
	p_carpark	Insufficient car park*	2,043	0,374
	p_crowded	Crowded*	2,183	0,347
	p_transp	Insufficient public transportation*	3,409	0,920
Satisfaction from housing environment**	**s_mncplty**	Satisfaction from municipality services**	4,274	0,601
	s_accessiblity	Satisfaction from accessibility to work / school**	4,515	0,528
	s_school	Satisfaction from school quality**	4,356	0,715
	s_health	Satisfaction from health facilities**	4,098	0,584
	s_cultural	Satisfaction from cultural facilities**	3,292	0,727
	s_green	Satisfaction from green areas**	3,346	0,834
	s_safety	Satisfaction from safety**	3,120	0,857
Dwelling characteristics	**floorarea**	Floor area (m^2)	95,468	8,484
	roomno	Number of room	3,317	0,316

* *Measured by Likert Scale. 1: a big problem, 2: no idea, 3: a problem, 4: not a problem*
** *Measured by Likert Scale. 1: completely dissatisfied, 7: completely satisfied*

The principal components are evaluated with their high explanation rates. Generally, the set of indicators has only one major dimension that explains most of the variance and the rest of the components are less important for the analysis. This major dimension is called as *casual factor* and reflects the major part of the relation among the indicators. According to explanation power, analysis result recommends the first principal component as causal factor of the EQI in this study.

Analysis result indicates that the weights of dwelling indictors and satisfaction from housing environment indicators are positive while the economic, social and accessibility indicators are negative for the casual factor which explains the environmental quality at the district level in the IMA (see Table 2.). Eventually, it can be said that the increasing environmental quality levels depend on the increasing quality of dwelling characteristics and satisfaction from the housing environment.

Table 2. *Component score coefficient matrix*

	Components					
	1	**2**	**3**	**4**	**5**	**6**
lndvl	-0,0716	0,0966	-0,0398	0,0761	0,1314	0,2142
fmlysz	-0,0553	-0,1215	0,1325	0,0657	0,0647	0,0296
education	-0,0103	0,2038	-0,0045	-0,0695	-0,1707	-0,1263
wrkngppl	-0,0486	0,1442	0,0145	0,0111	-0,0011	-0,0997
income	-0,0036	0,1823	0,0937	-0,1286	0,0200	-0,0902
carwnrshp	0,0201	0,0544	0,1390	-0,1900	0,1463	-0,0473
floorarea	0,0270	-0,0351	0,2348	0,0069	-0,1721	0,0472
roomno	0,0448	-0,0406	0,1912	-0,0577	-0,1307	0,1110
wrk-schl	-0,0055	0,0925	0,1545	-0,0490	0,0314	-0,2545
shppng	-0,0126	0,0347	0,0039	-0,2290	0,1680	0,4595
p_transp	0,0370	0,1253	0,0620	0,0833	0,3193	0,1571
p_infrastructure	0,0130	0,0298	0,0812	0,2751	-0,0764	-0,2939
p_green	0,0912	0,0335	0,0340	-0,0719	-0,0252	-0,1613
p_noise	0,0892	-0,0203	0,0175	-0,0899	0,0278	-0,2370
p_pollution	0,0870	-0,0118	-0,0073	-0,0847	0,0229	-0,2057
p_safety	0,0912	0,0074	-0,0568	-0,0126	-0,1311	0,0138
p_traffic	0,0770	-0,1021	-0,0403	-0,0376	0,1925	-0,1178
p_carpark	0,0755	-0,0814	-0,0838	-0,0327	0,0501	0,1101
p_crowded	0,0819	-0,0836	-0,0581	-0,0214	0,0820	-0,1137
s_mncplty	0,0445	0,0771	0,0246	0,2219	0,1397	0,1389
s_accessibility	0,0607	-0,0066	0,0975	0,0757	0,3510	0,0087
s_school	0,0796	0,0432	-0,0143	0,1340	0,0807	0,1351
s_health	0,0556	0,0919	0,0042	0,1476	-0,0079	-0,0321
s_cultural	0,0630	0,1042	-0,0600	0,0221	-0,2592	0,2579
s_green	0,0796	0,0952	-0,0538	0,0258	-0,1322	0,1405
s_safety	0,0842	0,0143	-0,0769	-0,0095	-0,1238	0,1874
popinc	-0,0030	-0,1265	0,1588	0,0827	-0,1917	0,2146
crimerate	-0,0489	-0,0042	-0,1959	0,0143	0,0430	-0,2440

After getting the components, to obtain the EQI at the district level, the indicator weights in the first principal component (in this study, it is accepted as the causal factor) are transposed and multiplied with the standardized (32 x 28) data matrix. The obtained values are EQI levels at the district level in the IMA. It is obvious that the results are influenced not only by indicators but also by the method. Figure 1 reflects the ranked EQI levels for 32 districts within the IMA.

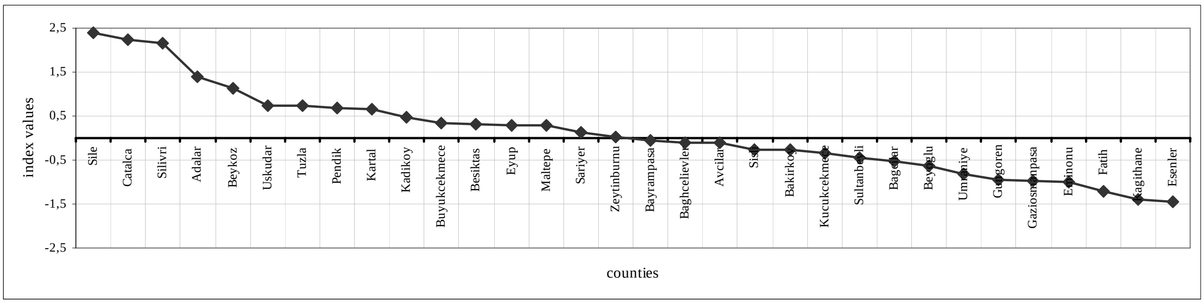

Figure 1. *The EQI levels' rank at the district level*

The EQI levels recommend the three obvious groups across the IMA. In 5 out of 32 districts, the EQI levels are above 1, and at the extreme side 16 out of them have index values below 0. Additionally, in 11 out of 32 districts, the EQI levels are between 0-1 intervals.

In the first group, results show that 3 out of 5 districts' EQI levels are above 2. These districts are respectively Sile, Catalca, and Silivri all of which are located in the outskirts of the metropolitan area (see figure 2). Both Sile and Catalca offer natural advantages with regard to the forest and coastal areas. Similarly, Silivri has the long and attractive coastal areas. Although their accessibility is limited when compare to the other districts, the natural advantages and low density levels may impact on the EQI levels. The other two districts are Adalar and Beykoz. Their EQI levels are between 1and 2. Likewise, these two districts take the advantage of the natural opportunities as well. The forest, the long coastal areas, the low density level, and no motor traffic may increase Adalar's competition level. As adjoining to Sile, Beykoz is located along to the coast and forest area and its natural potentials may effect to the index level as well.

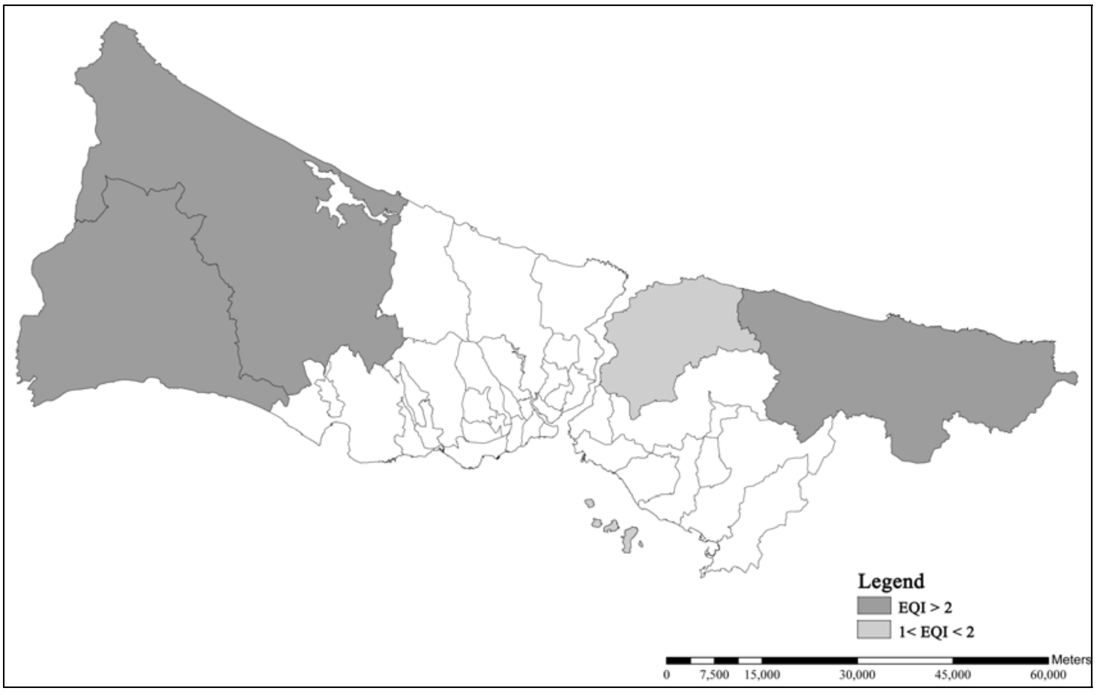

Figure 2. *The highest EQI level districts (EQI>1)*

The districts having EQI levels between 0-1 are located either in the central areas or they are neighbor of central areas. It can be followed from Figure 3 that most of them locate in the Asian part of the IMA. The Asian part is not as densely populated as the European side, its recreational potential is higher than the European side and perceived environmental problems in housing areas are lower than the European part. It is clear that all these characteristics may affect the obtaining index result (Figure 3.).

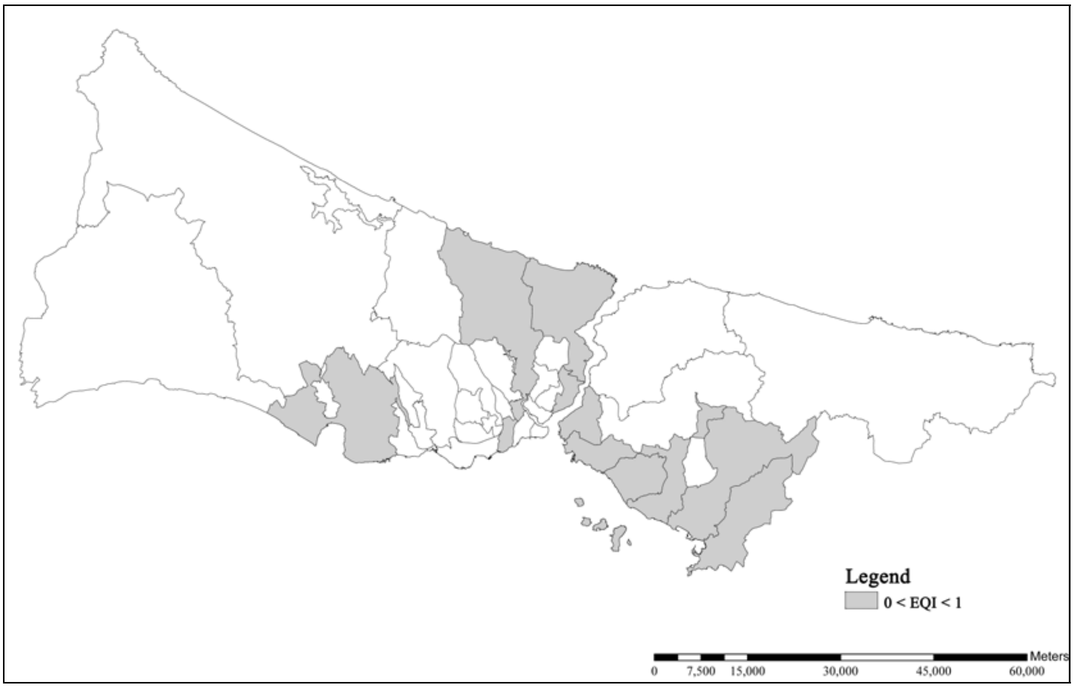

Figure 3. *The medium EQI level districts (0< EQI <1)*

Recall that, 16 districts ' EQI levels are below zero. Most of these districts are located in the central areas. Except two of them, they are located in the European side. Some of them are old housing areas of the IMA, and industrial area ratio is higher in these districts than that the others. In connection with industrial areas, there are huge unplanned housing areas (or squatter areas) within boundaries of these districts. Both the high density industry areas and unplanned housing areas may affect the EQI levels turning them to the negative. Figure 4 shows the spatial distribution of these districts.

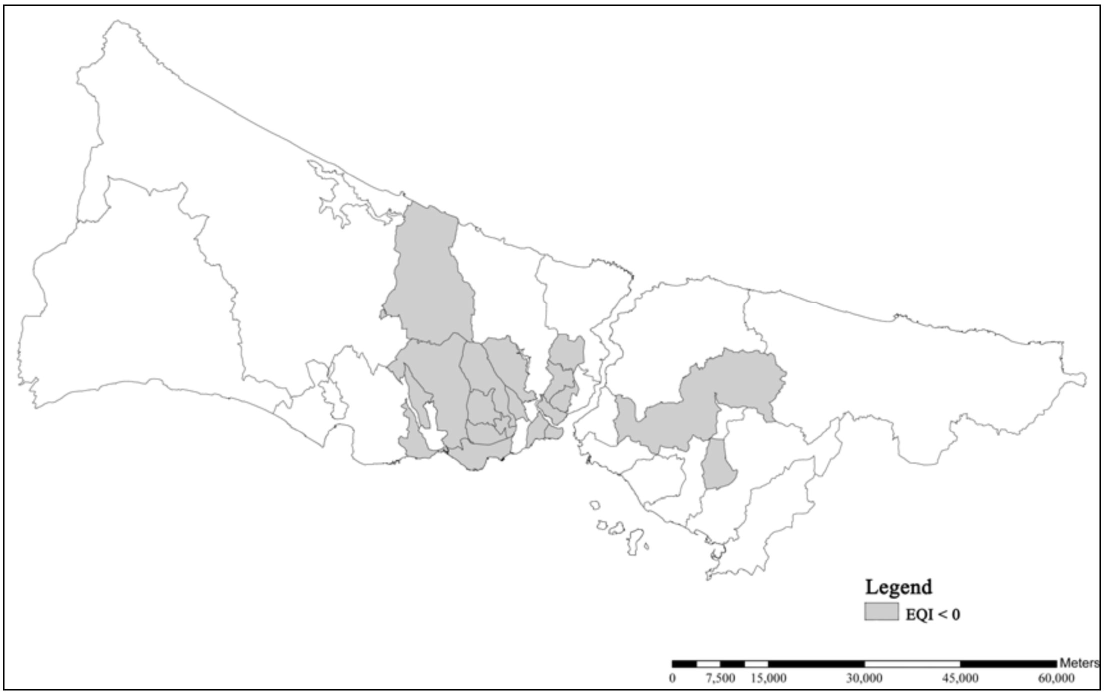

Figure 4. *The lowest EQI level districts (EQI <0)*

Literally, results demonstrate that the EQI levels at the district level have been highly affected by general spatial structure of the IMA. It is obvious that natural advantages, dissatisfactions based on high density and some negative externalities resulted from industrial areas have impact on the judgments of residents about their housing environments.

IV. The relationship between the environmental quality and housing sale prices

The section 3 describes how to construct the EQI at the district level. In this section, the relationship between the EQI levels and housing sale prices are examined.

As a method, the correlation coefficient and chi-square goodness-of-fit tests are utilized respectively. Housing sale prices in statistical tests reflect the average housing sale prices in the each districts.

Before applying those two statistical analyses, at first, it is explored whether a coincidence exists between the EQI levels and housing sale prices. It can be easily followed from Figure 5 that although some of the districts are ranked in the high EQI levels, their average housing sale prices are not high enough to consistent with their rank or vice versa. For instance, even Silivri is the 3rd rank district in the EQI levels; its average housing sale prices is quite low when it is compared with the other high EQI levels districts. On the contrary, even Beyoglu has the negative EQI levels, its average housing sale prices are ranked as the forth.

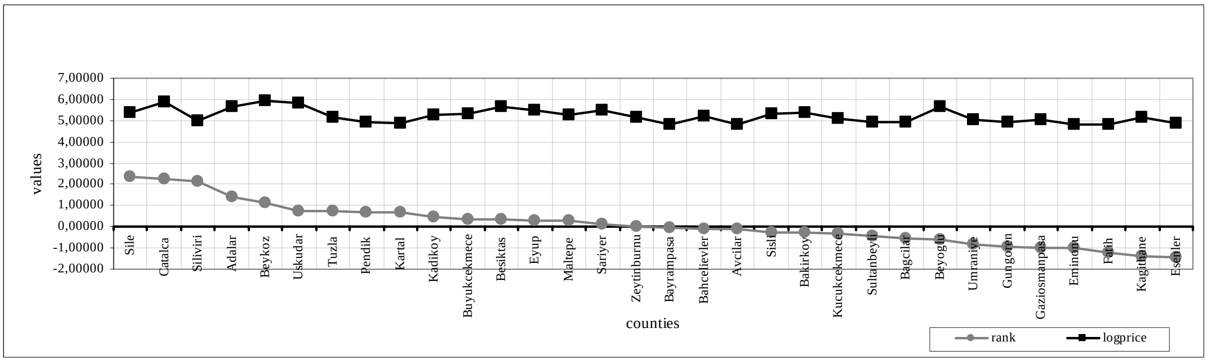

Figure 5. *Comparision of the EQI level rank to the housing sale prices*

All the figures (see Figure 6, 7 and 8) are statistical graphs that generated by using GeoDa. Those dynamically linked maps and scatter plots explore how the EQI levels and housing sale prices at the district level corresponds to each other. All maps show the housing sale prices of the districts and they are drawn according to standard deviation from mean. Scatter plots, which are illustrated on the right hand pane of the figures, are computed with the first specified variable (housing sale prices) on the vertical axis and the second variable (EQI) on the horizontal axis. The scatter plot can be shown for standardized values, such that the slope of the regression line corresponds to the bivariate correlation coefficient. Therefore, it is straightforward to identify locations where above mean (or below mean) values on both variables coincide, or, alternatively, locations where above mean (or below mean) values in one variable coincide with below mean values for the other. Since all the maps and the scatter plots are linked, the colored areas in the maps are counterparts of the dark points in the scatter plots.

In figure 6, the consistency between the high EQI levels and the high housing sale prices are explored. It is remarkable that the three districts, namely Catalca, Adalar and Beykoz, that have the highest housing sale prices are also have the highest EQI levels. Therefore, for those three districts above mean values on both variables coincide. However, Sile, which has the medium housing sale prices, and Silivri, which has the low housing sale prices, is included in the highest EQI levels class. Eventually, those two above mean districts coincide with below mean values for the housing sale prices.

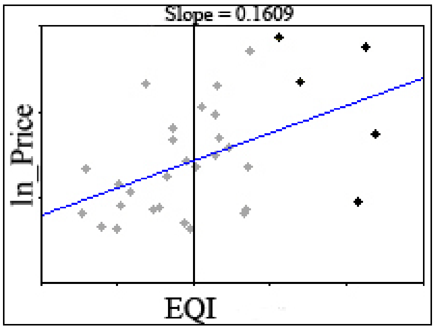

__Figure 6.__ The high EQI level districts vs the high housing sales price districts

Figure 7 explores the consistency between the medium EQI levels and the medium housing sale prices. It is noticed that most of the medium ranked districts according to the EQI levels, also have the medium housing sale prices which means that average mean values on both variables coincide. The extreme district is Uskudar. Although it includes in the medium EQI levels class, it is in the 3rd rank in the housing sale prices. On the other side, however Kartal and Pendik representatives of the low housing sale prices class, they are included in the medium ranked districts by EQI levels. In that group, the values of Uskudar, Kartal and Pendik do not coincide with values for the other.

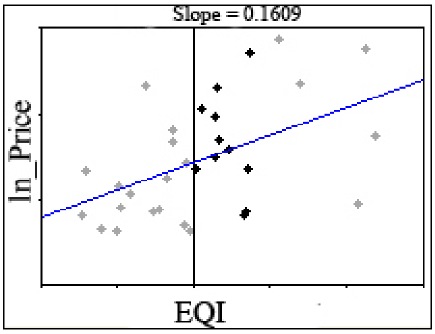

__Figure 7.__ The medium EQI level districts vs the medium housing sales prices districts

At last, Figure 8 demonstrates the low ranked district with respect to the EQI *levels and their housing sale prices. It is clear that most of the district that* have the low housing sale prices are also included in the low EQI levels class. There are three exceptions in this class. Beyoglu, Bakırkoy and Avcılar are representatives of the high and the medium housing sale price classes, respectively. However, they belong to the low ranked districts class according to the EQI. For those three districts, above mean values in housing sale prices do not coincide with below mean values for the EQI.

Figure 8. *The low EQI level districts vs the low housing sales prices districts*

Eventually, despite the some exceptions, the consistency is remarkable between the EQI levels and housing sale prices at the district level in the IMA. All three scatter plots provide evidences of their positive and linear relationship (slope=0,1609). However, this analysis is explorative. To test the strength of linear relationship between the housing sale prices and EQI levels, correlation coefficient test is done.

The correlation coefficient test proves that there is a strong and positive relationship between the EQI levels and housing sale prices (*Pearson correlation coefficient is 0,569. It is significant at the 0,01 level (2-tailed)*). This means, the increasing EQI levels imply the increasing housing sale prices or vice versa.

Although the correlation coefficient verifies the linear and strong positive relationship between two ranks, it does not reflect the dependency between them. To test whether the dependency exists between the EQI levels and housing sale price, chi-square goodness-of-fit test is utilized. The null hypothesis is that: "*these two ranks are independent* and it is tested against to *these two groups are dependent*".

Test results prove that these two ranks are dependent to each other (*chi-square = 20,399, sig.=0,009*) so that any change in EQI level means the change in the same direction in housing sale prices. Furthermore, contingency coefficient value is close to 1 which supports the high dependency level between these two ranks.

Results of section 4 can be sequenced as (1) there is a positive and strong linear relationship between the EQI levels and housing sale prices at the district level in IMA (2) the EQI levels and the average housing sale prices are dependent ranks.

V. Conclusions

In this study, the relationship between the environmental quality levels and housing sale prices is examined in the IMA.

Examination is carried out in two steps. In the first step, the EQI is developed by utilizing the principal component analysis. In the second step, relationship between the EQI and housing sale prices of districts are explored. For this reason, correlation coefficient and chi-square goodness-of-fit tests are utilized. Results provide enough evidence that there is a positive and strong linear relationship between the EQI and housing sale prices at the district level in IMA, and also the EQI and housing sale prices are dependent ranks.

The results of this study have importance in many ways. Results could enhance understanding of residents' environmental perception and evaluation of the different environmental attributes associated with their housing environment. They could be taken by both public and private decision makers including planners. Results allow them to gain an overview of the EQI at the district level. Also, results could show how environmental quality of housing areas can be a part of competition in a metropolitan area because the higher the EQI levels in a district; the higher are housing sale prices in this district.

The most important limitation of the study is lacking of time series data. Analysis is based on panel data which restricts the opportunities for allowing periodic monitoring and control. However, to develop the EQI according to stratifies such as family size, stage in life cycle; length of residence can be subject of further studies.

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