ITU A|Z
VOL: 1, NO: 2, 12-25, 2004-2

Modeling of land use - transportation interaction in Istanbul

Azime TEZER KEMER
Istanbul Technical University, Faculty of Architecture Istanbul TURKEY

Abstract:
This study assesses the interaction between urban land-use and transportation in Istanbul. The 1st and the 2nd Bosphorus Bridges which have important role on the physical urban development form, are evaluated to make some estimations of long-run effects on urban land-use and transportation interaction for future bridge proposals.

Due to the accelerated urban growth and the dispersion experienced in the 1950's together with the fact that the main Urban Transportation Planning (UTP) studies on the Bosphorus crossings took place after the 1950's, the data gathered for modeling of long-run impacts start with the year 1955 in the border of the Municipality of Greater Istanbul (MGI) from Pendik to K.Cekmece Counties. The basic view of emphasizing on the evaluation of the UTP process in Istanbul is to determine the impacts of transportation applications whether implemented or not by taking into account the land-use development.

Furthermore, this study aims to evaluate UTP and Urban Transportation Modeling (UTM) processes for Istanbul by giving importance to the long-run impacts of the Bosphorus crossings and connecting highways on physical dispersion of land-uses, and after models the impacts according to the existed interactions between land-use and transportation to estimate future impacts of possible Bosphorus crossings.

Keywords: *Land-use, transportation, urban development, land-use modeling, Istanbul*

Introduction

One of the very important problem of Turkey is migration from rural settlements to urban areas. This uncontrolled, unplanned and continuous development has been creating a heterogeneous and scattered structure which has been influencing on the urban space and life dramatically. Likewise in many developing countries, rapid population growth and movement has been concentrating in metropolitan areas. Controversial or unknown land ownership and treasury land have been occupied by migrants in big cities of Turkey since 1950's gradually.

As being the most populated city of Turkey, Istanbul has been experiencing a dramatic growth in population at the rate of about %5 annually since

1950's. The last two population census indicated that the increase rate has been decreasing to around %3 annually (SIS, Population Census Results). This very high amount of population growth causes rapid change and dispersion on the urban structure. Because of this uncontrolled development of population and urban dispersion, there is a high demand to transportation infrastructure same as for other urban services. However, Istanbul's geographical characteristics and historical urban texture do not allow very easy solutions on transportation proposals. The underground system has been used on limited infrastructure network for recent years belatedly. The construction of underground system started at the beginning of 1990's.

The first Transportation Master Plan was prepared for MGI in 1987 by a transportation consultant company with strategic transportation projects for the year 2005 (Metroplan, 1990). Istanbul Technical University (ITU), Transportation and Transport Vehicles Research Center has undertook a study for MGI to revise and update this plan by recalibrating the strategic transport model with the actual data collected in 1995. This model was used to identify the major transportation projects and infrastructure improvements to accommodate the predicted travel demand that will occur as a result of the land use allocations in the new Master Plan produced by local government Master Plan Bureau for the year 2010 (MGI, 1995).

Today Istanbul accommodates 24% of the total private cars in Turkey, the current daily readership by motor vehicles is about 7.3 million (Gercek, Demir, 1996). Although car ownership and daily trips per capita are lower than developed countries, the transportation system both roadway and transit has been unable to keep pace with rapid growth and change in the urban structure. Therefore, the citizens of Istanbul have to spend longer time in commuting on congested roads.

In this study, the investigation of the impact of transportation network structure on the location of new urban development has been handled for both planned and unplanned urban areas of Istanbul. The network characteristics of public transportation will be used to estimate the impacts on land development by utilizing SPSS (Statistical Package for Social Sciences) computer program.

Relations between urban development dynamics and transportation system in Istanbul

Istanbul's urban development dynamics have been handled in five periods between the years 1955-1993 in the earlier study (Tezer, 1997). This research has included the last two periods of 1997 and 2002 for built-up area development and population increase. The graphics which show the built-up area development of Istanbul were formed by using the present day maps of 1955, 1965 and 1975 and aero-photographs of these years (Tezer, Gülersoy, 1996). Others periods of 1986,1993, 1997 and 2002 were formed by using satellite images. The borders of built-up areas on existing maps, aero-photographs and satellite images were digitized then measured on computer for 19 counties of the MGI (see Figure 1 and Table 1). County borders were assumed as it was in 1985's administrative borders of MGI. As a consequence of this, Bahcelievler, Bagcilar, Esenler and Gungoren were assumed as in the border of Bakirkoy; Avcilar in KCekmece and Maltepe in Kartal county border. Adalar county were excluded from evaluations as having no direct connection with Bosphorus' bridge crossings and connecting highways.

The growth of built-up area development after 1980's is very outstanding and parallel with population growth (see Table 2). When the population growth and the built-up area development of districts are compared, the growth on both is generally on the outer districts where squatter developments are very widespread. In the 1/50000 scaled Master Plan Report is stated that 55% of the settled areas has squatter character and together with the value of irregular settled areas in 1990, it was 75% of all residential development in Istanbul (MGI, 1995).

The unplanned and illegal construction is dominated in Eyup, Bayrampasa, Kagithane, Gaziosmanpasa, Avcilar and Esenler counties of the European side of Istanbul. On the other side of the city-Asian side, Beykoz, Maltepe, Umraniye and Kartal counties occupy more than 50% of residential areas as irregular or squatter development (MGI, 1995). Because of increased accessibility, the districts having border with E-5 Highway and TEM (Trans European Motorway), have been facing this development considerably higher than other counties. Sultanbeyli County which is out of the border of this research, has started to grow very rapidly during the construction of TEM in 1980's (Bolen et.al, 1996).

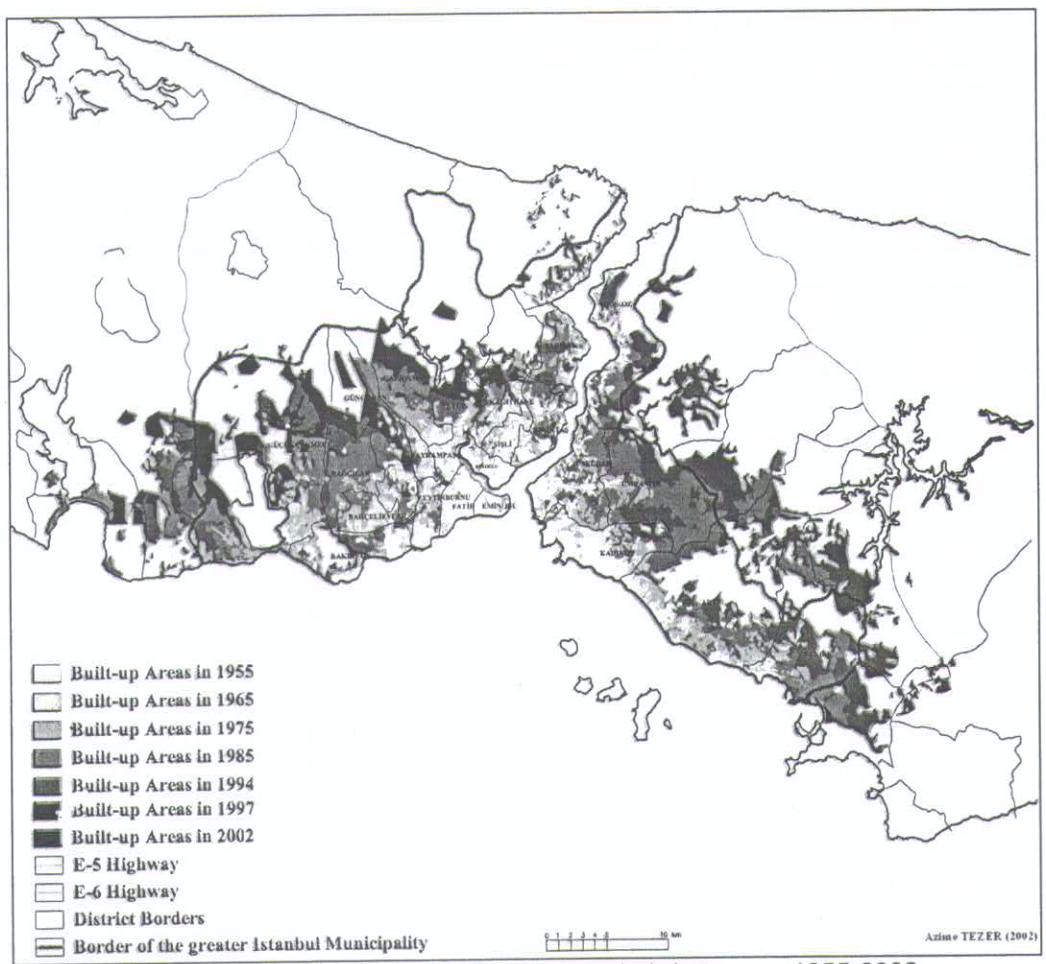

Figure 1: *Built-up area developments in Istanbul between 1955-2002 (Reproduced from Tezer, 1997).*

Figure 1. indicates sharply that, the drastic built-up area development occurred after mid 1980's not only east-west direction but also north-south direction in Istanbul. Unfortunately, the water basins and the natural communities of Istanbul have been encountering pollution and degradation or even possibility of their disappearance with uncontrolled and unplanned development. Although population increase rate is not higher in the last two census as it was during mid 1980's and 1970's; the spatial dispersion is more dramatic in the last two decades. Populist approaches and encouragement for illegal developments have been creating not completely-used building stock in the out skirts of the city since mid 1980's as a result of insufficient housing supply by public sector. Limited public enterprises of mass housing developments have been far from to keep pace with housing demand in Istanbul. They aim to have better public facilities and high living standards but on the other hand, only middle-high and high income group of households can afford the cost of these residences. The housing deficit which is covered by informal housing sector have been continuing for middle and low income group of households. Mass housing development areas have been hanged to main routes E-5 and TEM by connecting roads. Private enterprises on the other hand, developed new residences in a small scale but high standardized and luxury buildings around central districts for high and middle-high income groups of households during 1990's (Ergun, 1995).

Table 1: *Built-up Area Growths in Hectares Between 1955-2002 in Istanbul**

BUILT-UP AREA GROWTHS (HA)

	COUNTIES**	Total County Area (Ha)***	1955	1965	1975	1986	1994	1997	2002
1	BAKIRKOY	11639	640	1569	2705	7003	7090	8489	8920
2	BAYRAMPASA	673	29	454	517	736	751	778	781
3	BESIKTAS	1783	219	274	534	936	936	936	936
4	BEYKOZ	5873	281	430	495	1030	2077	2244	2244
5	BEYOGLU	845	520	623	809	849	849	849	849
6	EMINONU	491	334	349	381	376	376	376	376
7	EYUP	2259	280	583	721	1043	1487	2038	2378
8	FATIH	1095	951	1005	1050	1077	1197	1197	1197
9	G.OSMANPAS	4012	146	328	670	1600	1652	2075	2232
10	KADIKOY	3558	930	1552	2018	2928	2961	2961	3041
11	KAGITHANE	1491	58	335	813	1082	1345	1412	1575
12	KARTAL	9501	341	837	1792	3659	4549	4557	4557
13	K.CEKMECE	15000	51	389	986	3864	4167	4339	4339
14	PENDIK	5508	65	89	538	1758	2935	2935	2935
15	SARIYER	5266	338	391	428	1675	2061	2285	2522
16	SISLI	953	299	633	723	789	789	789	789
17	UMRANIYE	5634	47	51	369	3465	4860	4860	4875
18	USKUDAR	3867	524	743	1046	2833	2962	2962	2972
19	ZEYTINBURNU	1117	243	317	459	905	969	969	1007
	TOTAL	**80565**	**6296**	**10952**	**17054**	**37608**	**44013**	**47051**	**48525**

*(Resource: Reproduced from (Tezer, 1997), pp. 96).

** According to administrative division before 1990 (Bakirkoy consists of Bagcilar, Bahcelievler, Esenler and Gungoren; Kartal consists of Maltepe; and K.Cekmece consists of Avcilar Counties in total numbers of population).

*** Values measured on the computer from digitized maps.

Table 2: *(SIS, Census of Population)*

	COUNTIES*	1955	1965	1975	1985	1990	1997	2000
	BAKIRKOY	89702	82142	202942	123620	132827	177145	190686
2	BAYRAMPASA	4932	69064	157367	181218	212570	240427	246646
3	BESIKTAS	84698	107442	174931	204911	192210	202783	191776
4	BEYKOZ	36859	51689	76804	118697	142075	165028	178438
5	BEYOGLU	208158	218985	230532	245999	229000	231826	234964
6	EMINONU	146896	137849	122885	93383	83444	65246	55548
7	EYUP	52132	78095	95486	369887	200045	237210	233732
8	FATIH	286733	344602	504127	497459	462464	432590	407991
9	G.OSMANPASA	12604	69599	97118	279127	354186	573466	667809
10	KADIKOY	102865	164289	354957	577863	648282	699379	661953
11	KAGITHANE	3084	56157	164448	206707	269042	317238	345574
12	KARTAL	7442	20139	53073	557664	506477	646615	693181
13	K.CEKMECE	4573	22835	58709	210812	469431	674425	823248
14	PENDIK	8673	19216	38384	128606	289380	334451	378268
15	SARIYER	35446	46729	79329	138416	160075	214377	220171
16	SISLI	12811	208128	270577	526526	250478	257049	271003
17	UMRANIYE	1781	14800	38730	128666	242091	394132	446219
18	USKUDAR	88087	115336	202957	467212	395623	472124	496402
19	ZEYTINBURNU	17585	102874	123548	147849	165679	228786	244062
	TOTAL	**120488**	**192997**	**304690**	**631720**	**660082**	**874578**	**870384**

* According to administrative division before 1990 (Bakirkoy consists of Bagcilar, Bahcelievler, Esenler and Gungoren; Kartal consists of Maltepe, K.Cekmece consists of Avcilar Counties in total numbers of population)

The late 1990's and 2000's brought extensive private real estate developments in the outer parts of the city for high income households. Major banks started to develop real estate projects with partnership of construction firms. Most of them were linked with second bridge and the TEM highway. The 1999 Earthquake has been effecting the housing preferences of Istanbul's residents to have less risks. Unfortunately, the developers are overusing this idea for their future investments in less vulnerable locations for disaster risk but with less regard to nature protection, water quality and as a whole more sustainable development for Istanbul City.

As a conclusion, the rapid population growth; migration of rural population to urban areas; the continuous reconstruction amnesties and legalizations of squatter units after each election periods by political authorities; high/poor standardized residential developments in and around forest areas, water basins or natural sites are the common features to define housing market in Istanbul.

Econometric modeling of land-use and transportation interaction

Due to the accelerated urban growth and the dispersion experienced in the 1950's together with the fact that the main UTP studies for Bosphorus took place after 1950's; the data gathered for modeling of long-run impacts start with the year 1955 in the border of MGI from Pendik to Kucukcekmece Counties. In this part of the study, by giving importance to the long-run

impacts of Bosphorus crossings and their connecting highways on physical dispersion; the existing land-use and transportation variables will be modeled to estimate for the future impacts of other proposed Bosphorus crossings. The data at this stage includes between 1955-1993 periods. The most recent data (1997 and 2002) of built-up area and population were not used in the evaluations (see Figure 1. and Tables 1-2.) for not having parallel recent data for transportation variables (see Table 3.). The data used in the evaluation of the model on long-run impacts is listed below (Tezer, 1997):

Land-use data;

- Measurements of the built-up area of counties for the years 1955, 1965, 1975, 1986 and 1993 (see Figure 1., Table 1.),
- Population growths of counties for the years 1955, 1965, 1975, 1985 and 1990 (State Institute of Statistics-SIS, census of Population, see Table 2.),
- Population densities of counties for the years 1955, 1965, 1975, 1985 and 1990 (population/km^2, SIS, Census of Population)

Transportation data;

- Line distances of the railroad system in counties for the years 1955, 1965, 1975, 1986 and 1993 (railways, tunnel, light rail and tramway),
- Total access point (i.e. station) numbers of the rail road system in counties for the years 1955, 1965, 1975, 1986 and 1993,
- IETT bus-stop numbers in counties for the years 1955, 1972, 1978, 1982 and 1991 (Line maps of IETT)
- Ferry and sea-bus port numbers in counties for the years 1955, 1965, 1975, 1985 and 1993 (Istanbul Ferry Lines Management),
- Total access point numbers of all transportation systems in counties for the years 1955, 1965, 1975, 1985 and 1993 (bus, railway, ferry) (see Table 3.) and
- Accessibility densities of counties for the years 1955, 1965, 1975, 1985 and 1993 (total access points/county area)

Dummy variables group;

- Year variables of 1955, 1965, 1975, 1985 and 1990 (for the year in question, the value is 1 for others it is 0),
- 1st and 2nd Bridge variables (in all cases after the date of operation it takes 1, for other years it is 0) and
- Road 1 (E-5) and Road 2 (TEM) variables (since the date of construction, the counties for which the highway passes through have a value of 1, the counties for which it does not pass through have a value of 0).

Table 3: *Total Access Point Numbers of All Transportation Systems in Counties Between 1955-1993 (IETT Busses+Railway+Sea Transport, Tezer, 1997, pp.114).*

	COUNTIES*	1955	1965	1975	1985	1993
1	BAKIRKOY	16	46	47	65	227
2	BAYRAMPASA	0	7	7	10	38
3	BESIKTAS	24	26	38	38	87
4	BEYKOZ	9	13	19	25	92
5	BEYOGLU	26	20	25	25	56
6	EMINONU	25	25	25	27	37
7	EYUP	9	12	14	14	58
8	FATIH	30	34	35	34	64
9	G.OSMANPASA	0	8	19	20	45
10	KADIKOY	39	55	66	69	177
11	KAGITHANE	0	8	18	18	47
12	KARTAL	12	18	19	26	121
13	K.CEKMECE	7	11	18	24	125
14	PENDIK	5	5	10	17	35
15	SARIYER	15	27	35	34	126
16	SISLI	19	16	18	18	49
17	UMRANIYE	2	4	5	8	83
18	USKUDAR	35	46	54	54	147
19	ZEYTINBURNU	5	10	14	14	41
	TOTAL	2233	2356	2461	2525	3648

* According to administrative division before 1990 (Bakirkoy consists of Bagcilar, Bahcelievler, Esenler and Gungoren; Kartal consists of Maltepe, K.Cekmece consists of Avcilar Counties in total numbers of population)

Using all variables mentioned above, the long-run interactions have been tested in the SPSS program. As a land use function, the built-up area development is assumed like a dependent variable and tried to be explained by different variables of land-use and transportation for all time periods between 1955 and 1993. Linear multiple regression modeling is used to evaluate the impact of explanatory variables on dependent variables (i.e. built-up area). After many tests, the most appropriate formula on the built-up area development is used to estimate future land-use as well as transportation values according to different land-use functions and different bridge crossing proposals for the year of 2010.

As it can be seen from Table 1. and Figure 1., there is not a big change in built-up area development in some central counties for recent years as potential free land has been fully built. Because of this, some observations eliminated from tests to have accurate estimations on built-up area development. Instead of 95 cases, only 89 cases for 19 districts in 5 periods have been accepted for final analysis. Until the level of statistical tests of formula is acceptable, the different combinations of variables have been tested to explain the built-up area dependent variable. The formula of built-up area explained by land-use and transportation variables is given below (Tezer, 1997):

LNY = 1.08893 + 0.34664LNX1 + 0.0000X2 + 0.63474X3 + 0.53513X4 + 0.37344LNX5

Here;
Y : built-up area,
X1 : population,
X2 : lengths of railroads in counties,
X3 : year 1985 dummy variable,
X4 : II.Bosphorus Bridge dummy variable and
X5 : total access point numbers in counties.
R^2 = 0.77506
F = 59.57477
DW = 1.77236

The highest impact on dependent variable is obviously population. The number of total access points in counties has the second priority of explanatory variables on built-up area development. As it can be seen by the formula, all explanatory variables have positive and direct proportional relation with the dependent variable. The dramatic growth in migration and built-up area development after 1980's is reflected to the formula by the year 1985 dummy variable. The construction amnesties on general election periods during 1980's have facilitated this undesirable development in Istanbul (see Table 4.).

Table 4: *Statistical Tests of Variables in the Built-up Area Model (Tezer, 1997, pp.119)*

VARIABLE	COEFFICIENT	VALUE OF	VALUE OF T
A (Constant)	1.088931	-	1.620
X_1 (Population)	1.34664	0.395763	4.576*
X_2 (Railway Lenght)	0.00001	0.163946	2.774*
X_3 (Year 1985)	0.634746	0.25153	4.124*
X_4 (II. Bridge)	0.535131	0.183092	2.523*
X_5 (Total Access Point)	0.299008	0.257877	2.929*

* Variables which are meaningful in %95 confidence interval.

The maximum capacity of built-up area in counties is determined from MGI 1/50000 Scaled Master Plan Report to estimate the built-up area growths for the year 2010. The vacant land and forest areas have been taken into account to determine the capacity area for built-up area development. It must be emphasized that, the capacity area does not mean the suitable land for future development. Because, most of this areas fall on water reservoir area or agricultural land. According to built-up area model, future built-up area values and also 1994's vacant land and forest area values are given in Table 5. below.

Because of the vacant land in many central counties can not meet with built-up area which is needed for the year 2010, obviously this development will effect the densities (in population or construction) to rise or the forest areas which have very important role in Istanbul's sustainable development to be under danger by over-using. In other words; balanced, planned and sustainable development of Istanbul will be prevented with the continuous development survived since 1950's until today. Although the counties Sariyer, G.Osmanpasa, Umraniye and Pendik seem to have enough land for

the year 2010, but unfortunately their vacant land overlap with respectively Natural and Historical Site Conservation Area of Bosphorus, Alibeykoy Water-Basin Area, Elmali and Omerli Water Basin Areas and forest lands (Gulersoy, 1995).

According to the built-up area formula, the III. Bosphorus Bridge Proposal's impact on built-up area development have been estimated to emphasize the role of the existing crossings on urban development.

Estimation of the impact of Bosphorus crossings on land-use development

Bosphorus crossings subjected to local and central government's project's since 1950's. First bridge on the Bosphorus was operated in 1973 and after 16 years, the second bridge was constructed on the north of the first bridge. Beginning with the first bridge, Anatolian Side of Istanbul started to grow steadily by population and built-up area faster than it was before. After the second bridge was constructed, this growth gained more acceleration by the impact of improved accessibility of new connecting highways as it was argued very often in many levels of official or unofficial organizations dealing with planning. Because of the insufficiency of existing bridge crossings on travel demand growing day by day, new bridge crossings have been put on the agendas of planning authorities very often. Since the II. Bridge has been fully occupied by private cars after its operation, the III. bridge crossing has been spoken out by central and local government authorities very often.

In 1995, the third bridge proposal (K3) was developed by Master Plan Bureau of MGI to demonstrate sharply how this bridge located on the north of the two existing ones and passing through forest lands would create new speculations on built-up area developments (Ekinci, 1995; see Figure 2.). The aim of this proposal was not to support the idea of bridge crossing but to show how badly the impacts would occur. However, the State Highways Directory supported a proposal passing closer to the first bridge which was located on the south of the Bosphorus (see Figure 2.). After ten years of these discussions the subject is still fresh, and the location is going and coming back between north and south crossings through the years (Radikal, 2003; Milliyet, 2003; NTV MSNBC, 2003; Zaman, 2003; Milliyet, 2002; Cumhuriyet, 1998).

In this section, two Bosphorus crossings will be evaluated by using the variables in the built-up area formula which was mentioned above section. Table 5. summarizes the impacts of the K3 crossing on land development. As it can be visualized in Figure 2., this proposal will create new developments around connected highways first then will effect the densities to rise as lived with the two existing ones. The impact of the II. Bridge on built-up area development in the formula has been assumed same for the III. Bridge (K3) proposal to estimate the difference on new development (see Figure 2.). The effect of the III. Bridge Proposal (K3) on land development for the year 2010 has been given in Table 6.

Table 5: *Estimated Values of Built-up Area in Counties (Hectare) (Tezer, 1997, pp.121).*

	COUNTIES	Vacant	Forest-	Estimated	Total	Area to	Maximu
1	BAKIRKOY	1074	218	1858776	15202	8112	7373
2	BAYRAMPAS	-	-	350010	810	59	632
3	BESIKTAS	35	211	274627	1819	833	1553
4	BEYKOZ	242	13301	260042	2567	490	2319
5	BEYOGLU	-	-	281166	915	66	800
6	EMINONU	-	-	68466	692	316	450
7	EYUP	-	3121	364796	2153	666	1487
8	FATIH	-	-	894616	1044	36	1044
9	G.OSMANPA	4966	6547	639544	3150	1498	3468*
10	KADIKOY	248	212	912006	5907	2946	3100
11	KAGITHANE	190	307	378751	2603	1258	1443
12	KARTAL	2156	1500	4552104	8255	3706	8000
13	K.CEKMECE	9907	2167	3179231	8462	4295	5612*
14	PENDIK	1399	483	1073033	3685	750	649*
15	SARIYER	3330	6082	328223	2975	914	2416*
16	SISLI	887	1228	973672	2626	1837	1676*
17	UMRANIYE	775	4342	2101685	5274	414	361*
18	USKUDAR	517	628	967093	4255	1293	3198
19	ZEYTINBUR	10	191	400000	1116	147	994
	TOTAL	**25736**	**40538**	**19857841**	**73510**	**29686**	**57615**

* Land which is out of capacity area and not necessary to be built is excluded on the total cell of this table.

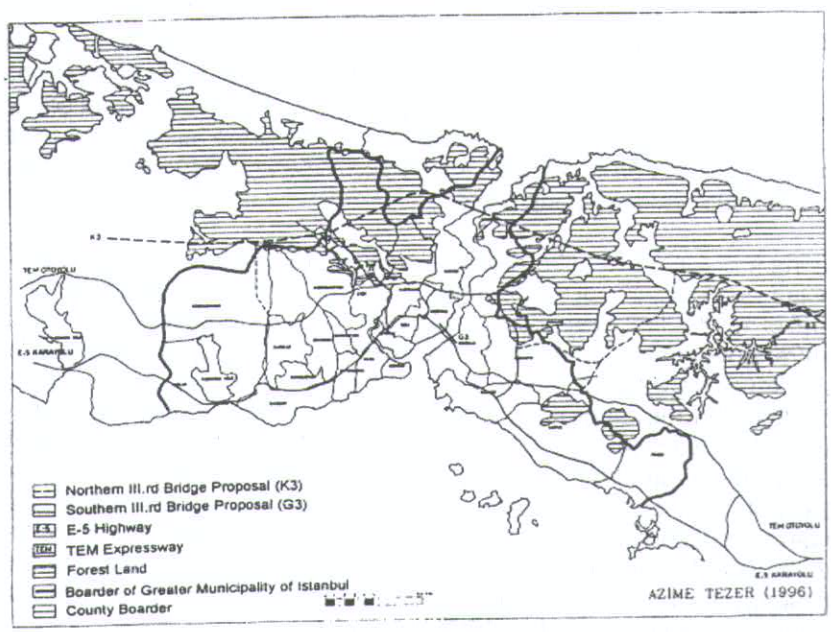

Figure 2: *Existing and Proposal Bridges on Bosphorus and Location of Forest Lands (Tezer, 1997).*

Table 6: *The Effect of K3 III. Bridge on Built-up Area Development in 2010 (Tezer, 1997, pp.126)*

	COUNTIES*	Impact on Total	Difference by the III.
1	BAKIRKOY	F	-
2	BAYRAMPASA	F	-
3	BESIKTAS	F	-
4	BEYKOZ*	4384	1817**
5	BEYOGLU	F	-
6	EMINONU	F	-
7	EYUP*	3676	1523**
8	FATIH	F	-
9	G.OSMANPASA*	5379	2229**
10	KADIKOY	F	-
11	KAGITHANE	F	-
12	KARTAL*	14096	(D) 5841**
13	K.CEKMECE*	14450	5988**
14	PENDIK	6293	(D) 2608**
15	SARIYER*	5080	2105**
16	SISLI	4484	(D) 1858**
17	UMRANIYE*	9006	3732**
18	USKUDAR	7267	(D) 3012**
19	ZEYTINBURNU	F	-

* Counties, directly connected to III. Bridge (K3).
** Counties, expected where forest areas will transform to built-up area.
F Counties, already full.
D Counties, will have density increase as a result of not enough land to be built.

K3 proposal has been tested on the counties which have direct connection with the proposal as a consequence of some counties have already been full by built-up areas. As it can be seen in Figure 2., K3 proposal and connecting highways are passing through forest areas. Under the assumption of built-up area formula, K3 proposal will cause approximately 13445 hectares of forest land to transform to built-up areas.

During mid 1990's, southern bridge crossing (G3) was much more attractive on the agendas of politicians and central government authorities. A bridge parallel to the first one brought planners and local government against to central government authorities. The major objective of the proposal was to ease travel congestion on the I.Bridge by operating each of them as in one direction. On the other side, urban planners, transport engineers and other related professionals were frequently emphasized that, priority of Istanbul's transportation problem was not having a new bridge (only for motor vehicles use) but more comprehensive approach on urban transportation had to be taken into account. According to a research on land use and travel pattern interaction of Istanbul, the amount of bridge crossings on daily total trips of passengers was not adequate enough to be a reason to construct a new bridge on Bosphorus (Gercek&Demir, 1996).

According to the situation experienced by the impact of existing bridges, G3 proposal can facilitate traffic congestion only for a limited time and distance,

but later, the congestion problem will occur on this bridge too. Because directing more traffic through central areas some definite points and conjunctions will be over-used. These points are already problematic by motor-vehicles. By giving more attraction to central areas, population and construction densities can rise up too. G3 proposal can assume to effect firstly the counties related with the new highway connections to this bridge. These counties are Besiktas, Beyoglu, Kadikoy, Kagithane, Sisli, Umraniye and Uskudar (Tezer, 1997).

As a result of the built-up area development model; population, developments on the transportation systems (increase on the access points and improvements on the railway systems and II. Bridge) are the most important factors on new developments of built-up areas. As it happened by the I. and II. Bridges on Bosphorus, new urban development pressures and speculations will be created on the groves decreasing day by day and the forests having important role on sustainable and ecological development of Istanbul by the effect of northern III. Bridge proposal. Therefore, the spontaneous development in built-up areas and lack of control in planning, new northern crossing are very objectionable for the forest land as being an important ecological community for Istanbul.

Conclusion

It seems that Istanbul will experience to discuss III.Bridge crossing for a few more years. Unfortunately, although the Transportation Master Plan of Istanbul foresights the progression of railway infrastructure (namingly Marmaray Project), the Ministry of Public Works and local representatives-the Directory of State Highways still support the third crossing for Istanbul. The success of integrated urban transportation systems can not be achieved with the competence among different transportation modes but only can via supporting to each other. Either local officials or central government's representative bodies have to evaluate extensively the impacts of investments and have to take into account local tendencies.

MGI's present urban transportation tendency is for supporting railway tunnel and connecting both sides suburban rail systems to each other. In the year 2008, the tunnel is expected to be constructed underneath of the Bosphorus (MGI, 2005). The financial support of the tunnel is supplied from Japanese Government.

Before producing new alternatives on bridge crossings, balanced and sustainable urban development policies and strategies have to be determined on land use-transportation interaction of Istanbul by obtaining the coordination on Urban Land Use Planning and Urban Transportation Planning procedures. By conserving the natural, cultural and historical values of Istanbul, the existing capacities have to be described and after new strategies on Urban Transportation Planning have to be produced according to these capacities. As a conclusion, "Transportation Master Plan" which has continuity and actuality on the basic strategies determined according to urban land use development plan i.e. 1/50000 scaled Master Plan has to be realized at local and national levels.

Acknowledgment

The author would like to express her appreciation to Evren Buçan (Graduate Landscape Architecture Student), for his help on the preparation of the last two terms of built-up area development maps.

References

Bölen, F., Erkut, G., Özsoy, A., Türkoğlu, H.D., Levent, B.T., Tezer, A., Pill, C., (1996), Shelter for All Versus Sustainable Development, Two Settlements in the Water Reservoir Area: Sultanbeyli and Sarıgazi, **Habitat II Workshops**, ITU, Faculty of Architecture, Taşkışla, 10-14 June.

Cumhuriyet (1998), Tüp Geçit İçin İmza Kapmpanyası, 9/11/1998 Tarihli Baskısı.

Ekinci, O., (1995), Bir Senaryo Paftanın Uyarıları, **İstanbul Dergisi**, Sayı.14, sf.65-66, Temmuz, İstanbul.

Ergun, N., (1995), **Planlı ve Plan Dışı Yerleşim Alanlarında Sosyal-Ekonomik ve Fiziksel Yapı Farklılıklarının Karşılaştırılması ve Yer Seçimi Eğilimleri**, İTÜ Mimarlık Fakültesi, Şehir ve Bölge Planlaması Bölümü.

Gerçek, H., Demir, O., (1996), Arazi Kullanımı-ulaşım İlişkisi ve Boğaz Geçişleri, **Metropolün Geleceğine Yönelik Öneriler, Habitata Doğru İstanbul 2020 Sempozyumu**, *Bildiriler*, İTÜ Mimarlık Fakültesi, Şehir ve Bölge Planlaması Bölümü, 17-19 Nisan, İstanbul.

Gülersoy, N.Z., (1995), Boğazi çi'nde Arazi Kullanımı ve Ulaşım, **İstanbul Dergisi**, Sayı.14, Sayfa 59-63, Temmuz, İstanbul.

Metroplan, (1990), **Kentsel Ulaşımı İyileştirme Projesi**, İstanbul Büyükşehir Belediyesi, Projeler Daire Başkanlığı, Ulaşım Koordinasyon Müdürlüğü, Nisan, İstanbul.

MGI (Municipality of Greater Istanbul), (1995), **1/50000 Ölçekli Nazım Plan Raporu**, Belbim Matbaası, İstanbul.

Milliyet (2002), Üçüncü Köprüye Haklı Tepki, 12/6/2002 Tarihli İnternet Sayfası.

NTV/MSNBC, (2003), Boğaz'da Üçüncü Köprü İstenmiyor, 28 Mayıs 2003 tarihli internet sayısı.

Radikal (2003), Köprüye İlk Adım, 5/6/2003 Tarihli İnternet Baskısı

SIS (State Institute of Statistics), **Genel Nüfus Sayımı Sonuçları 1955, 1965, 1975, 1985, 1990, 1997, 2000.**

Tezer, A., (1997), **Kentsel Ulaşım Planlamasında (KUP) Arazi Kullanımı-Ulaşım Etkileşiminin Modellenmesi: İstanbul Üzerine Bir Değerlendirme** *(Doktora Tezi)*, İTÜ, Fen Bilimleri Enstitüsü.

Tezer, A., Gülersoy, N.Z., (1996), İstanbul'un Planlaması ve Kentsel Gelişim Sürecinin Değerlendirilmesi, **Metropolün Geleceğine Yönelik Öneriler, Habitata Doğru İstanbul 2020 Sempozyumu, Bildiriler**, İTÜ Mimarlık Fakültesi, Şehir ve Bölge Planlaması Bölümü, 17-19 Nisan, İstanbul.

Zaman, (2003), Ya Trafikte Boğulacağız yada Raylı Araca Bineceğiz, 3/3/2003 Tarihli İnternet Sayfası.

İstanbul' da arazi kullanımı-ulaşım etkileşiminin modellenmesi

Bu çalışmada, İstanbul örneğinde kentin mekansal gelişmesi üzerinde rol oynayan ulaşım sistemlerinin kentsel gelişme üzerindeki etkileri değerlendirilmektedir. İstanbul'un mekansal biçimlenmesinde önemli rol oynayan Boğaziçi köprülerinin etkisi modellenerek, olası üçüncü bir karayolu geçişine bağlı olarak İstanbul'a etkilerin neler olabileceği değerlendirilmektedir.

Özellikle 1950'li yıllarla birlikte İstanbul'da yaşanan yoğun göç ve hızlı nüfus artışı ve İstanbul'a yönelik ilk önemli Kentsel Ulaşım Planlaması (KUP) ve Boğaz geçişi projesinin ele alınması, bu çalışma kapsamındaki değerlendirmeler için de başlangıç yılı olarak 1955 yılının kabul edilmesine neden olmuştur. Bu çalışma İstanbul'da KUP ve Kentsel Ulaşım Modellemesi (KUM) ile Boğaz geçişleri ve bağlantı yollarının uzun

dönemli etkilerini değerlendirmeyi hedeflemektedir. Çalışmada kullanılan verilerin büyük bölümü 1997 yılında tamamlanan araştırmanın sonuçlarına dayalıdır (Tezer, 1997).

Boğaz üzerinde üçüncü bir karayolu geçişi konusu, ikinci köprünün işletilmeye başlamasının ardından hem politikacıların, hem yerel yönetimlerin hem de ilgili kamu kuruluşları ile sivil toplum kuruluşlarının daima gündeminde olmuş ve günümüzde de hala önemini korumaktadır. Bu nedenle çalışma kapsamındaki temel verilerden nüfus gelişimi ve yapılaşmış alanlar ile ilgili haritalara yönelik ilçe bazındaki verilere 1997 ve 2002 yıllarına ait güncel veriler eklenmiştir. 1985 yılındaki idari bölünmeye göre 19 ilçe değerlendirmeye alınmıştır. İlgili tablolarda belirtilen ilçe sınırları içinde K.Çekmece Avcılar ilçesini; Bakırköy ilçesi Bahçelievler, Esenler, Bağcılar ve Güngören ilçelerini ve Kartal ilçesi de Maltepe ilçesini içermektedir. Değerlendirmeye alınan veriler yaklaşık 50 yıllık bir zaman dilimini içermektedir. Bu bakımdan idari sınırlarda değişiklik olması yer yer karşılaştırma yapmayı güçleştirmektedir. Çalışmada kimi ilçeler için birden fazla ilçeyi içerecek şekilde bütünleştirerek değerlendirme yapılırken kimi durumda da son idari sınırlara bağlı olarak verilerin oranı belirlenmiş ve geçmişe dönük verilerde bu oranlar baz alınarak tahmin yapılmıştır. Adalar ilçesi, köprüler ve bağlantı yolları ile doğrudan ilişkisi olmaması nedeniyle değerlendirmeye alınmamıştır.

Çalışmanın amacı, İstanbul'un kentsel gelişmesinde önemli etkisi olduğu kabul edilen köprüler ve bağlantı yollarının etkisini somut verilerle modelleyerek, olası üçüncü köprü ve bağlantı yollarının etkilerini değerlendirmektir. Böylece üçüncü köprü ile ilgili tartışmalara varsayımsal değerlendirmelerden çok, somut verilerle değerlendirme yapabilmek mümkün olacaktır. Değerlendirmelerde ilçe bazında elde edilebilen verilerden yararlanılmıştır. Bunlar:
-Demografik veriler (nüfus, yoğunluk)
-Ulaşıma yönelik veriler (İETT durak sayıları, Raylı sisteme yönelik hat uzunlukları, istasyon sayıları, deniz hatları iskele sayıları, toplam erişme noktaları ve yoğunlukları)
-İlçe bazında yapılaşmış alan verileri (sayısal ve grafik veriler)
-Kukla değişkenler (I.Köprü, II.Köprü ve bağlantı yolları ile yıl değişkenleri)dir.

Elde edilen veriler Statistical Package for Social Sciences (SPSS) programı kullanılarak ve çoklu regresyon modeli uygulanarak test edilmiştir. Yapılan değerlendirmeler sonucunda elde edilen model aracılığı ile III. Köprü geçişi etkilerinin kestirilmesi hedeflenmiştir. Bir arazi kullanım göstergesi olan yapılaşmış alan değişkeni "bağımlı değişken" olarak kabul edilmiş ve diğer ulaşım ve arazi kullanımı değişkenleri ile açıklanmaya çalışılmıştır. Modelleme aşamasında 1955 ve 1993 yılları arasındaki veriler değerlendirmeye alınmıştır. Son iki döneme ait ulaşım verilerinin elde edilememesi nedeniyle 1997 ve 2002 yılları için model uygulanamamıştır.

İTÜ Ulaştırma ve Ulaşım Araçları UYG-AR Merkezi, 1995 yılında hem arazi kullanım hem de ulaşım verilerini değerlendirerek İstanbul Büyükşehir Belediyesi için Ulaşım Master Planını hazırladı. Bu plana göre III.Köprü geçişi yerine, İstanbul için halen gündemde olan raylı sisteme yönelik tüp tünel önerisi getirildi. Böylece her iki yakadaki raylı sistem ve metro güzergahlarının birbirine bağlanması ve karayolu ve özel araca odaklı ulaşım yerine toplu taşımayı ön plana çıkaran ve kentsel biçimlenmede köprü ve bağlantı yolları gibi spekülatif etkileri olmayacak bir yaklaşım tercih edildi.

18 Şubat 2005 tarihinde tüp geçiş ile ilgili uluslar arası düzeyde kredi anlaşmalarının imzalanmış ve tüp tünel aşamasının 2008 yılında tamamlanması hedeflenmektedir. Ancak hem belediye düzeyinde, hem bilimsel araştırma kurumları tarafından yapılan değerlendirmelerde hem de sivil toplum kuruluşları tarafından desteklenmemesine rağmen III. Köprü konusu güncelliğini korumaktadır. III.Köprü yerel düzeydeki planlarla ve sit kararlarıyla çelişmektedir. Diğer taraftan mevcuttaki köprülerde yaşandığı gibi, doğal kaynakların ve kentsel dokunun tahrip edilmesine yol açma potansiyeli büyüktür. Bu nedenle ulaşım sistemi içinde sadece kısıtlı oranda ulaşım talebini karşılayacak uygulamaların tartışılması yerine, kentsel ulaşım sistemini bir bütün olarak değerlendiren çözümler üzerinde durulmalıdır.