DOKUZ EYLÜL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

ASSESSMENT OF THE PROBABLE EFFECTS OF PLANNED INVESTMENTS IN URBAN RENEWAL AREAS ON URBAN FORM USING GRAVITY MODEL AND GIS: THE CASE OF IZMIR

by

Nur Sinem PARTİGÖÇ

July, 2011

İZMİR

ASSESSMENT OF THE PROBABLE EFFECTS OF PLANNED INVESTMENTS IN URBAN RENEWAL AREAS ON URBAN FORM USING GRAVITY MODEL AND GIS: THE CASE OF IZMIR

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of Science
in Geographical Information Systems, Geographical Information Systems
Program

by
Nur Sinem PARTİGÖÇ

July, 2011
İZMİR

M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"ASSESSMENT OF THE PROBABLE EFFECTS OF PLANNED INVESTMENTS IN URBAN RENEWAL AREAS ON URBAN FORM USING GRAVITY MODEL AND GIS: THE CASE OF IZMIR"** completed by **NUR SİNEM PARTİGÖÇ** under supervision of **DOÇ. DR. KEMAL MERT ÇUBUKÇU** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

DOÇ. DR. K. Mert ÇUBUKÇU

Supervisor

Prof. Dr. Vahap TECİM

(Jury Member)

Doç. Dr. Semahat Özdemir

(Jury Member)

Prof.Dr. Mustafa SABUNCU

Director

Graduate School of Natural and Applied Sciences

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor Assoc. Prof. Dr. K. Mert ÇUBUKÇU. His comments, assistance and support made this thesis valuable.

I would like to thank the head of department Prof. Dr. Vahap TECİM for his sincere and objective support.

Additionally, I acknowledge Assoc. Prof. Dr. Semahat ÖZDEMİR and Dr. Çiğdem TARHAN for continuous support and valuable advices.

I also thank my friends Dalya HAZAR, Ezgi ELVEREN, Özlem AYDIN for their genuine help and patience during my study.

Finally, my deep gratitude and appreciation go to my mother Süheyla BÜYÜKBAĞRIAÇIK, my brother Kerim PARTİGÖÇ and my fiance Gökmen ÖZCAN for their help during my life. This thesis would never have been completed without their patience and support.

Nur Sinem PARTİGÖÇ

ASSESSMENT OF THE PROBABLE EFFECTS OF PLANNED INVESTMENTS IN URBAN RENEWAL AREAS ON URBAN FORM USING GRAVITY MODEL AND GIS: THE CASE OF IZMIR

ABSTRACT

The concept of urban renewal, especially in metropolitan cities, including both the built and the natural environment, describes a process that affects the city macro form and changes in terms of global, economic, political and social aspect. A case of renewal, for it contains the changes that occur in the process, all aspects of the city to recognize and understand the city's development brings with it. In this thesis, there are 11 regions that are defined as "Rehabilitation-Renewal Program Areas" in the metropolitan city, according to the 1/25000 scale Izmir Urban Regional Master Plan (IKBNIP) prepared by Izmir Metropolitan Municipality. Comparing the results in the case of implementation of planned investments with plan decisions that affect the resident population settle in "disadvantaged" parts of the city from social and economic aspects, besides the limited opportunities for physical environment, and the results in the current situation of these program areas is the main crucial goal of the study. Additionally, evaluating the size of the physical and planning is another goal of the thesis. According to these goals, the Lowry - Garin model and Hansen model will be used as quantitative methods. These models have taken place as a tool in line with the concept of the city dealing with economic and geographic dimensions of interaction and decision-support processes. The distribution of the population, basic and service employment will be determined spatially between residence areas and work zones. The spatial analysis will be converted to the thematic maps, using Geographical Information Systems (GIS) softwares.

Keywords: Urban Renewal, Geographical Information Systems, Lowry-Garin Model, Rehabilitation – Renewal Program Areas

KENTSEL YENİLEME ALANLARINDA PLANLANAN YATIRIMLARIN ÇEKİM MODELİ YÖNTEMİ VE CBS KULLANILARAK KENT MAKROFORMUNA OLAN ETKİSİNİN DEĞERLENDİRİLMESİ: İZMİR ÖRNEĞİ

ÖZ

Kentsel yenileme, özellikle metropoliten kentlerde hem yapılı çevreyi hem de yapılaşmamış doğal çevreyi içeren, kentin makroformunu etkileyip, küresel, ekonomik, politik ve sosyal açılardan değiştiren bir süreci tanımlamaktadır. Yenileme olgusu, süreç içinde meydana gelen değişiklikleri içerdiği için, kenti her yönüyle tanımayı ve kentin gelişimini anlamayı beraberinde getirmektedir. Bu kapsamda, tez kapsamında, İzmir metropoliten kenti merkezinde bulunan, İzmir Büyükşehir Belediyesi'nin hazırladığı 1/25000 ölçekli İzmir Kentsel Bölge Nazım İmar Planı (IKBNIP)'na göre, "Sağlıklaştırma – İyileştirme Alanları" olarak tanımlanan 11 bölge yer almaktadır. Kısıtlı fiziki çevre olanaklarının yanında, sosyal ve ekonomik açıdan kentin "dezavantajlı" bölgelerinde ikamet eden nüfusun, plan kararları ile öngörülen ve gelişmeye açılacak olan bölgelerde planlanan yatırımların gerçekleştirilmesi durumunda meydana gelecek sonuçları ile mevcut durumun süregeldiği koşulda gözlenecek sonuçların karşılaştırılması amaçlanmaktadır. Ayrıca, kente dair planlanan yatırımların fiziki ve planlama boyutunun irdelenmesi de, tez çalışmasının amaçlarındandır. Amaçlananlar doğrultusunda, karar destek süreçlerinde bir araç olarak yerini almış olan Lowry – Garin modeli ve Hansen modeli kullanılarak, nüfus, temel istihdam ve servis işgücünün bölgeler bazında ikamet edilen ve çalışma bölgeleri arasında nasıl mekansal olarak dağıldığı belirlenecektir. Yapılan mekansal analizler, Coğrafi Bilgi Sistemleri (CBS) yazılımları kullanılarak tematik haritalara dönüştürülecektir.

Anahtar Sözcükler: Kentsel Yenileme, Coğrafi Bilgi Sistemleri, Lowry-Garin Modeli, Sağlıklaştırma – İyileştirme Alanları

CONTENTS

Page

CHAPTER ONE
INTRODUCTION

Urban renewal areas affect the city's physical, social, economic and environmental dynamics. These effects are within the framework of a holistic approach in planning. Especially after the 1980s, urban renewal projects require intervention under the influence of internal and external factors. These projects are called studies of “strategic planning” approach and put into practice in certain areas of the city. Urban planning studies in Turkey have two important aims: Sustainable planning in medium-and long-term and the vitality of the region's development plan (Aksu, 2007; Öner, 2007).

1.1 The Concept of Urban Renewal

The concept of urban renewal can be defined in different ways in terms of format and objectives at the end of the renewal process. Considering the process, the general framework is taken into account on above. According to conceptual terminology, urban renewal is a continuous process of remodeling older parts of urban areas, including their central business district (CBD) areas by means of rehabilitation, conservation, and redevelopment (Aslam, 2009).

Also, urban renewal concept is illustrated as the displacement of an existing low-income population, creating space for more profitable office, commercial and residential development or the provision of transportation facilities (Tesfaye, 2005). Thus, this concept is part of a general process, by which the human environment is continually transformed and social capital is accumulated in urban areas as well as in non-urban areas (Zukin, 1980).

Urban renewal is the transition from an existing urban pattern or structure to another one. Urban renewal defines the changes in the whole or certain parts of urban areas (Keleş 2004). Therefore, it refers to all kinds of changes in physical, social, economic structures of urban space. According to Ataöv and Osmay (2007), the concept of urban renewal contains all physical, social and economic transformation processes in the built environment.

Tekeli (2003) identifies mostly the multi - stakeholders at urban renewal processes. He suggests that urban renewal is formed by the accumulation of the demands of land owners and can be realized by certain powerful actors, such as municipality. Additionally, increases in urban population cause in the development of new urban lands, creates new potentials for urban rant and results in the increasing cost of developing the urban land (Tekeli 2003).

In addition to this, the concept of renewal is described as a result of interaction process of the resources of a large number of domains. It also can be defined as the planning work, a more expanded form. One of the main objectives of this work is to integrate poor areas and their local residents through reinforcing poor areas in social and technical facilities. Second one is to improve the trio (construction – environment – building) in cooperation with the private and public sectors (Öner, 2007).

As a negative consequence of blight, the city ward migration is a result of concentration of economic activities in the urban center results to regional imbalance. So, urban renewal is evaluated as a response to problems arising from the blight (Salazar, 2010). The aims of this response are improving and rehabilitating of "substandard living spaces" in terms of social, economic and physical conditions.

Urban renewal programs are generally undertaken by public authorities or local governments. The main issue is on renewal areas which have fallen below current standards of public acceptability. These are commonly to be found in the residential parts of the inner city, as well as in the CBD itself (Serim, 2009). The crucial problems of residential parts of inner cities are follows: Inadequate housing, environmental degradation and presence of non-conforming uses. Moreover, main indicators of CBD are traffic congestion and obsolescence of buildings and sites.

In general, urban renewal comprises three different activities. These are redevelopment, rehabilitation and conservation. The differences among them are applicable area types. For example, redevelopment is applied to areas in which cannot provide opportunity for economic activity or satisfactory living conditions. On the other hand, rehabilitation is applicable to areas in which some degree of loss of original function is making itself seriously felt. Finally, conservation is applicable to areas generally suited to their function and quality.

The causes of urban renewal can be summarized as: (Öner, 2007; Dayıoğlu, 2006)

a. Negations that planning permissions cause in urban fabric,
b. Immigration to the city and population increase without planning,
c. Inadequate housing stocks for immigrants,
d. Illegal structuring in downtown,
e. Two – dimension perception about urbanization and urban life,
f. Planning projects projected and not implemented,
g. Inadequate conditions of local authorities economically and technically.

1.2 Historical Periods & Objectives

Today, the concept of renewal can be considered in a better way by examining how to grasp both physical and social environment changes in the history of country caused by the above-mentioned reasons.

In the 1950s, also called as Bulldozer Period, the scope of renovation work consists of the physical rehabilitation of the environment. The main aims of the renovation are appropriating conditions for a good human life and moving of households to "more safe and healthy" area with bring the necessary resources for the work (Hoffman, 2008; Serim, 2009).

Indeed, in the 1960s, one of the main goals of renewal projects is to minimize costs in the process of the demolition and reconstruction of households. Another goal is to make "on-site renovation" work by providing the participation of local people (Hoffman, 2008; Öner, 2007).

Parallel to the objectives in 1960s, the improvement and rehabilitation of the residential areas primarily inhabited by households and people have a say in the renovation work according to "participatory planning" approach (Environment & Urbanization, 2003).

Besides the developments in this period, in the 1980s, the new urban areas are opened with the regional land use planning and urban design projects. These projects are constituted under the influence of the concept of "gentrification" (Environment & Urbanization, 2003; Serim, 2009).

"Strategic planning" and "regional and urban planning" approaches have emerged in parallel to growing economy in the 1990s. Accordingly, any interventions made changes to protect the lifestyles of households. These changes give priority to the needs of local people (Environment & Urbanization, 2003; Öner, 2007).

Finally, after 2000 year, the policy of privatization and mass housing, as a construction type, are main objectives. Because, immigration from east parts to west parts of the country increases and the current housing stock is inadequate for new households in metropolitan cities (Environment & Urbanization, 2003). Figure 1.1 shows the principal objectives aimed in urban renewal projects in different historical periods in Turkey.

PERIODS	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	After 2000
OBJECTIVES	Rehabilitation of physical environment Improvement More secure and healthy settlements	Participation of local people Renewal – in-situ Minimization of costs	Participatory planning Participation of local people Rehabilitation and improvement	Gentrification Land-use decisions Regional and urban renewal projects	Strategic planning Regional and urban planning Maintain of current life conditions	Privatization Mass housing Strategic planning Gentrification

Figure 1.1 The schema for historical periods and objectives in urban renewal

Similarly, Figure 1.2 shows renewal interventions and their results in the 1950s in Turkey.

Guatemala C. Başkanı katledildi

Suikasdçı saray muhafızı derhal intihar etti.

Levendde türeyen çadır mahallesi

Şehrin muhtelif semtlerinde evleri yıkılan vatandaşlardan bir kısmı, hükümetçe gösterilen sahada, hükümetçe verilen çadırlarda nasıl yaşıyorlar?

Su sıkıntısı

bir teşkilât ticaret hayatında nâzım rol

Altı bin gecekondunun yıktırılmasına başlandı

Vali Yetkiner ve Belediye Reisi Aygün, evvelce alınan kararın değiştirilmesini isteyen ve kendilerine başvuran müracaat sahiplerini kabul etmediler. Dün 93 gecekondu yıktırıldı

Fırtına

(28 July 1957) *(2 June 1959)*

Figure 1.2 The renewal interventions in the 1950s in Turkey (Cumhuriyet Newspaper)

1.3 The Scope of Study & Problem Definition

The main problem carried out in this study is to determine future changes in both population and employment in urban areas under two scenarios: (1) Planned renewals are completed through investments; (2) Planned renewals are not completed through investments in Izmir city. In other words, the aim is to assess the potential impacts of urban renewal through mathematical models.

The legal ground of study is based on 73. Item of the law no 5393 (Municipality Law) that is accepted in year 2005. According to this item, "Council may apply urban regeneration and development projects in order to create social facilities in accordance with the development of the city to rebuild and restore parts of the old city, residential areas, industrial and commercial areas." (Genç, 2008).

1.4 The Study Area

According to the plan decisions of Izmir Urban Region Master Plan Revision (IKBNIPR) scale of 1/25.000, "Rehabilitation - Renewal Areas" are identified in the districts of Izmir metropolitan city center. A total of 11 different renewal areas are defined in Izmir city (IKBNIPR, 2007).

The settlement units known as "disadvantaged regions" or "substandard living areas" locate in this context in Izmir city. The districts of these areas are: Konak, Karabağlar, Karşıyaka, Gaziemir, Bayraklı, Çiğli, Bornova and Narlıdere districts (IKBNIPR, 2007; Bal, 2008). The existing values of population and employment are known in these regions that generally the lower income group of households settles. The change in these values after the planned interventions to the current city macroform is assumed (IKBNIPR, 2007; Bal, 2008).

Figure 1.3 shows inadequate and substandard settlement units that take place in the districts in Izmir and Figure 1.5 shows the urban rehabilitation – renewal program areas according to IKBNIPR. Besides the maps of areas, photos are shown substandard dwellings located in Izmir metropolitan area in Figure 1.7. Also, while urban rehabilitation – renewal program areas in Izmir city are listed in Table 1.4, urban rehabilitation – renewal program areas in metropolitan area in Izmir city with their area (ha), population (person) and population density (person/ha) are shown in Table 1.6.

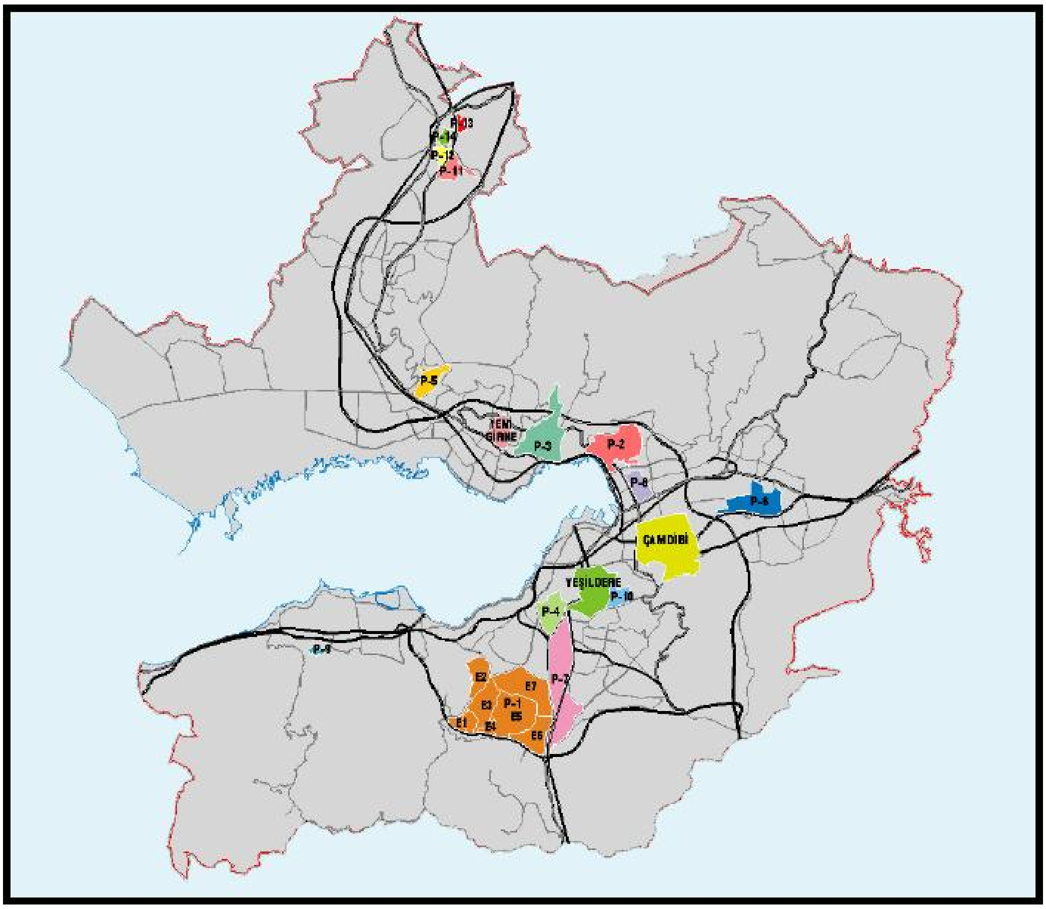


Figure 1.3 Inadequate and substandard settlement units in Izmir city

Table 1.4 Urban rehabilitation – renewal program areas in Izmir city

# of Area	# of Stage	Name of District	Name of Neighborhood
1	1	Konak	Cennetçeşme
1	2	Karabağlar	Salih Omurtak,Bahriye Üçok,Limontepe,Ali Fuat Erden
1	3	Karabağlar	Umut, Gazi, Özgür, Yüz. Şerafettin, Yurtoğlu
1	4	Karabağlar	Uzundere
1	5	Karabağlar	Devrim, Abdi İpekçi, İhsan Alyanak, Peker, Uzundere
1	6	Karabağlar	Emrez,Aktepe
1	7	Gaziemir	Kibar,Günaltay,Barış,Selvili,Yunusemre,Aydın
2	*	Bayraklı	Bayraklı,Alparslan,Çiçek, Fuat Edip Baksı,Cengizhan,M.Erener,R.Şevket İnce,Çay
3	*	Karşıyaka	Emek,Gümüşpala,Yamanlar,Org.Nafiz Gürman,Onur
4	*	Konak	Aziziye,Duatepe,1. ve 2. Kadriye,H.Özdemir,19 Mayıs,Çimentepe,Kocatepe,Zafertepe
5	*	Çiğli	Güzeltepe,Şirintepe
6	*	Bornova	Mevlana,Doğanlar
7	*	Karabağlar	Hürriyet,İnkılap,O.Aksuner,A.Veysel,Akıncılar,Seyhan,Göksu,İnönü,Bin.Reşatbet
8	*	Bornova	Adalet,Mansuroğlu
9	*	Narlıdere	Atatürk,2. İnönü
10	*	Konak	26 Ağustos,Ulubatlı,M.Akif,Saygı
11	*	Menemen	Asarlık-1
12	*	Menemen	Asarlık-2
13	*	Menemen	Asarlık-3
14	*	Menemen	Menemen
15	1	Bornova	Altındağ,Çamdibi
15	2	Karşıyaka	Yeni Girne
15	3	Konak	Yenirşehir,Gürçeşme,Yeşildere

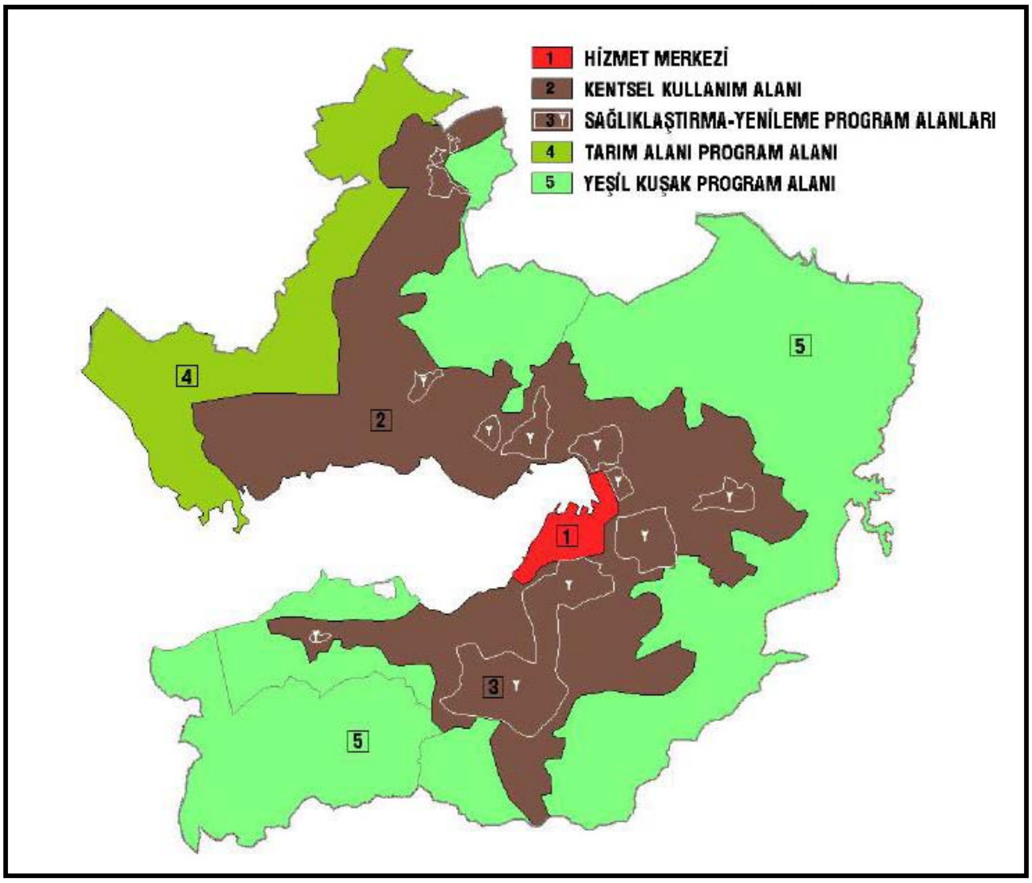


Figure 1.5 Urban rehabilitation – renewal program areas as part of IKBNIPR

Table 1.6 Urban rehabilitation – renewal program areas in metropolitan area

# of Area	# of Stage	Name of District	Name of Neighborhood	Area (ha)	Population (Person)	Population Density (Person/ha)
1	1	Konak	Cennetçeşme	40	3354	83,85
1	2	Karabağlar	Salih Omurtak,Bahriye Üçok,Limontepe,Ali Fuat Erden	125	14801	118,41
1	3	Karabağlar	Umut, Gazi, Özgür, Yüz. Şerafettin, Yurtoğlu	180	33144	184,13
1	4	Karabağlar	Uzundere	33	2932	88,85
1	5	Karabağlar	Devrim, Abdi İpekçi, İhsan Alyanak, Peker, Uzundere	317	30353	95,75
1	6	Karabağlar	Esmez,Aktepe	162	11267	69,55
1	7	Gaziemir	Kibar,Gümaltay,Barış,Selvili,Yunusemre,Aydın	295	53946	182,87
2	*	Bayraklı	Bayraklı,Alparslan,Çiçek, Fuat Edip Baksı,Cengizhan,M.Erener,R.Şevket İnce,Çay	310	86491	279,00
3	*	Karşıyaka	Emek,Gümüşpala,Yamanlar,Org.Nafiz Gürman,Onur	347	72213	208,11
4	*	Konak	Aziziye,Duatepe,1.-2. Kadriye,H.Özdemir,19 Mayıs,Çimentepe,Kocatepe,Zafertepe	165	40064	242,81
5	*	Çiğli	Güzeltepe,Şirintepe	120	17031	141,93
6	*	Bornova	Mevlana,Doğanlar	237	24559	103,62
7	*	Buca	Hürriyet,İnkılap,O.Aksuner,A.Veysel,Akıncılar,Seyhan,Göksu,İnönü,Bin Reşatbet	510	58471	114,65
8	*	Bornova	Adalet,Mansuroğlu	107	33399	312,14
9	*	Narlıdere	Atatürk,2. İnönü	24	9862	410,92
10	*	Konak	26 Ağustos,Ulubatlı,M.Akif,Saygı	81,5	20365	249,88
15	1	Bornova	Altındağ,Çamdibi	632,4		
15	2	Karşıyaka	Yeni Girne	108		
15	3	Konak	Yenişehir,Gürçeşme,Yeşildere	322,7		

Figure 1.7 Substandard dwellings located in Izmir metropolitan area

1.5 The Importance of Study

The main subject of the scope of the study is the urban renewal. Planned renewals will be applied in accordance with upper – scale district plan decisions and determination of the changes. These decisions and changes may occur as a result of such a comprehensive intervention in the city center. The urban renewal that is indented to implement in disadvantaged areas of the city is an issue attracting attention in recent times especially by local governments, relevant ministries, and civil society organizations.

Urban renewal is a process that affects many aspects of the urban structure. It includes multi – stakeholders. It also varies in terms of intervention forms and completely open to criticism. One of the most important features is to affect directly the lifestyles of households in terms of physical, social, economic and space quality. For this reason, the concept of urban renewal that persons have limited knowledge about should be addressed with alternative scenarios and additionally, valid solutions should be produced.

According to the alternative scenarios; modeling, analysis and evaluation of potential future increases in population and employment are extremely important. If these steps of planning process are not realized, the critical and unforeseen results occur in the entire city. As examples for these results, the increase of illegal construction, the increasing number of slums, and misuse of urban land may be followed.

As a result of the completed thesis, the obtained data presents solutions in which direction land use plan decisions are formed. The evaluation of the empty land areas in urban residential and business areas, providing access to urban activities and estimation of the development aspects of the city are among these solutions.

1.6 The Main Objectives & The Alternative Scenarios of Study

The main objectives of study are the following:

(a) Identification of the change in the household population and employment,

(b) Assessment of the adequacy of current housing stock for the demand of new households in the districts and new plan proposal for the development of residential units,

(c) Assessment of the adequacy of current labor units' stock for the demand of new households including to current business and employment and new plan proposal for the development of labor units.

The population and employment at the district level are estimated using the Lowry – Garin Model and Hansen Model under two scenarios. These scenarios are:

(1) The renewal areas within IKBNIPR are renewed under proposal planning decisions,

(2) The renewal areas within IKBNIPR are not renewed under proposal planning decisions.

1.7 The Stages of Study

The basic steps are followed during the study as follows: (I) Comparison of the current and projected population and employment values, (II) analysis by using numerical methods and (III) mapping the changes in the urban macroform.

I. From the data of Turkey Statistical Institute (TUIK), the values of the population in the province of Izmir metropolitan area in different years (1985, 1990, 2000, 2007, 2008 and 2009) and employment levels by the year 2002 are used. Using these values, the answers to critical questions are looked for: How and in what direction the population has changed in the entire metropolitan area? How is the distribution of labor on the basis of regions? Are these values necessary for digital models to be calibrated? If necessary, what kind of effect has on the model? Are predicted values at the end of the estimation appropriate for the current trend? How changing values of the population and employment can be interpreted for the whole city?

II. From numerical models, Hansen Model and Lowry – Garin Model are chosen for the estimation of the model of the workspace. Using these models, the questions might be answered: What are the necessary data for the estimation of the models? How the distribution of the possible increase or decrease in the value of the population and employment on the basis of districts? How the distribution in the housing areas is modeled? How the distribution occurring in the workplace is modeled? How does the distribution of basic and service employment on the basis of districts?

III. Possible spatial changes in city macroform in the future are shown in thematic maps. This is for the creation of maps; base maps in different layers are prepared. (District boundaries, hierarchy of roads, districts within and not within the scope of the renewal process, etc.) According to the desired analysis, the necessary queries are made and the change is shown with thematic maps. Mapping of the distribution and change has found answers to these questions: In which districts urban renewal is applied in the entire city? How is the distribution of housing on the basis of the district? How new housing units or employment units can be settled, if the planned investments are made? How is the hierarchy of roads in the city center? What is the positioning of the districts to each other? Where is the direction of renewed growth areas?

Finally, the remainder of the study is organized as follows. Chapter 2 consists in a comprehensive literature review for the study. The modeling methodology in detail is presented in chapter 3. The data that are used for analysis and research study are described in chapter 4 and the empirical results are presented and analyzed in chapter 5. Chapter 6 finally concludes the study and evaluates crucial results of scenarios elaborated according to the scope of study.

CHAPTER TWO
LITERATURE REVIEW

Although the interest and need for numerical models have increased after the 1960's, the applicable fields are not constituted because of the fact that not only the practicing planners of the era but also the students in planning do not have mathematical backgrounds. Modeling cannot be considered to be independent of mathematics. According to Lee (1973), the results of applied methods are more realistic and exact, when models are estimated though quantitative models.

Modeling is a simplified abstraction of a real-world phenomenon. Among various models, the urban models are considered to be descriptive of different aspects of the urban systems using mathematical equations (Foot, 1981). Additionally, urban models in planning are by definition mathematical abstractions of the real world. They attempt to combine the most important characteristics of urban systems within a mathematical formulation to represent a simplification of complex real world processes (Foot, 1981). Urban modeling can provide important benefits to these processes together with the analysis of urban systems and planning policy (Kendrick and Taylor, 1970).

There exist two main goals in urban modeling: The first goal is to define the structure, mechanism and behavior of urban systems. The second goal is to develop future-oriented policies. Because of the fact that the urban structure is a complex network of relationships that consists of many sub-systems, urban models and modeling is often (Wegener, 1994).

Urban models are generally used to evaluate and understand the probable changes in the existing patterns, activities, relationships in the future considering the parameters on residential areas, industrial sectors, population distribution, employment and transportation (Waddell, 2002). According to Foot (1981), the urban models are operational in the sense that they have been successfully developed and applied in actual planning studies in different parts of the world, rather than being developed for theoretical and economic reasons.

These models have attracted the attention of researchers worldwide. Also, they have been used and developed continuously in many different places from England to North America, as from Moscow to Australia. There are two different usages of urban models (Foot, 1981). The first example is Urban System model developed by Voorhees. The model is applied in Texas. Besides its application, alternative planning policies are considered in detail. For example, sub-models for transportation, urban and economic development, social justice, environmental, energy issues, etc. The second one is Land Use Transportation model developed by Echenique. In the 1970s, scientists have worked on a model about comprehensive land-use transportation in many different countries, like Chile, Venezuela, Brazil, Spain, etc. In addition, the model includes calculations of the cost of service – access added to land rents, according to the economic base theory of Alonso. This theory is based on economic activities and establishing supply – demand balance (Foot, 1981; Çubukçu, 2008).

As a tool, models help urban planners to understand the complex structure and behavior of urban systems (Waddell, 2002). Lee (1973) mentions that there is a growing acceptance that the usage of these models can help the planners to understand and predict the behavior of urban systems in appropriate circumstances. Models are considered as an essential part of discipline of planning.

According to Chadwick (1978), the discipline of planning is the overall system that includes not only the optimization of the real-world, but also to understand, compare and interpret the optimized conceptual system. The construction process along with research, analysis and plan within the overall system has been adopted and applied with enacting Planning Act in 1947 in the U.S. Since scientific, industrial and military developments are provided in the field. By the time, different system alternatives are built up following to these developments. Table 2.1 shows the differences in planning process according to Catanese (1970), Steiss (1970) and Lee (1973).

Table 2.1 Differences of planning process

According to Catanese & Steiss (1970)	According to Lee (1973)
Definition of problem	Definition of the overall system and problem
Definition of conditions in future	Analysis and presentation of solutions
Determination of the parameters, boundaries and objectives	Evaluation and selection of solution
Determination of goals and objectives	Implementation and monitoring
Determination of alternatives	
Implementation of qualitative and quantitative analysis	
Selection and implementation of politics	

2.1 Quantitative Models in Planning

As mentioned before, when models are estimated using quantitative methods, they are more promising. Based on this point, different models have been developed by researchers to understand and simulate urban systems. The models can be classified as descriptive models, predictive models and planning models.

Descriptive models can be defined as the models that simplify the complex structure of the real world and the urban environment. They consist of "the city, everything affects everything" approach, which includes proposing a shortcut for hard measurable data (household income level, socio-economic structure, etc.) and conducts short-term model predictions (Lee, 1973). According to Lowry (1964), besides the other alternative models, descriptive models do not directly satisfy the planner’s demand for information about the future or help him/her for choosing one of alternative programs. Thus, one needs rather predictive or planning models.

Predictive models are related to the case of simulation of future conditions based on cause and effect relationship. They do not focus on the current situation (Colenutt, 1968; Lee, 1973). Therefore, in the predictive model, input variables are predicted in their future values and implicates the condition that if X occurs, then Y will happen as “impact analysis”.

Unlike other models, planning models have specific goals and constraints. Besides the developments that are expected spontaneously, this model is formed by the request and direction of planners as well (Lowry, 1964).

Planners rely on the implementation of the planning models since the 1960’s. As an important tool and take advantage of the “black-box approach” in the model. This approach is known as implicating calling the needed information from the box by the person who makes the analysis, producing alternatives, doing cost – benefit analysis and identification of theoretical and numerical studies based on expert’s opinion. Some scientists suggest that there is a missing of theoretical body in this model and its outline cannot be determined exactly as a disadvantage (Lee, 1973).

According to Foot (1981), the criticisms of urban modeling can help understanding and determining the urban systems and differences among these model types. These criticisms can be listed as:

- Models’ structures are highly simplified and have inadequate variables, and their structures are static.
- The models are inadequate in terms of the analysis of social behavior, as behavior cannot be described in a mathematical equation.
- The models do not reflect the continuous change in the real world and they do not consider future conditions.

2.2 Gravity Models

The spatial interaction model can be generalized as the “single - constrained gravity model”. It includes the concept of spatial connection depending on land use activities and journeys made, like journeys from work to home, from home to school, from home to shopping, etc (Butler, 1972; Haynes and Fotheringham, 1984). Accordingly to Foot (1981), the general spatial interaction allocation model can be used as a residential location model to distribute employed persons from their place of work to their place of residence.

The logic of the model is based on the number of people working in different areas. The dwellings in the surrounding areas are calculated using this distribution. As a result, the travel distribution matrix is estimate. A parameter in the formula measures the quality and quantity of residential areas. The housing stock on the index includes housing prices, rents, etc (Foot, 1981).

A general assessment of the gravity model reveals that there are structural problems including (Butler, 1972; Foot, 1981):

- Studying the land use patterns only on one sector,
- Theoretical base on the explanation for the model behaviors,
- Although the model has varying parameters, the structure is static,
- The supply for housing stock, trade and other services cannot be participated into account,
- The data is limited with trade in sectoral analysis,
- Small and limited study area,
- The collected data is entered and less,
- Not more than the number of variables are not highly sophisticated formulation,
- The consideration of land use patterns changed with more trips and finally not determination exactly how many and how smaller area will be measured in the area.

2.2.1 Applications of The Lowry and The Lowry – Garin Models

- ***Pittsburg Region Project (1958)***

According to Lowry, the design of the Pittsburg Model is constrained by the resources available for fitting its parameters and validating its overall structure. In this respect, the study team has prepared the Pittsburg Area Transportation Study (PATS) that has been collected and archived the small area data pertaining to land use conditions, household characteristics and travel behavior in the field in particular based on the business and shopping trips for year 1958 (Lowry, 1964).

The characteristics of this small study area can be listed as: The size of area is about 420 square miles; the area locates in the city center; the total population of area is nearly 448,000 persons (while total population of city overall is 1,500.000 persons) and additionally, the total employment is about 191,700 persons (while total employment of city is about 500,000 persons); study area is related to the other units in the neighborhood surrounding the area; there exists an area that its size is 225 square miles around the study area to be fit for habitation and agriculture. The data used in the model are population by age groups totally 13 neighborhood units, the number of employment, households' race, gender, the number and the ownership rate of vehicles in the study area (Lowry, 1964).

The two significant findings of study after the simulation of model can be summarized as:

- For the distribution of households, there occurs an inversely proportional relationship between the distance and the density. When the distance increases from dwelling units to the Central Business District (CBD), the number of households reduces and in contrast that, while the distance from dwelling units to CBD decreases, the number of households increases.

- For the distribution of work places; similarly to the households, there occurs an inversely proportional relationship between the distance and number of units. While the distance increases from work places to the CBD, the number of work places reduces and in contrast that, while the distance from work places to CBD decreases, the number of work places increases.

- ***Ankara Metropolitan Region Project***

As an example of the Lowry-Garin model, as a comprehensive study has been conducted in Ankara, Turkey. The study has aimed to determine the probable spatial distribution of population and employment in metropolitan city of Ankara, for the years 1995, 2005 and 2015. The followed steps for the project can be summarized as:

designing the model as a tool to help the process and deriving the recommendations as the clues for the process.

The data used in the model include population, total employment data (basic and service employment) and measurement of distance between regions (distance matrix). Estimation of total populations and the spatial distribution of the total population estimates for the years are based on two main assumptions. The first one is population projections according to the upper-scale plan and the second one is spatial distribution of population according to the strategies of current plan. According to main goals, the results can be summarized as: The inter-regional interactions will increase; the main effect of the choice of place of employment increase; the more the interaction level rise, the more the distribution of population and employment changes proportionally.

- ***Istanbul Metropolitan Region Project (1995)***

A project has developed in Istanbul to determine the distribution of development potentials in population and employment using a Dynamic Lowry Model and the population data from year 1985 to year 2000. The study area of this project is 16 districts in Istanbul that have been directly affected by the city center.

The results of the analysis can be listed as: First, when the size of urban district in metropolitan areas reduces dramatically, the density of population rises. Second, if the population and population density increase in surrounding districts of city, the population and population density will decrease in the city center. In the same way, when the service employment in the surrounding districts rises, the employment in the central districts increases. Additionally, planning of new urban centers in Istanbul will affect the urban development to prevent the city from randomly development.

2.2.2 Applications of The Hansen Model

- ***Washington Metropolitan Region Project (1959)***

Hansen focuses on the relationship between accessibility and potential development of residential areas. In his study, firstly the accessibility for work, current population and shopping facilities are calculated for 70 different regions in

Washington metropolitan area, U.S. After the total future populations of these regions are calculated using population data of 1948 and 1950, the total additional population in regions is distributed to the available residential settlements in the city. As a result of these calculations, according to Hansen's hypothesis, the difference between current population and projected population in the region is based on a single parameter. (Please see modeling section for details in formulation)

Moreover, in the next step of the application of the model, the development potential (D_i), and the accessibility to work in regions are calculated. According to these calculations, the value of development potential is equal to 13.7 and the accessibility to employment is 2.7. Another result of the study is the estimated growth for the region by 1965 year is 2,000 more people and 1,000 more jobs (Hansen, 1959). Table 2.2 shows the distribution of residential development in three cases, according to Hansen.

Table 2.2 The distribution of residential development

Cases	**Hypothesis 1**	**Hypothesis 2**
Case 1	Travel times between regions are the same in 1965	The increase in employment takes place in Zone 1
Case 2	Reducing travel times by 1965 with building of an express highway	The increase in employment takes place in Zone 1
Case 3	Travel times between different zones are the same in 1965	The increase in employment takes place in Zone 3

- ***Adana - Ceyhan Region Project***

Similarly, in Ceyhan, Adana, Ayhan and Çubukçu (2007) conduct a case study using Hansen Model. In this example, for 7 different sub – regions in the city, the projected population is estimated and the need of various facilities (cultural, economic, social, etc.) are determined using current population data in 2004 – 2005 in Ceyhan, Adana, and master plan proposals. The parameter value is set to 2.0 and the distance parameter is not calibrated in the study.

Finally, by the year 2020, the total future population of all regions in Ceyhan District is 145,001 persons and the additional population is 36,802. As another result of the study, necessary area for various facilities for each neighborhood is calculated using the model results (Ayhan and Çubukçu, 2007).

2.3 Geographical Information Systems (GIS)

In recent years, Geographic Information Systems (GIS) are among the technologies widely used in the field of urban and regional planning as in many areas. A GIS can be defined as a computer system that allows such operations as a collection for a specific purpose, computer storage, update, control, analyze and display with using geographical and non – geographical data more quickly and accurately than traditional tools (Carter, 1994; Maguire, 1991; Tecim, 2008; Aksu, 2007).

GIS is based on remote sensing, satellite photography and information technology. It was first introduced in the European Union countries starting from 1990 and it has been increasingly popular in many different fields like energy and climate change, community mapping and analysis, health, housing, education/research, land and wildlife conservation, natural disasters - risk and vulnerability analysis, urban growth management planning, water systems, biodiversity, impact assessment, pollution management (ESRI - UK, 2007; Mather, 1987; Thrall, 1999). Figure 2.3 shows different sectors that GIS techniques and technology are used.

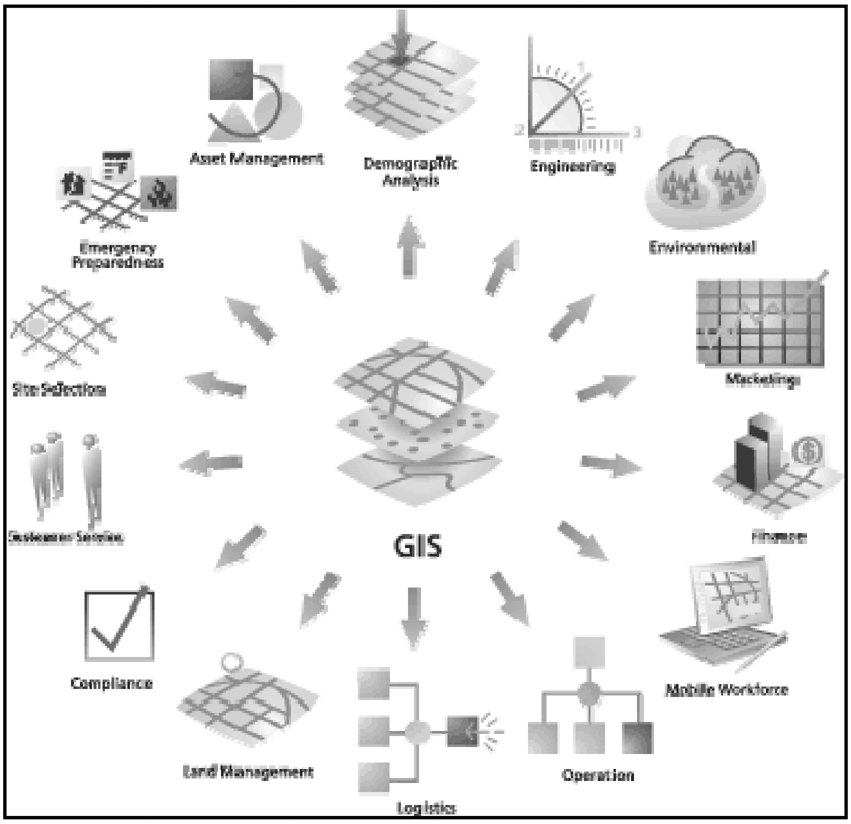


Figure 2.3 Various sectors using GIS techniques and technology (Tecim, 2008)

GIS, as a means, can help to generate alternative solutions and scenarios in decision making process in urban space. This process can be identified through the main steps including: data collection, data entry, analysis, synthesis, scenarios and alternatives, generation, planning and presentation. In addition, this functional system provides not only production of strategies to solve the problem with using various software and geographic analysis through the multi-layered structure, but also a better detection at the end of the planning process of projects by providing better quality and visually rich presentation formats (Carter, 1994; Maguire, 1991; Parker, 1988; Aksu, 2007).

In terms of the multi-layered structure, a GIS centrally stores information about the world in a collection of digital map layers. In comparison to many formats stored in multiple places as filing cabinets, different computer systems or static paper maps, a GIS pulls together very different pieces of information into one system. These map layers may be over-laid and linked together to create maps, integrate information, visualize and compare scenarios, solve problems, and more effectively manage resources (Carter, 1994; Maguire, 1991; Chidambaram, 2010). Figure 2.4 shows the flow chart that is prepared for the study about monitoring the impacts of urbanization in Torbalı region in different data layers using GIS.

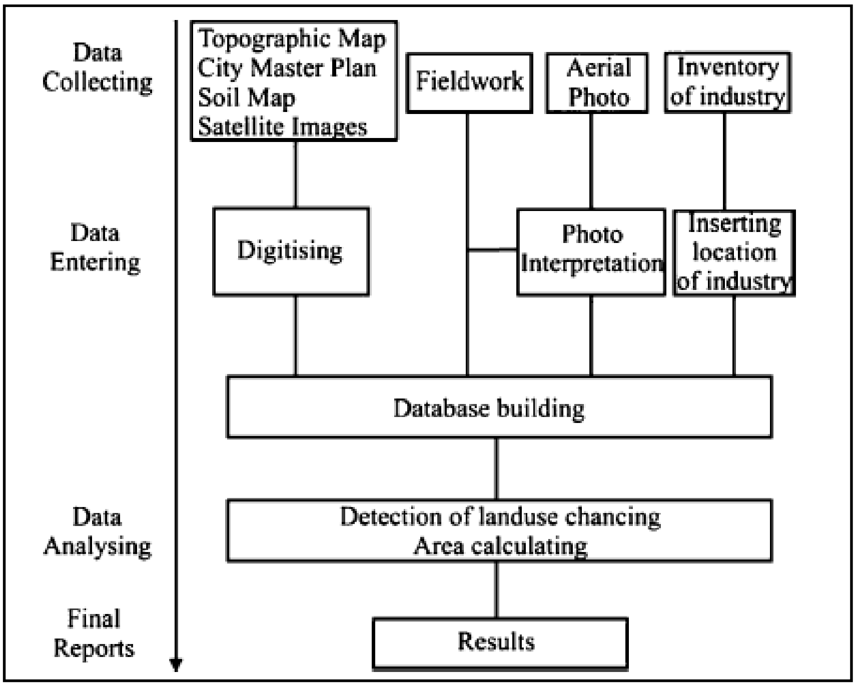


Figure 2.4 Flow chart of study combines data layers from different sources (Bolca, 2007)

According to the results of search for solutions to the problem and spatial analysis that are made for a specific purpose, GIS is used as a system with all the features of the problem until the end of the process. Using GIS technology is extremely necessary to drive using of spatial information, geographic database management and decision support systems, when how much difficulties are found in the process of the planning process, different institutions, collecting and analyzing data generated in different ways (Carter, 1994; Maguire, 1991; Aksu, 2007). Figure 2.5 shows the relationship among components of GIS, like computer aided design, remote sensing, computer cartography and database management, etc (Maguire, 1991).

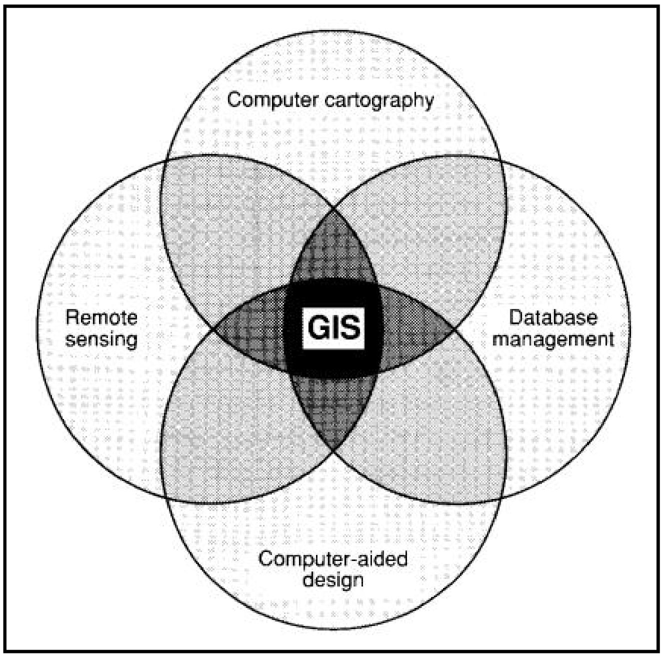


Figure 2.5 The relationship between components of GIS (Maguire, 1993)

The GIS software widely used around the world can be listed as: AutoCAD MAP, MapInfo Professional, Map Basic, Geo Media, NETCAD, Microstation Geo Graphics, Inter Graph, Map Objects, Arc View GIS (ESRI), Arc Info (ESRI), ERDAS, IDRISI, GRASS, SDE, Microstation Geo Graphics and Caris (Çukur, 2002; en.wikipedia.org; Levine, 1996). Figure 2.6 shows the comparative distribution graphic of software companies that work on GIS and serve these services to the market.

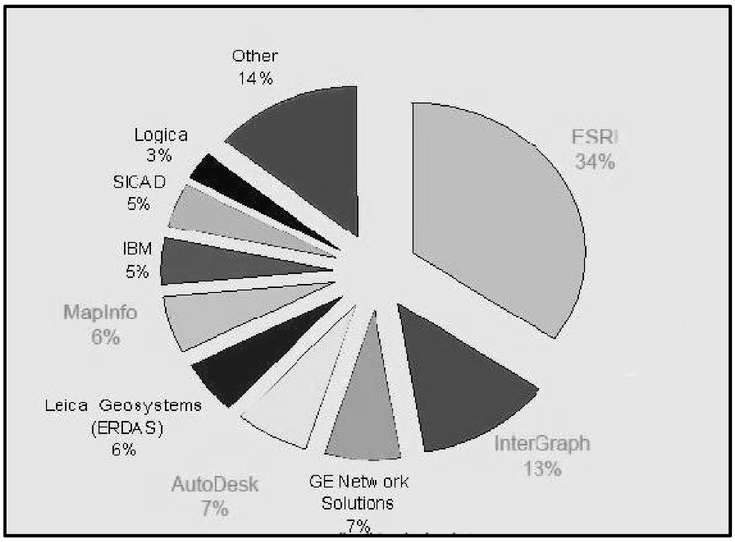


Figure 2.6 The distribution graphic of GIS Software Companies *(Çukur, 2002)*

The significant components that are each equally important to the success of GIS are hardware, software, data, methods and staffs. *Hardware* is defined the whole of computer and related by-products that make GIS possible to process, like printer, plotter, scanner, digitizer, data collector, etc. Therefore, *software* may possible to define as algorithms in high-level programming languages that run the computer program, geographic information store, analyze and display functions to provide services that users need, like Arc Info, Intergraph, Map Info, Small World, Genesis, IDRISI, Grass, etc. The term *data* refers to qualitative or quantitative attributes of a variable or set of variables, like attribute data, geographic data, tables, etc. The *methods* can be presented as efficient techniques must be developed and implemented to provide spatial information flow between institutions within the units or agencies of rules in GIS. Finally, *staffs* are expert technicians who design and use this system to improve the performance of daily tasks with a large mass of system users, implement real-world problems and prepare development plans (Thrall, 1999; Levine, 1996; Carter, 1994; Tecim, 2008; Çukur, 2002).

CHAPTER THREE
MODELLING METHODOLOGY

As mentioned, selected quantitative models are the Lowry - Garin Model and the Hansen Model in this study. The Hansen model can be called a kind of potential gravity model, as it is based on the potential interaction between regions. The Lowry - Garin model is known as the spatial interaction model that integrates with the economic-base concept (Çubukçu, 2008). In this chapter, detailed descriptions of structures of these models within their variables and formulas will be presented. Firstly, general information will be provided on the selected models. Secondly, the role of Geographical Information Systems (GIS) in the study will be pointed out.

3.1 The Lowry – Garin Model

Spatial interaction models, unlike the general comprehensive models, evaluate all parts of the systems using different analysis tools. General comprehensive models contain more complex networks and relationships, so it's difficult to configure their parameters (Haynes and Fotheringham, 1984). According to Foot (1981), while general comprehensive models attempt to describe several parts of the urban systems and simulate the allocation and interaction between several land use activities; the Lowry-Garin model combines them through the economic base mechanism that has been quite widely applied largely all over the world. The Lowry – Garin model is thus a residential location model and a service location model.

Besides many well-developed urban models, the Lowry model has a wider context, so it can help planners in decision making process (Horowitz, 2004). As a different model from the others, Lowry model has two significant influences on the urban modeling zone. The first one is the prediction and the distribution the population and employment simultaneously. The second one is that it combines the three components of urban structure in a single model including population, employment and the interaction between these two components (Garin, 1966; Lee, 1973).

The Lowry model's structure is based on economic based model. This model has been initiated by the American and British planners. It is used to make inference on two separate sectors. The basic sector can be defined as the sector that provides in goods and services to the national economy. The service sector or non – basic sector provides contribution to the local economy (Lowry, 1964; Lee, 1973; Richardson and Gordon, 1978). According to the economic - base theory, the change in basic industries affects the local employment and population directly and indirectly. These sectoral and spatial distributions of the estimated employment are considered by Lowry on the model (Garin, 1966). The formulas of basic employment, service employment and population with their parameters are as follows:

$$Ei = Eb + Es \tag{3.1.1}$$

where,

E_i = Total employment in zone i,

E_b = Basic employment in zone i,

E_s = Service employment in zone i.

$$Es = Pi * \beta \tag{3.1.2}$$

where,

E_s = Service employment in zone i,

P_i = Total population in zone i,

β = Parameter of function.

$$Pi = Ei * \alpha \tag{3.1.3}$$

where,

P_i = Total population in zone i,

E_i = Total employment in zone i,

α = Parameter of function.

Lowry has focused on a part of a wide region in Pittsburg city and made mathematical analysis based on the economic base mechanism. General point of this mechanism is that the basic employment, service employment and population are the crucial components of the model (Goldner, 1971). The basic employment is presented as the rest of employment in the region and is directed to the production of goods and services for elsewhere. On the other hand, the service employment is regarded as serving the local population and is therefore related to the production of goods and services for residents in the study area (Foot, 1981). Finally, after considering the principal activities of population and employment in this region, Garin has synthesized the analysis gathering from Lowry's modeling study by using the gravity model and reformulated in matrix form successfully (Horowitz, 2004; Garin, 1966).

The model of Lowry-Garin, in fact, is a type of the gravity model. It includes the location of both residential units and employment in the region (Goldner, 1971). Moreover, the Lowry-Garin model has been the identity as an "operational model" after developments in the 1960s and winning worldwide interest during the 1970s (Horowitz, 2004). In comparison to the other models, there are two main reasons for this extremely common interest for Lowry-Garin model. The first one is the inclusion of the economic and geographic dimensions of the phenomenon of interaction with the city. The second one is covering the planning decisions in the form of external data (Foot, 1981; Lee, 1973).

The reasons for using the Lowry-Garin model successfully not only in scientific research, but also in application are as follows: It removes the differences among subscales and accomplishes the distribution of population and employment, providing transition of spatial interaction and assessment of decision effects on urban structure in terms of type and volume in the urban system (Horowitz, 2004; Richardson and Gordon, 1978; Güvenç, 1987).

The main components of the urban system are population, employment and interaction between these two components (Foot, 1981; Lee, 1973). Figure 3.1 is an illustration of the urban system described in the Lowry – Garin model.

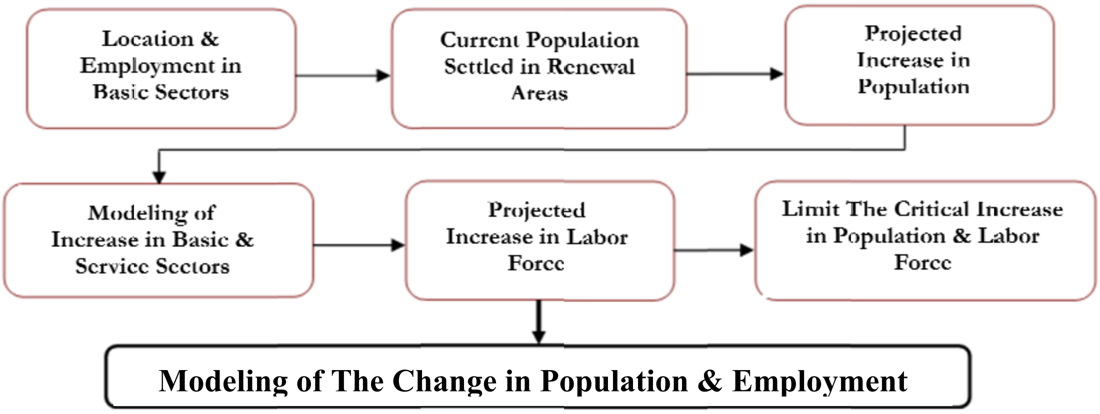


Figure 3.1 The flow chart of the Lowry – Garin model

The question of how the future distribution of the workforce will be in the region of the entire city can be responded using the Lowry - Garin model in the scope of the study area. Because Lowry (1964) developed the model has the following characteristics: (Foot, 1981; Lee, 1973)

(a) Using the basic employment size and spatial distribution as data,

(b) Producing the service (local) employment and distribution of labor force,

(c) Producing results about the size of urban activities,

(d) Examining the relationships among population, labor force and spatial interaction between them.

Data types used in the model includes total population, the population sizes of the regions to work, the estimation data of the total employment for the year, the year's total inter-regional estimation data and distance measurement. When assumptions of the model are examined, the total population estimates and target goals, the spatial distribution of the total population estimates for the years stand out (Güvenç, 1987, Çubukçu, 2008). If the obtained data types are promoted to be calibrated according to the Lowry-Garin model, the total area and region area on the basis of population are calculated using formulas below (Güvenç, 1987):

$$Tij = Aj * Ei * Hj * e(-\gamma * Cij) \tag{3.1.4}$$

where,

T_{ij} = Total population that people live in zone i and work in zone j,

A_j = Attraction index of zone j,

E_i = Distribution of basic employment index of zone i,

H_j = Location of new residential development,

C_{ij} = Travel cost of transportation,

γ = Parameter of travel cost functions.

The problems and constraints of the model can be summarized as follows: The static structure of model; the difficulty of observing the effects of the policies developed on urban systems over time; the simplified relationships between urban activities; the inadequate explanation the process of supply-demand relationship through housing and employment; inadequacy of monitoring the behavior of more than one factor in space; inadequacy of explaining the behavior of housing activities seen in the housing areas; difficulties in estimation of the model because of space constraints in housing (Garin, 1966; Lee, 1973; Horowitz, 2004).

There are important terms involved in the setup of numerical methods. In the Lowry - Garin model these concepts are as follows: The rate of population to basic employment (α), the rate of population to service employment *(β),* service employment in zone *(E_s),* basic employment in zone *(E_b),* total employment in zone *(E_i),* total population in zone *(P_i),* the function of Work Place – Home *($a_{ij}^{'}$),* the function of Home – Service Sector – Home *($b_{ij}^{'}$)* (Cubukcu, 2008). To begin the estimation of data in the model, firstly the rate of Population – Basic Employment (α) and the rate of Population - Service Employment (β) are calculated.

$$\alpha = \frac{Pi}{Ei} \tag{3.1.5}$$

where,

$\alpha =$ The rate of population to basic employment,

E*i* = Total employment in zone *I,*

P*i* = Total population in zone *i.*

$$\beta = \frac{Es}{Pi} \tag{3.1.6}$$

where,

$\beta =$ The rate of population to service employment,

E*s* = Service employment in zone I,

P*i* = Total population in zone i.

After the calculation of the rates, matrices of (α) and (β) are formed. The matrices of calculated rates (α) and (β) can be created as (Garin, 1966):

$$\alpha = \begin{bmatrix} \alpha & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \alpha & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \alpha & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \alpha & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \alpha & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \alpha & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \alpha & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \alpha \end{bmatrix} \quad \text{and} \quad \beta = \begin{bmatrix} \beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \beta & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \beta & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \beta & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \beta \end{bmatrix}$$

Therefore, the function of Work Place – Home ($a_{ij}^{'}$) is formulated and its matrix is created. The function of Work Place – Home ($a_{ij}^{'}$) defined as (Garin, 1966):

$$a_{ij}^{'} = \frac{e^{-0.1\,tij}}{\sum_{j=1}^{n} e^{-0.1\,tij}} \tag{3.1.7}$$

Similarly, the function of Home – Service Sector – Home ($b_{ij}^{'}$) is formulated and its matrix is created. The function of Home – Service Sector – Home ($b_{ij}^{'}$) can be defined as (Garin, 1966):

$$b_{ij}^{'} = \frac{e^{-0.1\, tij}}{\sum_{j=1}^{n} e^{-0.1\, tij}} \tag{3.1.8}$$

After these calculations of the functions, to figure out the distribution of total labor forces over all the study area (Garin, 1966):

$$Ei = E^{b} * [I - (A^{'}[\alpha][\beta]B^{'})]^{-1} \tag{3.1.9}$$

this formula is used. While calculating the total labor force value, variables in the above formula are used (Garin, 1966):

$$Ei = Eb + Es \tag{3.1.10}$$

where,

E_i = Total employment in zone *i,*

E_b = Basic employment in zone *i,*

E_s = Service employment in zone *i.*

this formula is used and the total employment in zone *i* can be figured out.

$$Es = Pi * \beta \tag{3.1.11}$$

where,

E_s = Service employment in zone *i,*

P_i = Total population in zone *i,*

β = Parameter of function.

this formula is used and the service labor force can be figured out.

Finally, by looking at data obtained from the labor force and population, a population estimated by the Lowry - Garin Model envisaged. The formula that is used for calculating the total projected population is as follows (Garin, 1966):

$$P = E * A' * (\alpha) \tag{3.1.12}$$

where,

P_i = Total population in zone *i,*

E_i = Total employment in zone *i,*

A' = The function of Work Place – Home,

α = Parameter of function.

this formula is used and the total population in zone *i* can be figured out with using (α).

$$Pj = G * \sum_{i=1}^{n} \frac{Ei}{dij} \tag{3.1.13}$$

where,

P_j = Total population in zone *j,*

G = Parameter of growth,

E_i = Total employment in zone *i,*

dij = Parameter of distance from zone *i* to zone j.

this formula is used and the total population in zone i can be figured out with using (dij).

$$Pj = \alpha * \sum_{i=1}^{n} Tij \tag{3.1.14}$$

where,

P_j = Total population in zone *j,*

α = Parameter of function,

T_{ij} = Facilities made in zone *i* and zone j.

this formula is used and the total population in zone i can be figured out including facilities between zones (T_{ij}).

3.2 The Hansen Model

Land – use planning is a key tool in coordinating the development activities in urban areas with using models. According to a principle that is worked on by Jacobs and Lynch, a "good" land use plan with "good" implementation produces a "good" environment (Jacobs, 1978; Lynch, 1981). What is built, where it is built, and when and how it is built are so critical questions that are needed to answer by different actors in urban systems, like land planners, interests (neighborhoods, farmers, etc.), market (lend owners, developers, etc.) and finally government (federal, regional, local, etc.) (Kaiser, 1995; Godschalk, 1995; Chapin, 1995).

Land use models are used to estimate the distribution of different activities on physical environment on urban pattern. Owing to this feature of these models, various predictions can be made related to how urban activities and future population are distributed all over the entire city (Hansen, 1959; Haynes and Fotheringham, 1984).

The Hansen model that is based on the relationship between the accessibility index and land use planning is an example for this type of models (Wilson, 1974). According to Hansen (1959), the more accessibility provided to land use activities, the more development potentials for the future of the city implemented to physical environment with plans. Because of this crucial reason, this model is based on the potential interaction among regions which can be implemented. Thus, the Hansen Model is a "*potential gravity model*" (Lee, 1973).

Using numerical models, the changes of the urban system observed and expected to occur in the future can be analyzed. In addition, questions about envisaged urban activities in the scenario and existing land use can responded. For example, when the planned investments are realized, it is possible to answer how the distribution of increase in population and labor force will be in residential areas throughout the city by using the Hansen model. Because the model developed by Hansen revealed that these critical relationships: (Hansen, 1959)

(a) Land development is directly proportional to the accessibility index.

(b) The increase in population and labor force is directly proportional to the land development.

(c) The increase in labor force is directly proportional to the accessibility index.

(d) The accessibility index is inversely proportional to the distance among regions.

(e) If availability of employment and the total potential land amount are known, the development in housing in each region is predictable.

(f) Additional population in regions is directly proportional to the labor force and the size of suitable land for settlement.

(g) The future population in regions is inversely proportional to the distance matrix and distance.

Considering the research included what kind of and where people make trips in metropolitan city that vary like home to work, home to school, home to other, etc. According to the results, most of these trips are home based. So, Hansen firstly aims to define the relationship between the accessibility of urban facilities (commercial, industrial, etc.) and the development potential of residential areas (Hansen, 1959). In his study, the accessibility is defined as the generalization of the population over distance relationship and the density of potential interaction. The main hypothesis of the gravity models is what the function of accessibility can be. The hypothesis of the Hansen Model is the exponent value of model to calculate the accessibility should be the same with the value of exponent in Gravity Models (Hansen, 1959; Haynes and Fotheringham, 1984; Butler, 1972).

The terms that used in the Hansen Model can be summarized as: the accessibility index (A_i), the development potential of region (D_i), the additional shares of the population of the region (R_i), the additional population in each region (G_i), the total additional population in region (G_T), exponent value (α) can be listed. According to Hansen (1959), when the data are analyzed in long – distance studies worked with using Gravity Model, the value of exponent is estimated as 0.5 and 3.0. However, the waiting time is a very small portion of total travel time in long – distance journeys, so this value is not very appropriate for long – distance journeys. On the other hand, when the waiting time is quite important for trips in the city, the distance parameter should be between 2.5 and 3.0. As an example, the value of 2.20 is suitable for trips made for business purposes, 3.00 for shopping trips, for other trips this number should be 2.35 (Hansen, 1959).

Firstly the accessibility index (A_i) for all districts in study areas is calculated.

$$A_i = \sum_{j=1}^{n} \frac{Ej}{d_{ij}^{\alpha}} \qquad (3.2.1)$$

where,

A_i = The accessibility index,

E_j = Total employment in zone *j,*

d_{ij}= The distance from zone i to zone *j,*

α = The exponent parameter.

After the index calculation in accessibility of the districts, the development potential of the districts (D_i) values are calculated. These values are used to calculate the following formula:

$$D_i = A_i * H_i \qquad (3.2.2)$$

where,

D_i = The development potential of districts,

A_i = The accessibility index,

H_i = Vacant residential area (ha).

In addition to these calculations, the additional shares of the population of the districts (R_i) are calculated in the scope of the thesis work. For the calculation of additional shares of the population of the districts, the formula is used:

$$R_i = \frac{D_i}{\sum_{j=1}^{n} Dj} \tag{3.2.3}$$

where,

D_i = The development potential of districts,

R_i = The additional shares of the population of the districts.

For determining how the total population of districts will distribute in Izmir city should be, firstly need to calculate the additional value of the total population the additional and total population values in each district are needed to calculate. The additional population in each district (G_i) is obtained by multiplying the total additional population in districts (G_T) and the additional shares of the population of the districts (R_i). This is the formula for calculating the following format: (Cubukcu, 2008).

$$G_i = G_T * R_i \tag{3.2.4}$$

where,

G_i = The additional population in each district,

G_T = The total additional population in districts,

R_i = The additional shares of the population of the districts.

For all districts, the additional population in each district (G_i) is calculated and summed up with the current population values in t year *(P_i^t)*, each districts' population *(P_i^{t+1})* that are projected at the time *t+1* is calculated (Çubukçu, 2008).

3.3 The Role of Geographical Information Systems (GIS) in Modeling

GIS is used as a tool for two goals in this study: First is to calculate the size of zones and the distances among the districts in this study. Second is to visualize the results of these calculations. The softwares of GIS used are ArcMap, MapInfo, Idrisi GIS.

The size of area, the distribution of population and employment and the distances among the districts are calculated and analyzed using base maps. These base maps are obtained from IKBNIPR plan revision. Thematic maps, charts and matrices are prepared using these calculations and analyses. The charts and matrices take place in the Data section. Also, the thematic maps are presented in Results & Estimations section.

There exist certain features of GIS which make the system more preferable to use it in different applications, as well as in modeling. Actually, the features of the system can be considered as responses of main questions. Why GIS is used in this study? How GIS can be used in this study? These features of the system are as follows:

- The multi – layered analyses can be made by using the GIS. These analyses are important and determinative in planning as well, in terms of decision making process. So, GIS is used in this study, as a method.
- There are similarities between planning process and GIS in terms of main steps. These steps can be identified as follows: Data collection, data entry, analysis, synthesis, scenarios and alternatives, planning and presentation. Thus, using GIS is chosen, as a process.
- GIS provides better decision making for its users. People are beginning to realize that making the correct decision about a location is strategic to the success of an organization or a planning process. Using statistics, projections and GIS in this study, scenarios and alternatives can be produced about urban renewal areas in future. In this way, GIS is used in this study, as a tool.

- Geography is emerging as a new way to organize and manage organizations. In other words, GIS is preferred to manage geographically. Not only making analyses for study area, but also considering and developing strategies about the area, GIS maintains facility to its users. Therefore, GIS is chosen in this study, as a method.

CHAPTER FOUR
DATA

11 urban renewal areas in 9 districts are defined in the metropolitan city of Izmir with the 1/25000 scale Izmir Urban Regional Master Plan Revision (IKBNIPR). The quantitative models are used to assess the impact of urban renewal areas on the distributions of population and employment in Izmir. These models are the Lowry - Garin model and the Hansen model. The data that is used in the models for the estimation vary according to content of the model. For example, the necessary data for the Lowry – Garin model are as follows: Employment, population and distance matrix. The Hansen model requires data on population, size of available residential areas, employment and distance matrix.

The population data is available for the years 1985, 1990, 2000, 2007, 2008 and 2009; and the employment data on a sectoral basis is available for the year 2002 in Izmir central city. These data are obtained from Turkey Statistical Institute (TUIK).

Depending on the data, the geographical unit of the study is set to districts. These districts are: Konak, Karabağlar, Karşıyaka, Gaziemir, Bayraklı, Çiğli, Bornova and Narlıdere. Although urban renewal applications are discussed in the scale of the neighborhoods, research at the district level is found more effective. The base of this study is the decisions of 1/25000 scale IKBNIPR. According to the this plan, 11 different areas in these districts are defined as “Rehabilitation – Renewal Areas”(IKBNIPR, 2007; Bal, 2008).

In year 2008, "The Law of Establishment of District in the Metropolitan City Boundaries and Amending Some Laws" (No. 5747) is adopted by Grand National Assembly of Turkey (TBMM). Therefore, new additional 43 districts are assembled to within the boundaries of metropolitan municipalities across the country. On the two new districts newly established within the boundaries of Metropolitan Municipality of Izmir is Bayraklı district that is created by combining some neighborhoods in Karşıyaka and Bornova districts. Another one is Karabağlar district that is detached from the district boundaries of Konak. According to this new regulation, the number of the districts that are included the study increased from seven to nine. Figure 4.1 shows the boundaries of districts in Izmir metropolitan area.

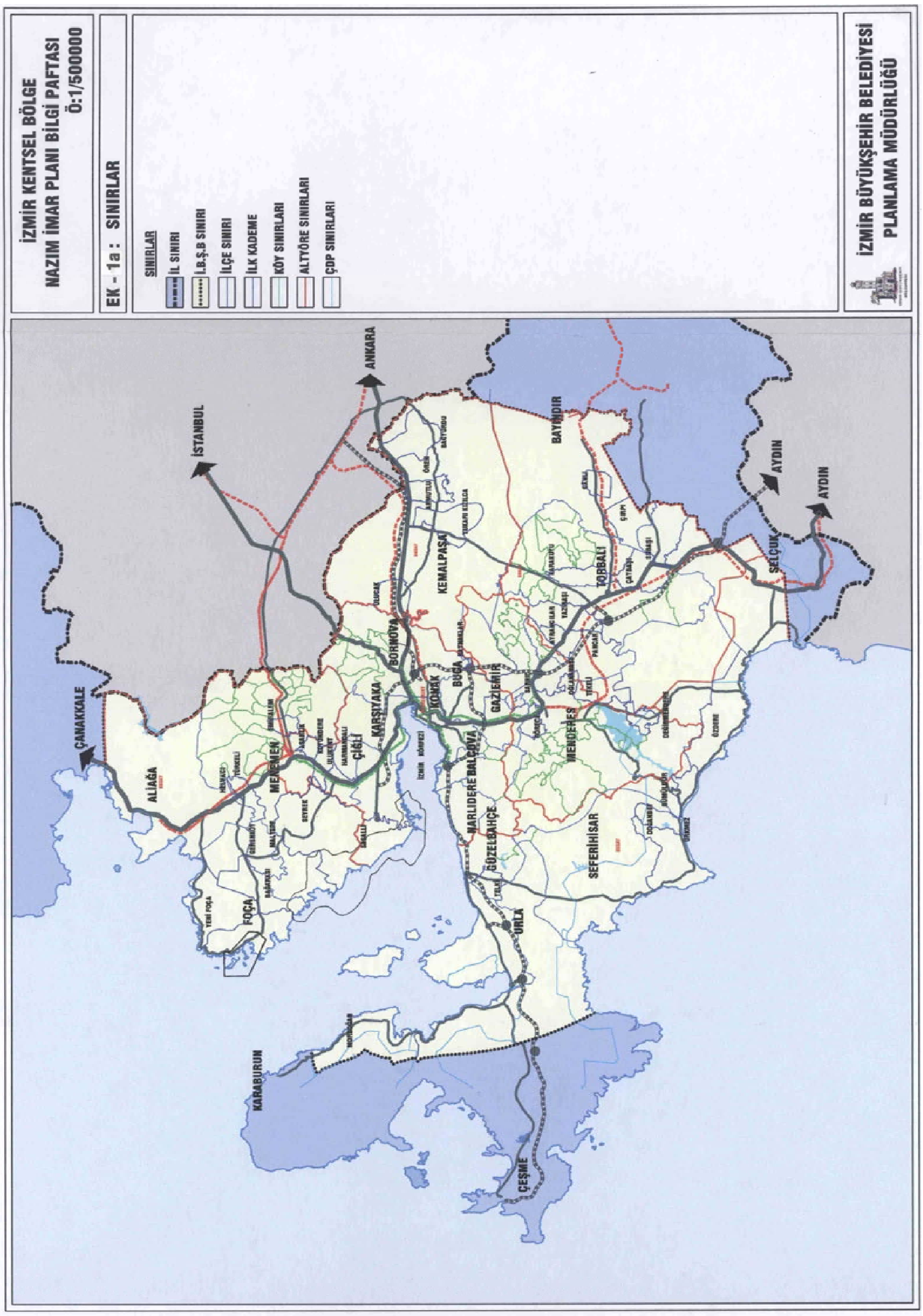


Figure 4.1 The district boundaries in Izmir metropolitan city

For the execution and completion of the study, data from different sources are used in many different formats, as listed in Table 4.2. Table 4.2 shows the types of data used and the list of resources the data is obtained from, in other words, the data - purpose matrix for the study.

Table 4.2 Data – purpose matrix for thesis study

NO	DATA TYPE	DATA NAME	INTENDED USE	DATA SOURCE AGENCY	RECEIVED DATE	FORMAT
1	Numerical	Population, Izmir (Izmir - 2000)	Using in Population Calculations	TUIK (Izmir)	April 2010	Excel
2	Numerical	Employment, Izmir (Izmir - 2002)	Using in Labor Force Calculations	TUIK	November 2010	Excel
3	Numerical	Employment, Turkey (Turkey - 2009)	Using in Labor Force Calculations	TUIK	November 2010	Excel
4	Document	Report For Current Situation & Need Analysis (Izmir - 2009)	Assessment of Plan Decisions	IBB	July 2010	PDF
5	Drawing	1/25000 Scaled IKBNIP	Assessment of Plan Decisions	IBB	March 2010	.NCZ, .DXF
6	Image	1/25000 Scaled IKBNIP	Assessment of Plan Decisions	IBB	March 2010	Raster
7	Drawing	1/1000 Scaled Base Maps	Assessment of Plan Decisions	IBB	March 2010	.DWG
8	Numerical	Population Projections (IKBNIP)	Using in Population Calculations	IBB	March 2010	.PDF
9	Image	Izmir Satellite Images	Assessment of Current Situation	DEU CBS	May 2010	Raster
10	Image	Photos From Land Survey	Assessment of Current Situation	ŞPO Technical Survey	2007	Raster

4.1 Population

The population data for the metropolitan districts of Izmir are obtained from TUIK. This data is for the years 1985, 1990, 2000, 2007, 2008 and 2009. According to this data, the total population of the districts in the study is 1,489.772 people in year 1985, the total population of Izmir is 2,317,82. By the year 2009, the total population of the districts in the study is 2,626.554 and the total population of Izmir is 3,795.978 (TUIK). Table 4.3 shows the changes of the population of the districts within the study area over the years.

Table 4.3 The distribution of population in neighborhoods according to years

POPULATION DISTRIBUTION OF IZMIR DISTRICTS & NEIGHBORHOODS ACCORDING TO YEARS						
	POPULATION DISTRIBUTION (District Populations)					
DISTRICTS	1985 Year	1990 Year	2000 Year	2007 Year	2008 Year	2009 Year
Konak	946,225	720,502	781,363	847,409	411,112	411,112
Karabağlar	*	*	*	*	442,337	448,846
Gaziemir	*	39,905	70,035	86,111	112,149	121,255
Bayraklı	*	*	*	*	303,816	306,427
Karşıyaka	342,944	345,360	438,430	514,917	295,743	304,220
Çiğli	*	73,364	106,740	141,769	153,508	154,397
Bornova	200,603	274,226	396,770	470,211	392,631	402,453
Buca	*	199,130	308,661	393,934	404,472	412,639
Narlıdere	*	31,844	54,107	61,455	59,161	65,714

The current population and current population densities of neighborhoods that are subject to urban renewal are listed. Table 4.4 shows the size of area (ha), population (person) and population density (person/ha) of neighborhoods in study area.

Table 4.4 The size of area, population and population density of neighborhoods in study area (ha) (person) (person/ha)

# of Area	# of Stage	Name of District	Name of Neighborhood	Area (ha)	Population (Person)	Population Density (Person/ha)
1	1	Konak	Cennetçeşme	40	3354	83,85
1	2	Karabağlar	Salih Omurtak,Bahriye Üçok,Limontepe,Ali Fuat Erden	125	14801	118,41
1	3	Karabağlar	Umut, Gazi, Özgür, Yüz, Şerafettin, Yurtoğlu	180	33144	184,13
1	4	Karabağlar	Uzundere	33	2932	88,85
1	5	Karabağlar	Devrim, Abdi İpekçi, İhsan Alyanak, Peker, Uzundere	317	30353	95,75
1	6	Karabağlar	Emrez,Aktepe	162	11267	69,55
1	7	Gaziemir	Kibar,Günaltay,Barış,Selvili,Yunusemre,Aydın	295	53946	182,87
2	*	Bayraklı	Bayraklı,Alparslan,Çiçek,Fuat Edip Baksı,Cengizhan,M.Erener,R.Şevket İnce,Çay	310	86491	279,00
3	*	Karşıyaka	Emek,Gümüşpala,Yamanlar,Org.Nafiz Gürman,Onur	347	72213	208,11
4	*	Konak	Aziziye,Duatepe,1.-2. Kadriye,H.Özdemir,19 Mayıs,Çimentepe,Kocatepe,Zafertepe	165	40064	242,81
5	*	Çiğli	Güzeltepe,Şirintepe	120	17031	141,93
6	*	Bornova	Mevlana,Doğanlar	237	24559	103,62
7	*	Buca	Hürriyet,İnkılap,O.Aksuner,A.Veysel,Akıncılar,Seyhan, Göksu,İnönü,Bin.Reşatbet	510	58471	114,65
8	*	Bornova	Adalet,Mansuroğlu	107	33399	312,14
9	*	Narlıdere	Atatürk,2. İnönü	24	9862	410,92
10	*	Konak	26 Ağustos,Ulubatlı,M.Akif,Saygı	81,5	20365	249,88
15	1	Bornova	Altındağ,Çamdibi	632,4		
15	2	Karşıyaka	Yeni Girne	108		
15	3	Konak	Yenişehir,Gürçeşme,Yeşildere	322,7		

4.2 Employment

The employment data is for the year 2002. It includes the number of local units and employment by districts. As the projection year, the year 2030 is determined in parallel with 1 / 25000 scaled IKBNIPR. Employment by year 2002 are obtained from the "4. Statistical Region Units, the number of local units and employment by economic activity branches" tables (TUİK, 2002). This data is prepared according to workplaces' counts throughout the city of Izmir in year 2002.

The employment is divided into two types. These types are basic and local (service) employment. This division is an assumption of the economic base model. According to this assumption, the total employment is equal to the sum of the basic employment and local (service) employment. The total employment is formulated as (Çubukçu, 2008):

$$e_i = b_i + n_i \tag{4.2.1}$$

where,

e_i = Total employment in zone *i*,

b_i= Basic employment in zone *i*,

n_i = Local (service) employment in zone *i*.

For the separation of these two types of employment, there exist a number of methods. One of these methods is the Location Quotient (LQ) technique. The location quotient is a criterion of the relative concentration of a sector in the settlement (Nagle, 2000). In terms of the type of data used in calculation, this method is not complicated. Because of this, it is commonly used and developed (Klosterman, 1990). The location quotient (LQ) is calculated using formulas below (Kaiser and other., 1995):

$$LQ_i^t = \frac{\frac{e_i}{e_T}}{\frac{E_i}{E_T}} \quad (4.2.2)$$

where,

e_i = Employment in sector *i* in zone,

e_T = Total employment in zone,

E_i= Employment in sector *i* in country,

E_T = Total employment in country.

The location quotient is used to decide which sectors are basic or local. If the location quotient is greater than 1, *i* sector is basic. If the location quotient is less than or equal to 1, *i* sector is local. Table 4.5 shows the list of the number of local units and employment in Izmir and Turkey in year 2002 by economic activity branches, according to the location quotient.

Table 4.5 LQ values for the industries in Izmir by the year 2002

SECTORS	NAME OF SECTORS	ECONOMIC ACTIVITY	EMPLOYMENT IN TURKEY (Ei)	EMPLOYMENT IN IZMIR (ei)	LQ
C	Mining&Quarrying	Service	74154	1897	0,357635
D	Industry	Basic	1887456	155995	1,155423
E	Electricity, Water&Gas	Service	96430	4240	0,614697
F	Construction	Service	224874	13068	0,812414
G	Collected&Retail Trade	Service	1876525	128521	0,957474
H	Restaurants&Hotels	Service	545167	34835	0,893292
I	Transportation&Communication	Service	612814	36778	0,839009
J	Financial Institution	Service	173151	10020	0,809003
K	Real Estate&Business	Basic	339502	31225	1,285782
M	Education Services	Basic	79129	6592	1,164632
N	Health Services	Basic	101193	7400	1,022324
O	Other Services	Service	177924	12084	0,949475

The employment values are obtained from the list of "4. Statistical Region Units, the number of local units and employment by economic activity branches" (TUİK, 2002). The employment data in different districts within the scope of urban renewal for the years are estimated. Accordingly, the ratio of the employment values of each district to the total employment is assumed to be constant. Using these values, the employment data for other years are calculated, with assuming that the current trend in increase or decrease will continue. Table 4.8 shows a list of employment values in both sectoral aspects of the districts, as well as economic activity in the study area.

Table 4.8 Employment according to sectoral and economic activity in districts (1)

		ECONOMIC ACTIVITY				ECONOMIC ACTIVITY				ECONOMIC ACTIVITY	
DISRTICT	**SECTORS**	***BASIC***	***SERVICE***	**DISRTICT**	**SECTORS**	***BASIC***	***SERVICE***	**DISRTICT**	**SECTORS**	***BASIC***	***SERVICE***
BUCA	C	0	18,4	BORNOVA	C	0	28	ÇİĞLİ	C	0	55,3
	D	707,78	9635,2		D	9133,52	18318,5		D	15076,42	10528,6
	E	0	0		E	0	766		E	0	82,3
	F	0	983,2		F	0	1128		F	0	253
	G	0	8669		G	0	16622		G	0	4285
	H	0	1879		H	0	3436		H	0	739
	I	3644,66	3128,3		I	0	3170		I	0	1501
	J	0	443		J	0	917		J	0	427
	K	0	790		K	1156	3295		K	0	970
	M	0	296		M	0	375		M	0	145
	N	0	313		N	0	473		N	0	84
	O	174,72	908,3		O	0	1242		O	0	373

Table 4.9 Employment according to sectoral and economic activity in districts (2)

		ECONOMIC ACTIVITY				ECONOMIC ACTIVITY	
DISRTICT	**SECTORS**	***BASIC***	***SERVICE***	**DISRTICT**	**SECTORS**	***BASIC***	***SERVICE***
GAZİEMİR	C	0	18,4	KARŞIYAKA	C	0	36,8
	D	3140,97	4087		D	0	5679
	E	0	41,2		E	0	0
	F	0	97		F	0	158
	G	0	3292		G	2869,68	9067,3
	H	0	403		H	156,77	2634,2
	I	0	1152		I	0	218
	J	0	270		J	0	774
	K	0	446		K	3565,53	1640,5
	M	0	156,4		M	169,65	382,3
	N	0	79		N	373,04	489
	O	0	217		O	828,28	859,7

Table 4.10 Employment according to sectoral and economic activity in districts (3)

		ECONOMIC ACTIVITY				ECONOMIC ACTIVITY	
DISRTICT	**SECTORS**	***BASIC***	***SERVICE***	**DISRTICT**	**SECTORS**	***BASIC***	***SERVICE***
KONAK	C	0	178	NARLIDERE	C	0	18,4
	D	0	35335		D	0	308
	E	78,03	2187		E	0	0
	F	0	714		F	412,64	80,4
	G	7278,65	42558,4		G	0	0
	H	0	12086		H	137,18	194,8
	I	0	10515		I	0	179
	J	905,05	3927		J	23,12	61,9
	K	7794,32	7699,7		K	269,68	121,3
	M	0	376		M	56,72	28,3
	N	2038,01	2295		N	176,84	36,2
	O	346,8	4035,2		O	43,42	63,6

4.3 The Distance Matrix

In the study, the distances across the district centers of nine districts and from the district centers to the farthest point of each district are calculated. After these calculations, the time and distance matrices are generated. For the generation of the distance matrix, as the primary method, satellite images of Izmir metropolitan area by year 2011 are used. These images are obtained by using Google Earth and City Surf and the 3D guide to the city that has been prepared by the Metropolitan Municipality of Izmir. By using ortho photos in the program, the routes among the district centers are defined.

In Figure 4.11, the satellite image that shows the whole Izmir metropolitan obtained using the program City Surf. Figure 4.12 shows the satellite images obtained using the program Google Earth. Table 4.13 shows the distance matrix of the districts in the scope of the study area.

Figure 4.11 Satellite images of Izmir metropoliten area in 2011 year – Citysurf

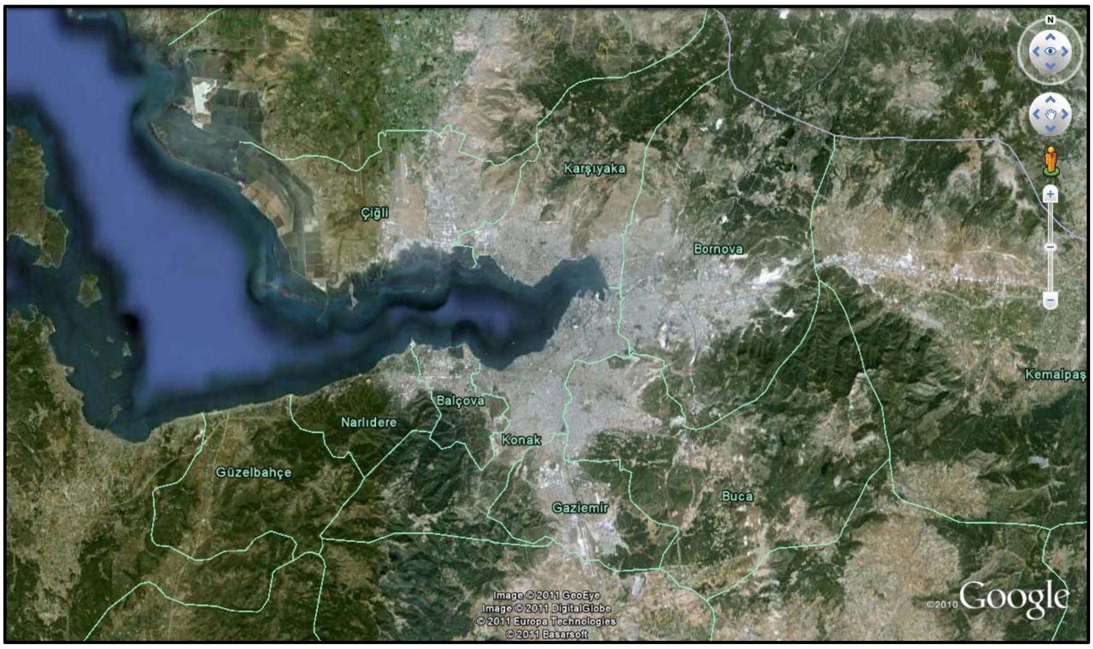


Figure 4.12 Satellite images of Izmir metropoliten area in 2011 year – Google Earth

Table 4.13 The distance matrix of districts in study area (Meter)

Dij (m)	Bayraklı	Buca	Bornova	Çiğli	Gaziemir	Karabağlar	Karşıyaka	Konak	Narlıdere
Bayraklı	6,550	15,390	9,404	6,743	23,148	17,765	3,458	12,258	24,824
Buca	15,399	10,700	12,151	19,969	9,051	5,938	15,176	6,240	14,969
Bornova	9,643	11,857	9,150	15,386	19,615	13,812	11,031	8,305	20,871
Çiğli	6,527	20,231	15,510	2,850	27,018	21,153	6,399	15,646	28,212
Gaziemir	22,728	8,250	19,622	27,015	8,650	7,722	22,222	11,724	16,032
Karabağlar	17,115	5,811	14,215	21,402	7,767	8,800	16,609	5,459	9,434
Karşıyaka	3,381	15,309	11,006	6,579	22,096	16,231	5,950	10,724	23,290
Konak	11,773	6,170	8,873	16,060	11,760	5,508	11,267	4,700	12,570
Narlıdere	24,512	15,229	21,612	28,799	15,791	9,598	24,006	12,798	2,050

The average speed is determined for determining the time (minute) in the distance matrix. These speeds are 45 km / h for 1. degree roads, 25 km / h for 2. degree roads, 65 km / h for the highway (Çolak, 2010). The roads types and graduation of roads are presented in Figure 4.15. The distance matrix as a result of the measurements is shown in Table 4.14 in terms of minutes and in Table 4.13 in terms of the length (meter).

Table 4.14 Time matrix of districts in study area (Minute)

Tij (min)	Bayraklı	Buca	Bornova	Çiğli	Gaziemir	Karabağlar	Karşıyaka	Konak	Narlıdere
Bayraklı	18	21	8,681	8,991	30,864	23,687	8,299	16,344	33,099
Buca	20,532	30	11,216	26,625	21,722	14,251	20,235	8,320	19,959
Bornova	8,901	15,809	22	14,202	26,153	18,416	14,708	11,073	27,828
Çiğli	8,703	26,975	14,317	14	36,024	28,204	8,532	20,861	37,616
Gaziemir	30,304	7,615	26,163	36,020	19	10,296	29,629	15,632	8,708
Karabağlar	30,304	19,800	26,163	28,536	18,641	17	22,145	13,102	8,708
Karşıyaka	8,114	20,412	14,675	8,772	29,461	21,641	20	12,533	31,053
Konak	15,697	14,808	11,831	21,413	15,680	13,219	15,023	14	16,760
Narlıdere	32,683	20,305	28,816	38,399	14,576	12,797	32,008	17,064	10

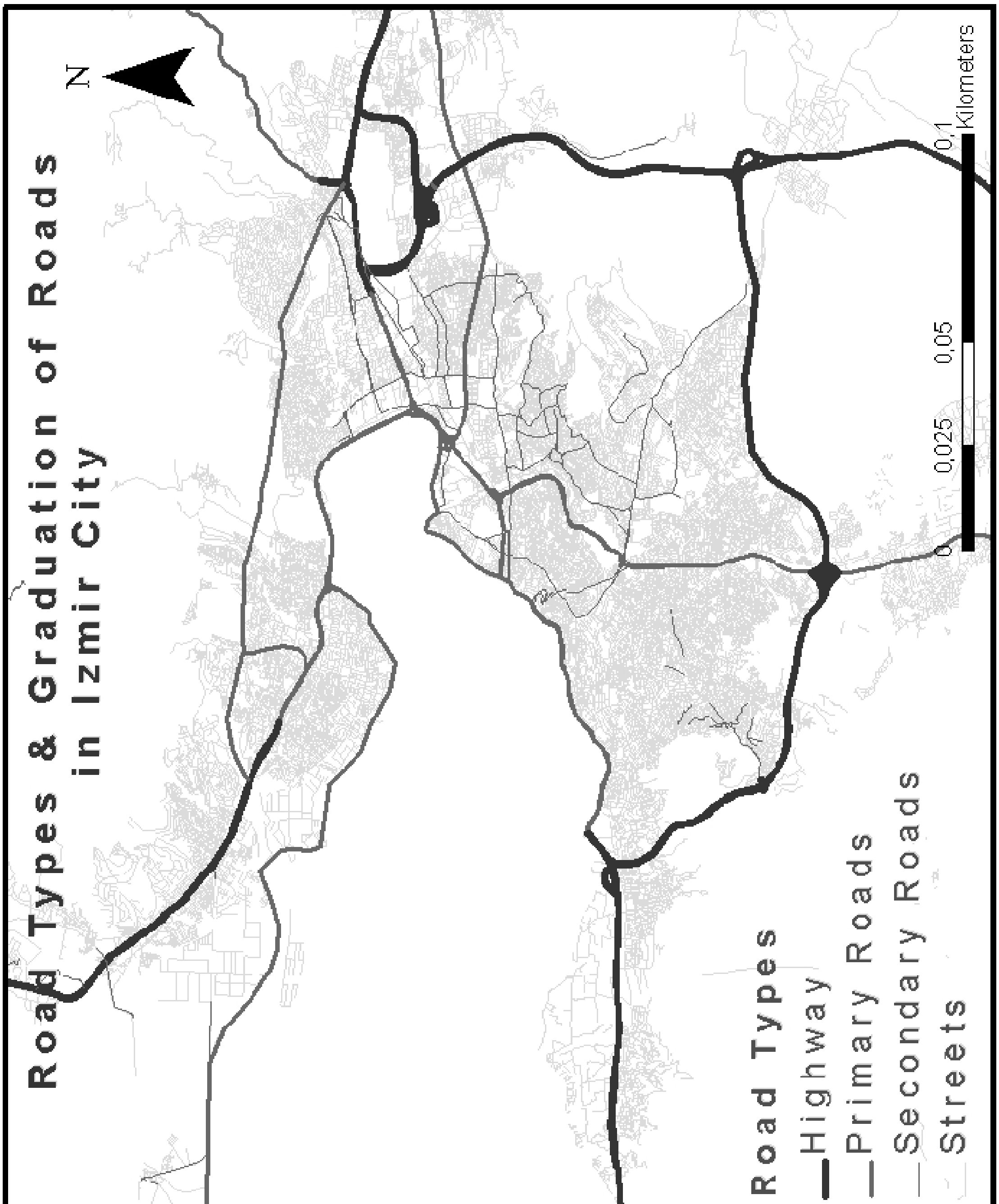


Figure 4.15 The roads types and graduation of roads in Izmir city

In addition, as the second method, the Route Application of Opet is used for the determination of the shortest and fastest routes. The Route Application can be defined as an application that determines of the selected best route on a map between two selected settled centers in the boundaries of Turkey. Moreover, this application is possible to find the shortest route or fastest route. The selected using unit is meter in the measurements made in both two methods. Figures 4.16, Figure 4.17, Figure 4.18 and Figure 4.19 show alternative routes obtained using the Route Application of Opet.

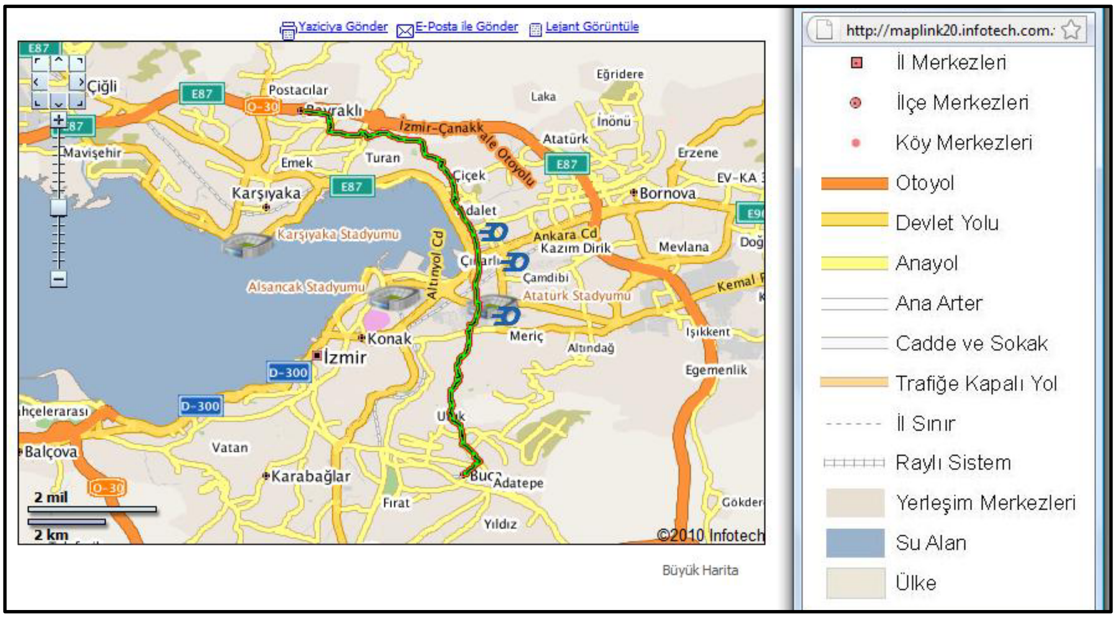


Figure 4.16 Designated routes by Opet route application (Bayraklı – Buca)

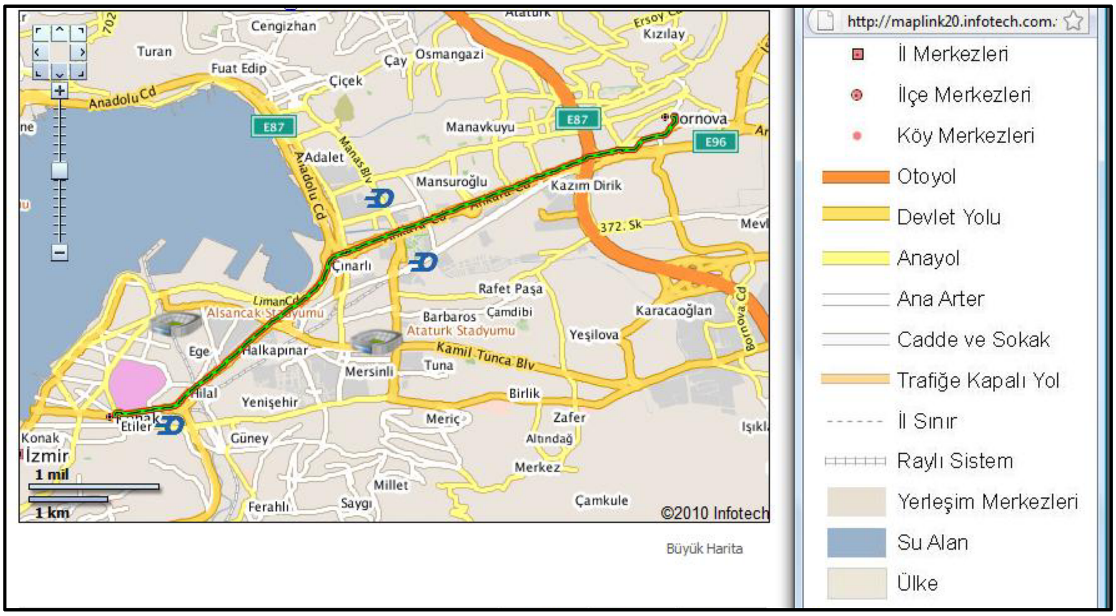


Figure 4.17 Designated routes by Opet route application (Bornova – Konak)

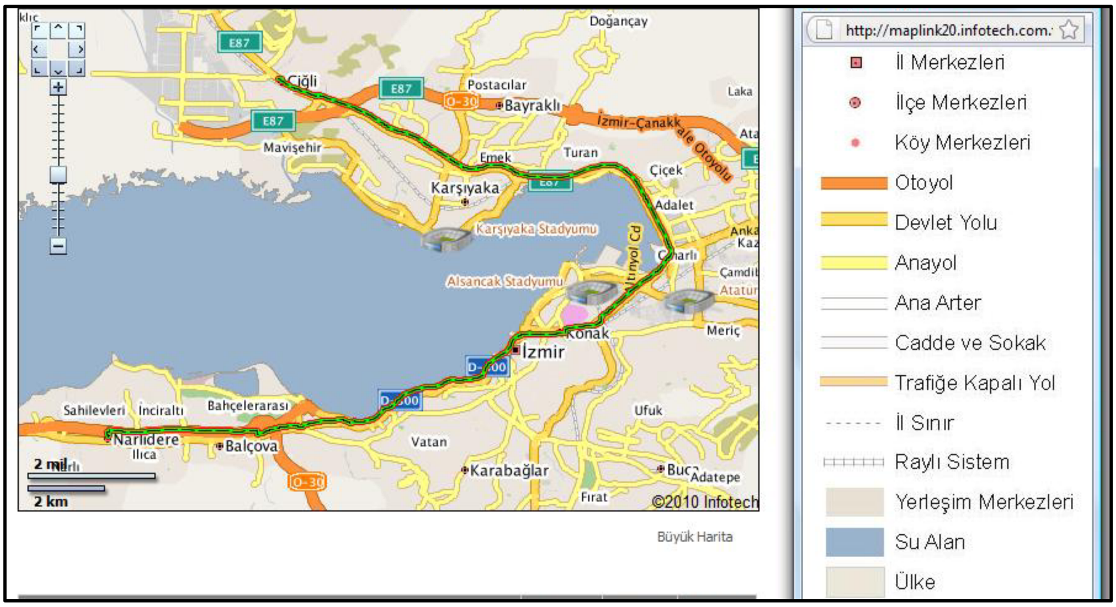


Figure 4.18 Designated routes by Opet route application (Çiğli – Narlıdere)

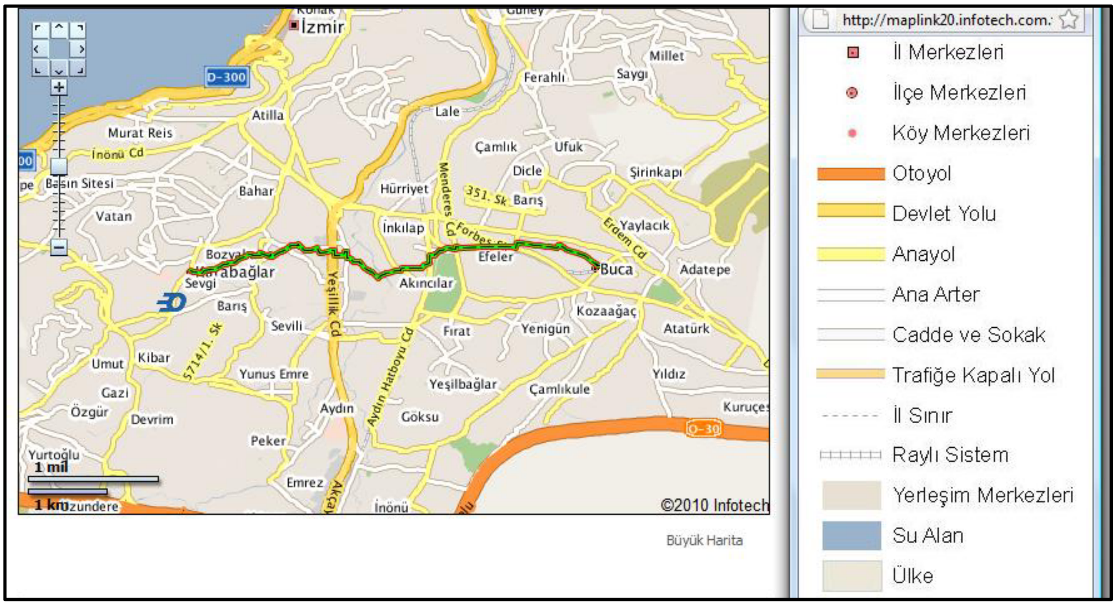


Figure 4.19 Designated routes by Opet route application (Karabağlar – Buca)

When the time and distance matrices are prepared, two types of calculation are made. One of them is to measure distances among districts. This type of calculation can be made for the shortest path in three ways: The bird's-eye, time or distance. Generally, the commercial centers of districts will be based on for the calculation (Çubukçu, 2008). As another calculation, to measure the distance of each district itself is used. In this calculation, the way followed is to receive a adequate number of random points and to average of these distances in the districts through the district centers (Çubukçu, 2008).

In the study, using method is to measure distance from the most distant point in the district by using satellite images and half the distance of this point is taken numerically. In other words, half the distance is used from each of district centers to the farhest point of each of districts. For example, the most distant point of Bayraklı district from own center is Postacı neighborhood and the distance between them is determined as 13.1 meters. The distance between the closest point and the distant point in this district takes places as 6.55 meters in the matrix. The most distnat points that are located according to district centers are shown in Table 4.20.

Table 4.20 Distant points of each district according to district centers

DISTRICT	DISTANT POINT OF EACH DISTRICT
Bayraklı	Postacılar Neighborhood
Buca	Doğancılar Neighborhood
Bornova	Kavaklıdere Neighborhood
Çiğli	Metin Oktay Neighborhood
Gaziemir	Zafer Neighborhood
Karabağlar	Arap Hasan Neighborhood
Karşıyaka	Yamanlar Village
Konak	Çınarlı Neighborhood
Narlıdere	2. İnönü Neighborhood

In the determination of the routes among the districts, the average speeds are used that change depending on the grading of roads. The shortest time is chosen option when the time matrix is prepared and the shortest distance is taken into consideration while the preparation of the distance matrix, as chosen option. For this reason, the average speeds may vary along the route among districts. For example, when calculating the shortest route between Çiğli – Narlıdere districts, the average speed of 1. degree roads is used from Çiğli to Fahrettin Altay neighborhood, and then the average speed of highway (Izmir – Çeşme highway) is used from Fahrettin Altay neighborhood to Narlıdere.

4.4 The Size of Available Residential Areas

For the determination of the available residential areas, plan decisions of 1 / 25000 scale IKBNIPR plan revision in terms of land use decisions are examined in three separate categories. These categories are as follows: (a) Residential Areas -> Existing residential areas and available residential areas; (b) Non - Residential Areas of Study -> Industrial areas, central business district (CBD)and so on; (c) Non - Developed Areas - > Agricultural land, forest areas, and so on.

The structure of four districts in 1990 year that includes Konak, Karşıyaka, Buca and Bornova districts has evolved into a structure of nine districts in 2009 year with established districts recently (Çolak, 2010). After the transformation, the quantitative differences in land - use has occurred. These differences can be observed by examining the decisions of 1 / 25000 scale Izmir Urban Regional Master Plan Revision (IKBNIPR). The plan is prepared in 2005 year and approved by the the Metropolitan Municipality of Izmir in 2006 year.

CHAPTER FIVE
RESULTS

In the study, two classical models have been applied to assess the probable effects of the 11 urban renewal areas on population and employment distribution in Izmir metropolitan area: the Hansen model and the Lowry – Garin model. The results of these models are discussed in this chapter with respect to IKBNIPR decisions.

5.1 The Application of The Hansen Model

The projected population and the distribution of population are estimated in year 2030 in Izmir using the proposals of Izmir Urban Region Master Plan Revision (IKBNIPR). The distances of districts to each other are calculated using the shortest existing roads linking the centers of districts. Moreover, the distance from the farthest point to the center of district is calculated and noted in the distance matrix (Çubukçu, 2008). In Figure 5.2, the districts of Izmir metropolitan area with urban renewal areas and the ones with no renewal areas in IKBNIPR are presented.

In the implementation of the Hansen model, two different scenarios are operated in the study. Scenario (1) assumes that the renewal areas within IKBNIPR are renewed under proposed planning decisions. Scenario (2) assumes that the renewal areas within IKBNIPR are not renewed under proposal planning decisions. For both of these scenarios, the data used are as follows: the distance matrix, the current and projected populations, the accessibility index, the development potential, the total and additional populations. The size of available residential area and the development potential are the differences between the two scenarios.

The available residential area is calculated using the additional population data for each district. The unit of the available residential area is people. The numbers of people that will settle to these districts are different in two scenarios. Therefore, estimated the available residential area is more in Scenario (1), because of the implementation of urban renewal. According to this, in Çiğli district, the the increase of available residential area is more than the other districts in Scenario (1). Therefore, in Bayraklı, Bornova and Karabağlar districts, the increase in available residential area is higher than the other districts in Scenario (1). In Konak district, the available residential area will not increase in Scenario (2). The carrying capacity of this district in terms of urban facilities, traffic network, housing and employment units is almost full and there is not more area for newcomers to the district. The available residential areas under two scenarios by year 2030 are presented in Table 5.1.

Table 5.1 The available residential areas in districts by year 2030 under two scenarios

Districts	*Available Residential Area Under Scenario (1) (People)*	*Available Residential Area Under Scenario (2) (People)*	*Additional Population Under Scenario (1) (People)*
Bayraklı	64408	28031	36377
Buca	72159	58833	13326
Bornova	72990	27887	45103.3
Çiğli	191094	179640	11454
Gaziemir	50509	30591	19918
Karabağlar	69187	7331	61856
Karşıyaka	45966	40149	5817
Konak	13302	0	13302
Narlıdere	72640	66569	6071
TOTAL	***652253***	***439029***	***213224.3***

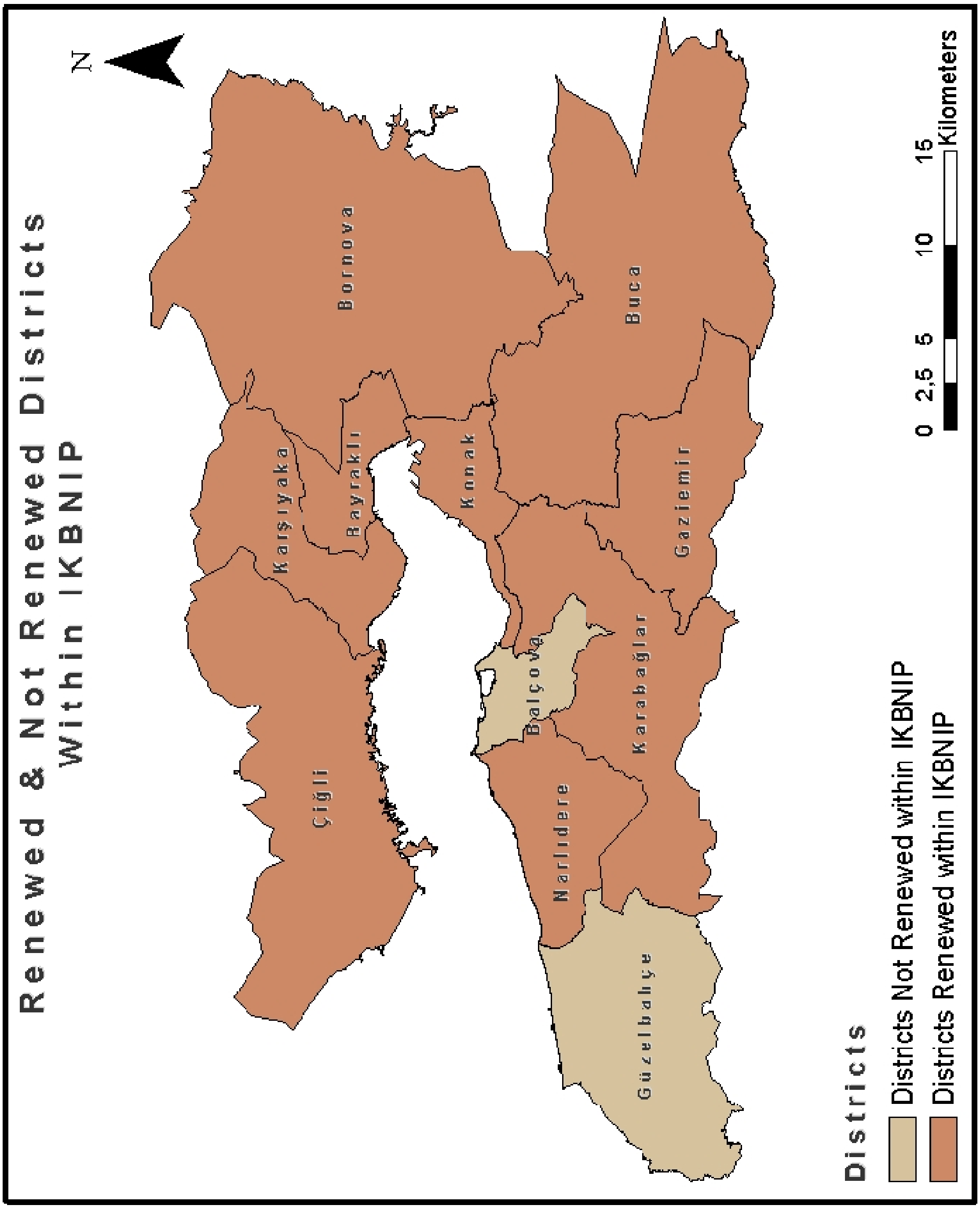


Figure 5.2 The renewed and not renewed districts within IKBNIP proposals

5.1.1 Scenario (1): The renewal areas within IKBNIPR are renewed

According to the results after the implementation of the model, the total population of the districts in year 2009 *(P_i^{2009})* is 2,626.554 and the estimated population *(P_i^{2030})* in IKBNIPR in year 2030 is 3,762.912. Therefore, the additional population of households (G_T) that will be added to the current population is estimated 1,136.358 persons. Following Çolak (2010), the distance parameter is set to 1.98. The data for the Hansen Model for the year 2030 in Scenario (1) are presented in Table 5.4. The time matrix made among districts in the study area (T*ij)* is shown in Table 5.3.

Table 5.3 The time matrix of districts listed in the study (T*ij)*

Tij (min)	***Bayraklı***	***Buca***	***Bornova***	***Çiğli***	***Gaziemir***	***Karabağlar***	***Karşıyaka***	***Konak***	***Narlıdere***
Bayraklı	18	21	8.68	8.99	30.86	23.68	8.29	16.34	33.09
Buca	20.53	30	11.21	26.62	21.72	14.25	20.23	8.32	19.95
Bornova	8.90	15.80	22	14.20	26.15	18.41	14.70	11.07	27.82
Çiğli	8.70	26.97	14.31	14	36.02	28.20	8.53	20.86	37.61
Gaziemir	30.30	7.61	26.16	36.02	19	10.29	29.62	15.63	8.70
Karabağlar	30.30	19.80	26.16	28.53	18.64	17	22.14	13.10	8.70
Karşıyaka	8.11	20.41	14.67	8.77	29.46	21.64	20	12.53	31.05
Konak	15.69	14.80	11.83	21.41	15.68	13.21	15.02	14	16.76
Narlıdere	32.68	20.30	28.81	38.39	14.57	12.79	32.00	17.06	10

The total employment of districts under Scenario (1) is presented in Figure 5.5. Figure 5.6 shows the available residential areas in the districts under Scenario (1).

Table 5.4 Total employment, available residential area and projected population data of districts in study under Scenario (1)

Districts	***Total Employment (E_i) (People)***	***Available Residential Area(H_i) (People)***	***Projected Population Data (P_i^{2030}) (People)***
Bayraklı	273609	64408	393093
Buca	279425	72159	521928
Bornova	316672	72990	463950
Çiğli	71197	191094	435138
Gaziemir	43548	50509	137309
Karabağlar	247493	69187	540990
Karşıyaka	275535	45966	484799
Konak	270487	13302	354038
Narlıdere	28194	72640	94419

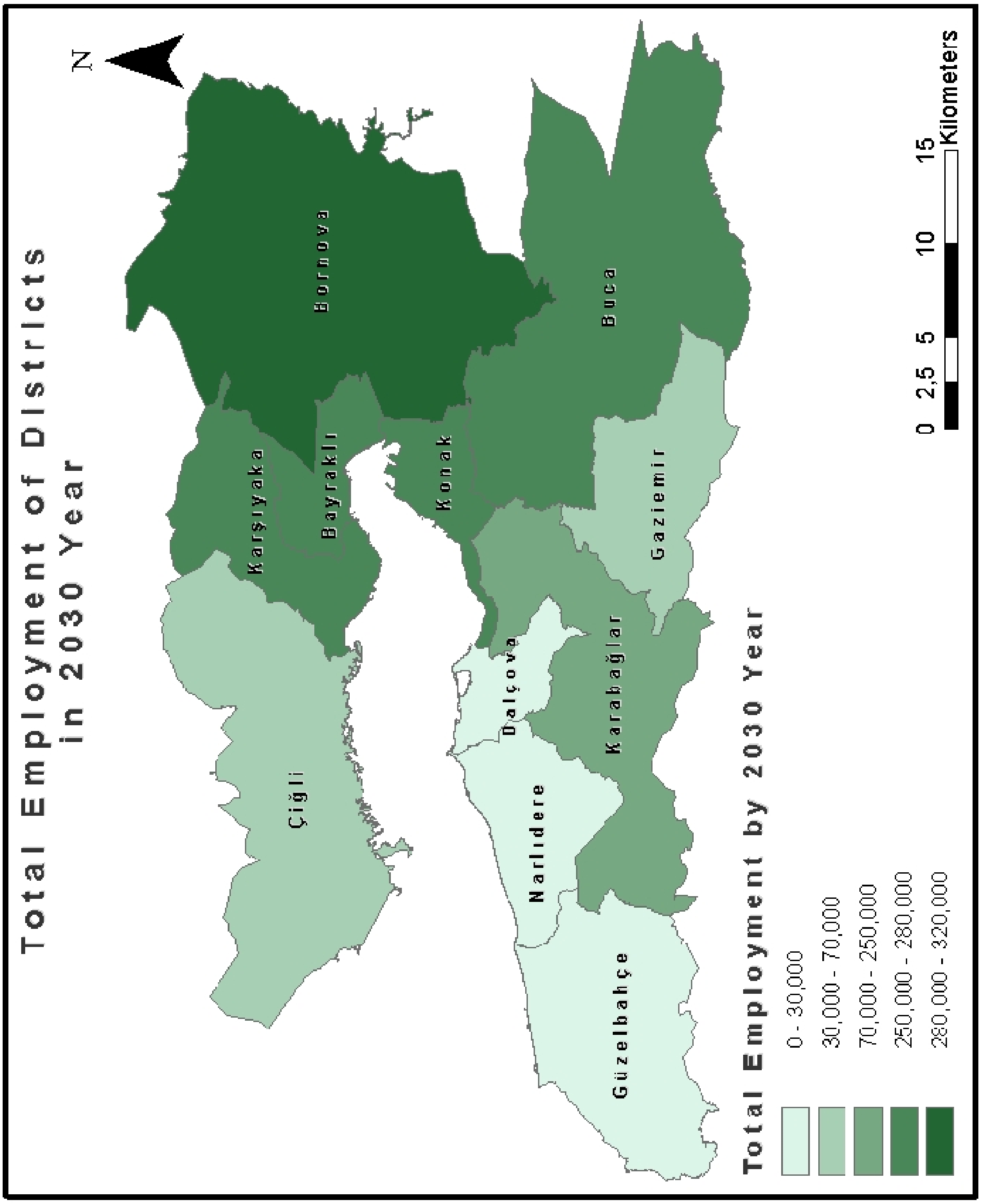


Figure 5.5 The total employment of districts under Scenario (1)

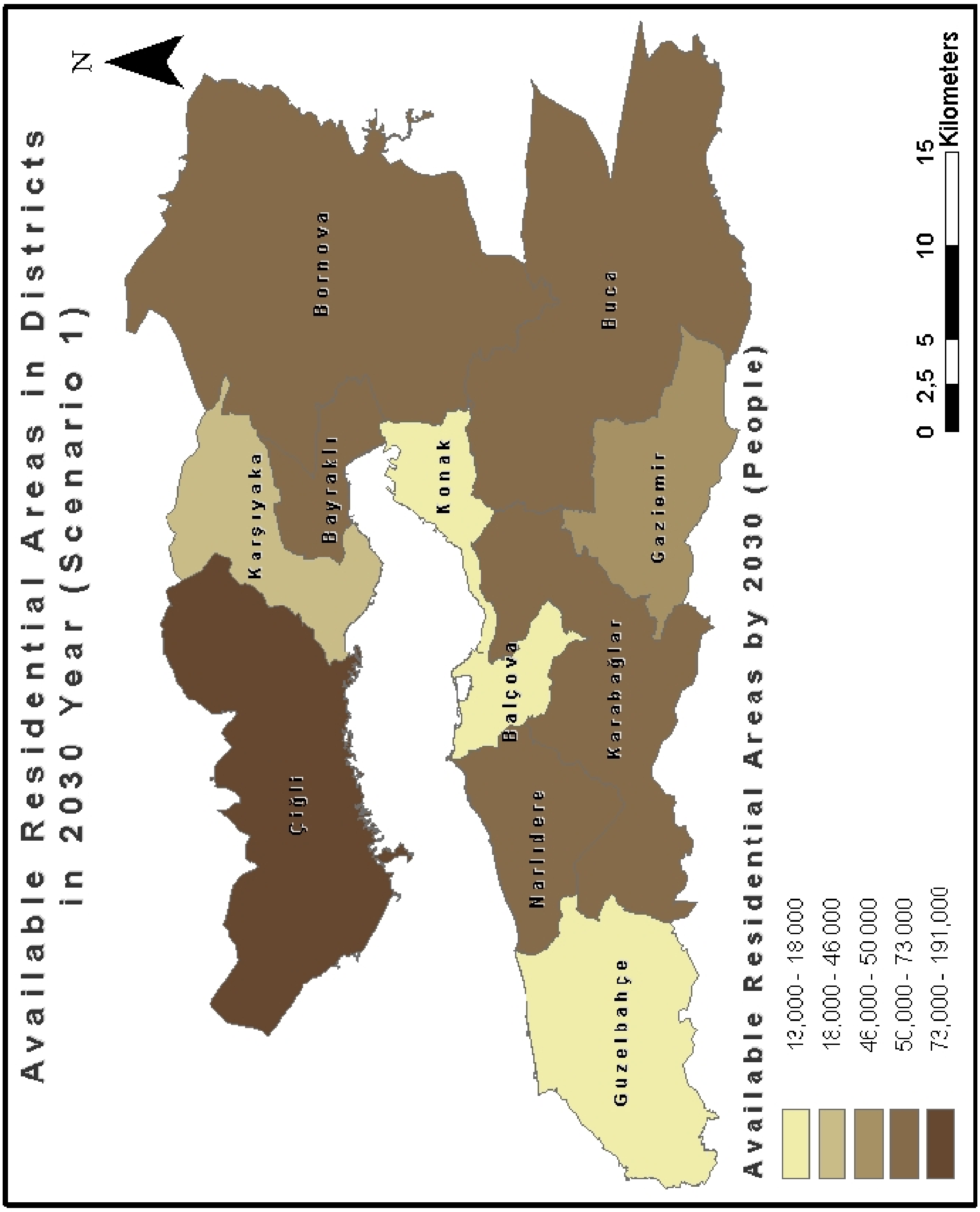


Figure 5.6 The available residential areas in the districts under Scenario (1)

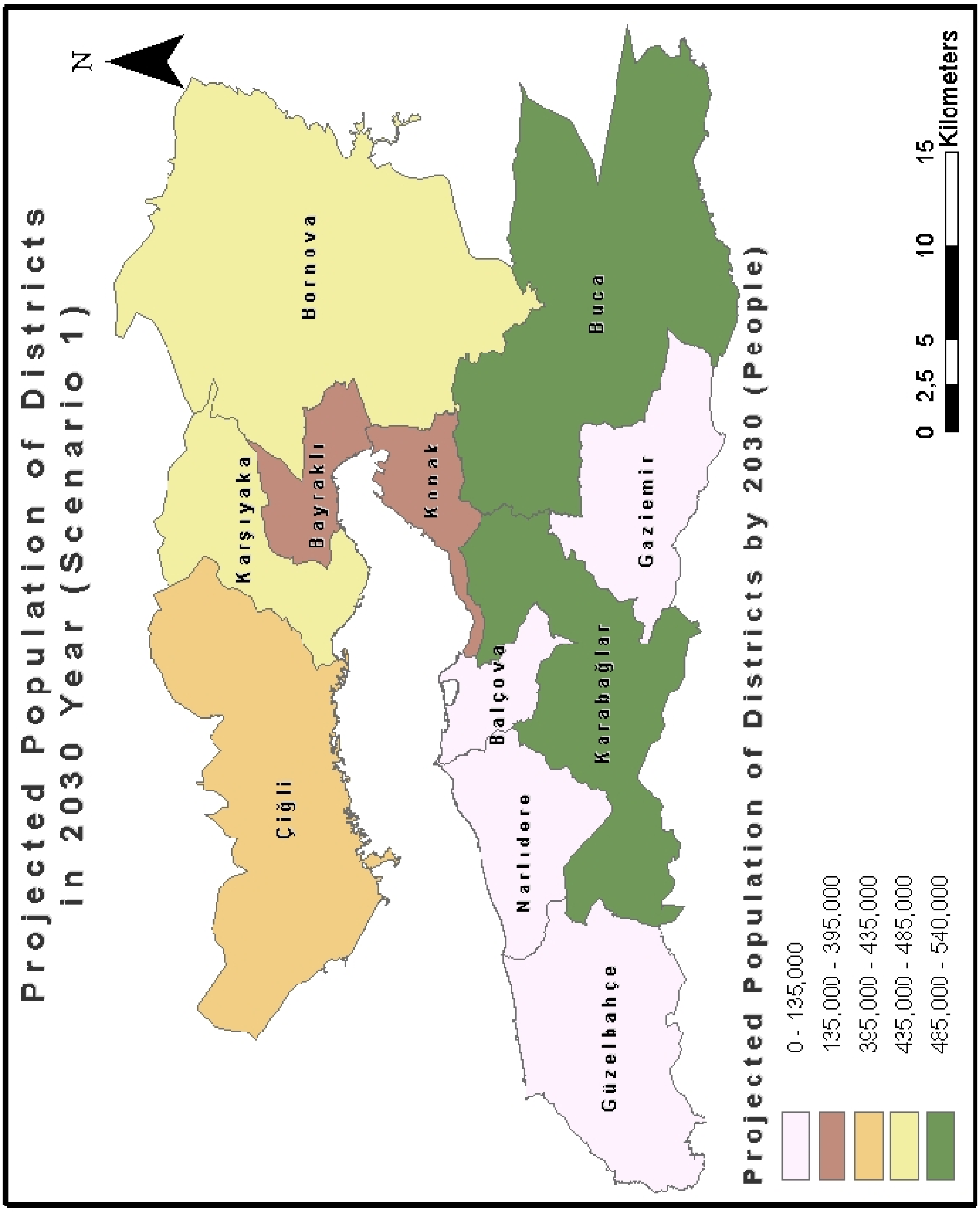


Figure 5.7 The projected populations of each district under Scenario (1)

To begin with the solution, firstly the accessibility index (A_i) for all districts is calculated. In Table 5.8, the results of calculation for this parameter are pointed out. These indexes are used to calculate the following formula:

$$A_i = \sum_{j=1}^{n} \frac{Ej}{d_{ij}^{\alpha}} \tag{5.1.1.1}$$

where,

A_i = The accessibility index,

E_j = Total employment in zone *j,*

d_{ij}= The distance from zone to zone *j,*

α = The exponent parameter.

Table 5.8 The accessibility index values for districts in study under Scenario (1)

Districts	***Accessibility Index (Aj)***
Bayraklı	66.156
Buca	11.671
Bornova	28.606
Çiğli	16.442
Gaziemir	5.779
Karabağlar	131.802
Karşıyaka	31.134
Konak	211.573
Narlıdere	11.979

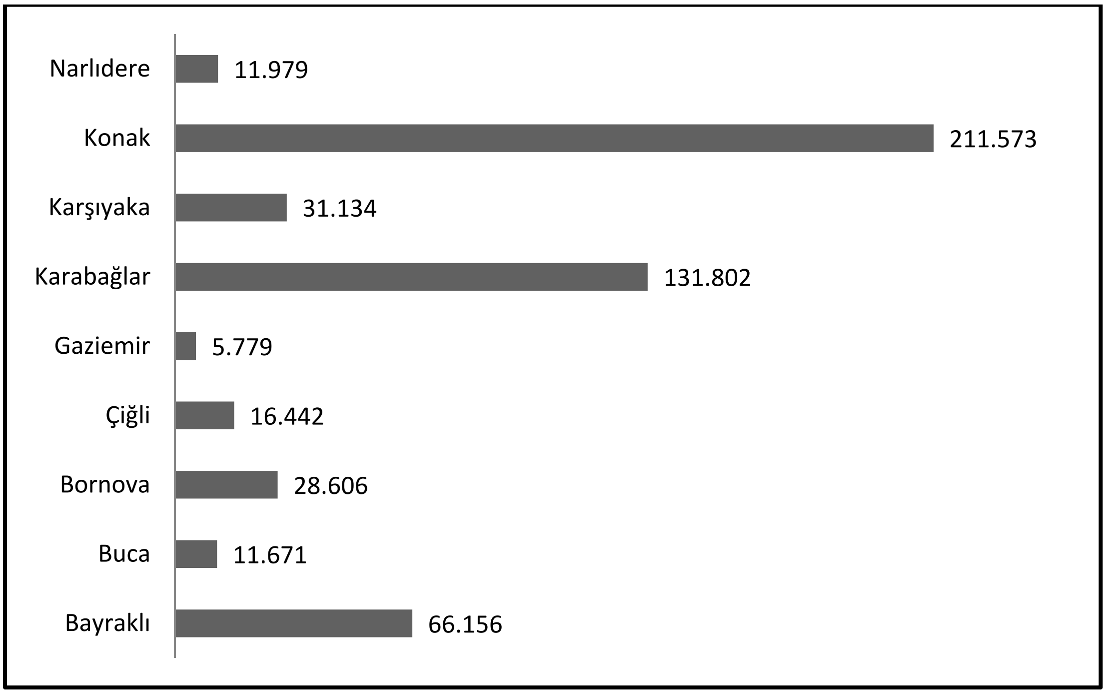


Figure 5.9 The comparative accessibility index values in each district under Scenario (1)

According to Figure 5.9, Konak and Karabağlar districts are the most accessible among all districts in the study area. The reasons can be the geographical location of districts and urban facilities included employment, social activities, network, etc. in these districts. Bayraklı, Bornova and Karşıyaka districts are relatively more accessible than Buca, Çiğli and Narlıdere districts. The routes of primary roads and urban facilities required by citizens affect the accessibility index of these districts. The least value of index is observed in Gaziemir district, according to the graph. In Figure 5.10, the comparative accessibility index values in each district are presented.

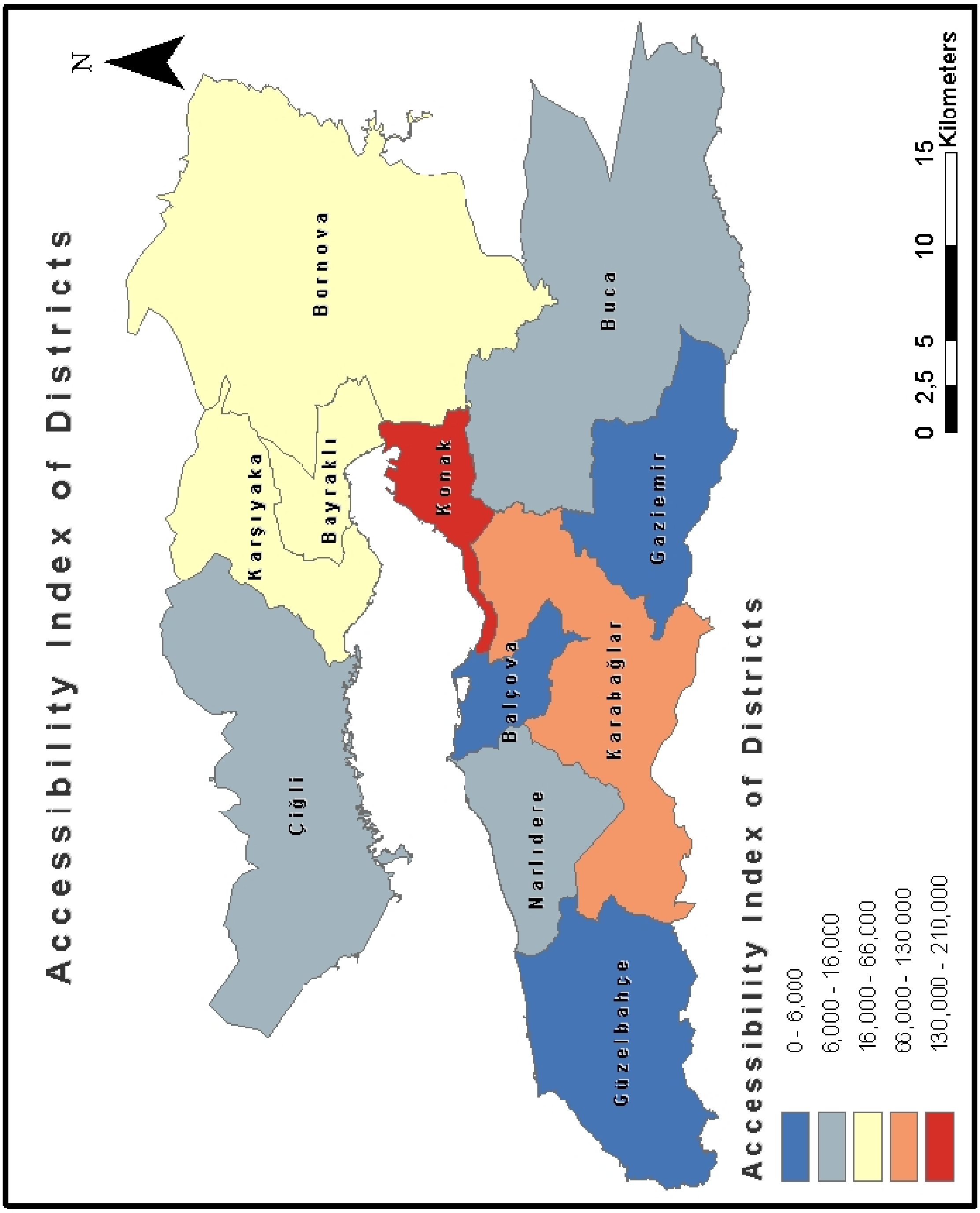


Figure 5.10 The accessibility index values in each district under Scenario (1)

After the index calculation in accessibility of the districts, the development potential of the districts (D_i) are calculated. In Table 5.11, the results of calculation for this parameter are presented. Figure 5.12 shows the comparative percentage of development potential in districts. Also, in Figure 5.13, the development potential values in districts under Scenario (1). These values are used to calculate the following formula:

$$D_i = A_i * H_i \quad (5.1.1.2)$$

where,

D_i = The development potential of districts,

A_i = The accessibility index,

H_i = Available residential area (ha),

Table 5.1.1.4 The development potential values in districts in study under Scenario (1)

Districts	***Development Potential (Di)***
Bayraklı	4.260.943
Buca	842.188
Bornova	2.087.945
Çiğli	3.142.047
Gaziemir	291.910
Karabağlar	9.118.908
Karşıyaka	1.431.091
Konak	2.814.344
Narlıdere	870.162

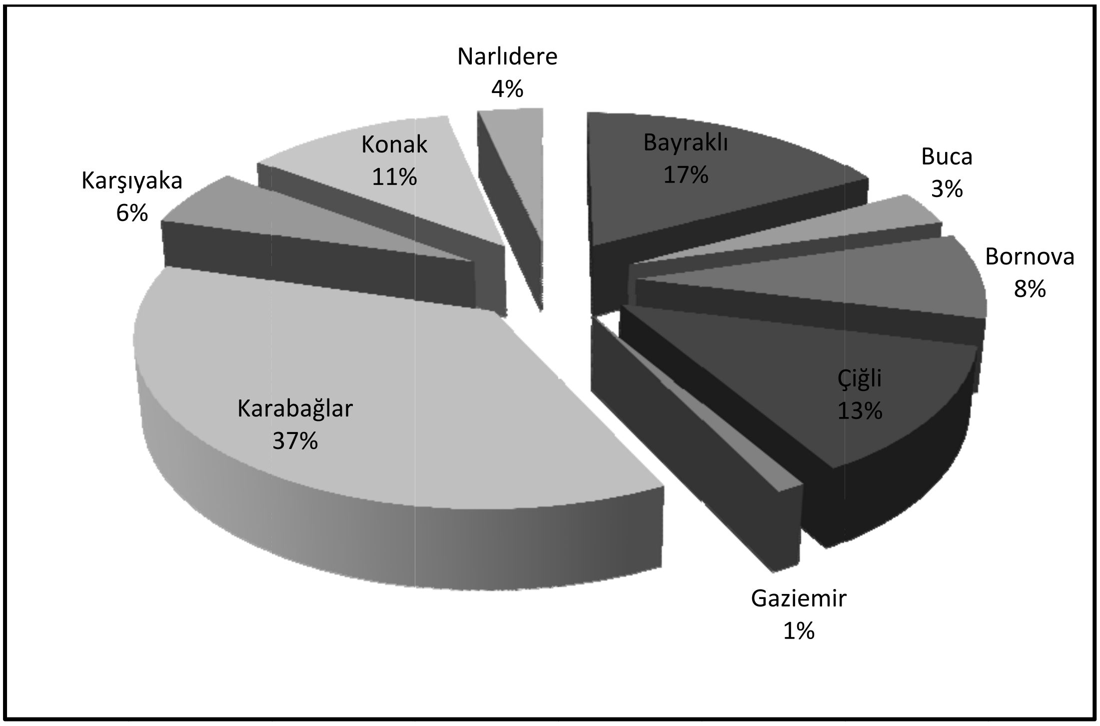


Figure 5.12 The comparative percentage of development potential in districts under Scenario (1)

In terms of the development potential, in Karabağlar district the highest rate is observed among all districts. The reasons may be the geographical locations, their importance in terms of urban activities, and many neighborhoods which will be implemented urban renewal or excess demand for employment. On the other hand, in Konak, Bayraklı and Çiğli, the rate of development potential is relatively less. The location far from the city center, less neighborhoods which will be renewed or few demand for employment can be reasons in these districts. In addition, in Narlıdere, Buca, Bornova, Karşıyaka and Gaziemir districts the lowest rate is monitored among all of them. For Narlıdere and Çiğli, they are newly emerging and become urbanized districts in Izmir city. There are not almost any neighborhoods that will be renewed by the time in comparison to the other districts. For Buca, the carrying capacity of residential and employment units may be full. So, development potential is the least all of the districts.

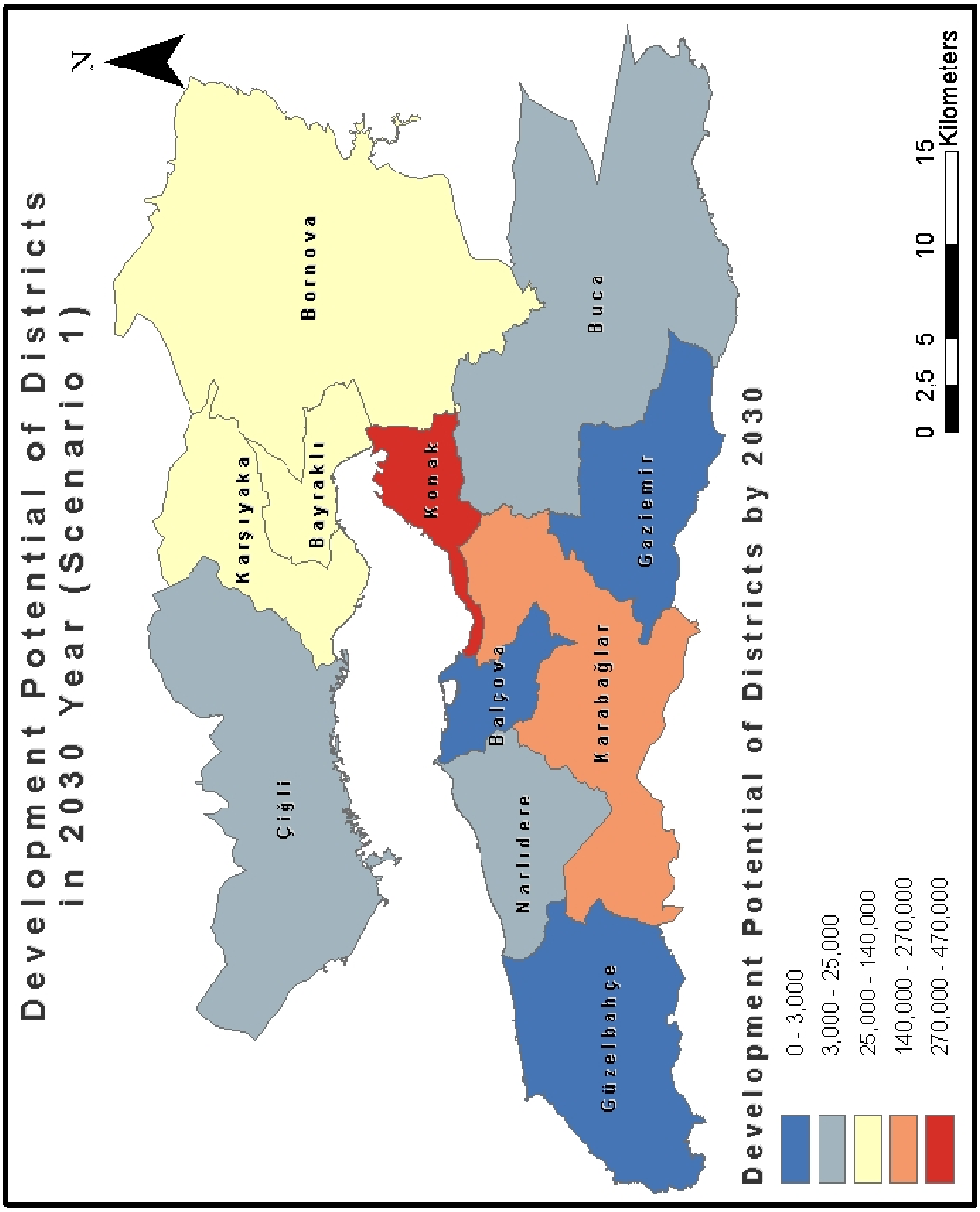


Figure 5.13 The development potential values in districts under Scenario (1)

In addition to these calculations, the additional shares of the population of the districts (R_i) are calculated in the study. Table 5.14 shows the results of calculation for this parameter. For the calculation of additional shares of the population of the districts, the formula is used: (Çubukçu, 2008).

$$R_i = \frac{D_i}{\sum_{j=1}^{n} Dj} \tag{5.1.1.3}$$

where,

D_i = The development potential of districts,

R_i = The additional shares of the population of the districts,

Table 5.14 The additional shares of population of districts in study under Scenario (1)

Districts	***Additional Shares of Population (Ri)***
Bayraklı	0,171
Buca	0,034
Bornova	0,084
Çiğli	0,126
Gaziemir	0,012
Karabağlar	0,367
Karşıyaka	0,058
Konak	0,113
Narlıdere	0,035

The projection year is set to year 2030 and how the total population of districts will be distributed in Izmir city is determined. For this, firstly the additional populations are needed to calculate in each district. The additional population in each district (G_i) is obtained by multiplying the total additional population in districts (G_T)

and the additional shares of the population of the districts (R_i). In Table 5.15, the results of calculation for these parameters are listed. In addition, Figure 5.16 shows the comparative current population and estimations of projected population in each district. Figure 5.17 presents the comparative estimations of additional population in each district under Scenario (1). Figure 5.18 shows the additional population in each district under Scenario (1). This is the formula for calculating the following format: (Cubukcu, 2008).

$$G_i = G_T * R_i \tag{5.1.1.4}$$

where,

G_i = The additional population in each district,

G_T = The total additional population in districts,

R_i = The additional shares of the population of the districts.

Table 5.15 The current population under Scenario (2), additional and projected population in districts in study under Scenario (1)

Districts	***Current Population (P_i^{2009}) (People)***	***Additional Population (G_i) (People)***	***Projected Population (P_i^{2030}) (People)***
Bayraklı	306427	194773	501200
Buca	412639	38497	451136
Bornova	402453	95442	497895
Çiğli	154397	143627	298024
Gaziemir	121255	13344	134599
Karabağlar	448337	416836	865173
Karşıyaka	304220	65417	369637
Konak	411112	128647	539759
Narlıdere	65714	39776	105490

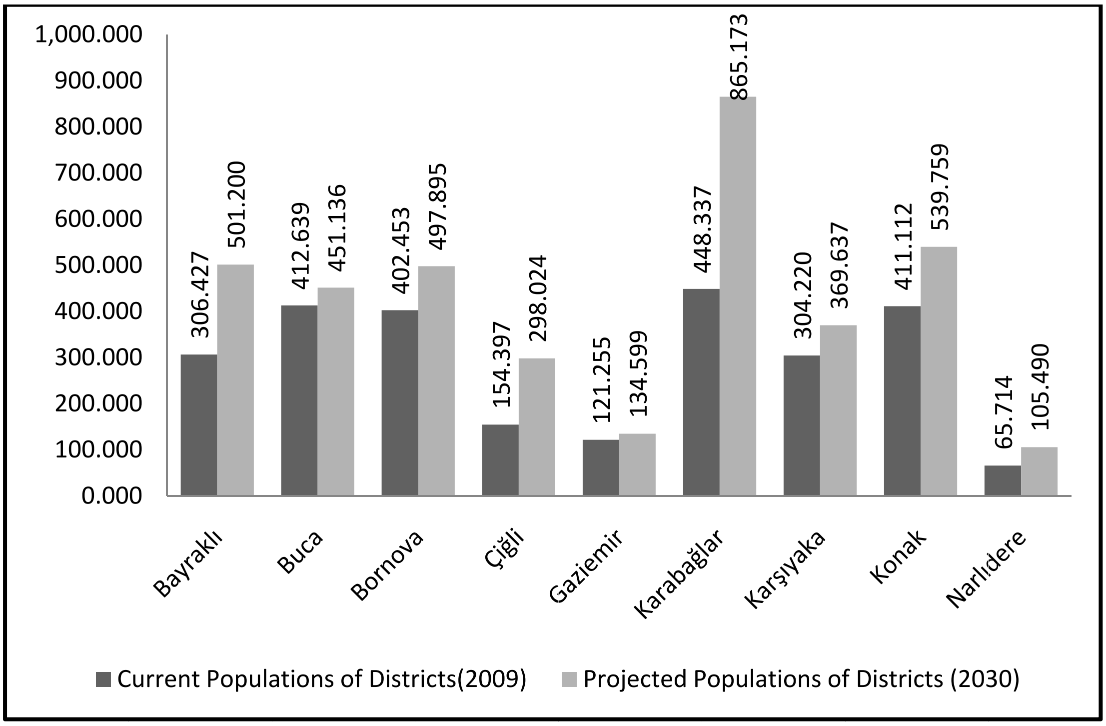


Figure 5.16 The comparative current population and estimations of projected population in each district under Scenario (1)

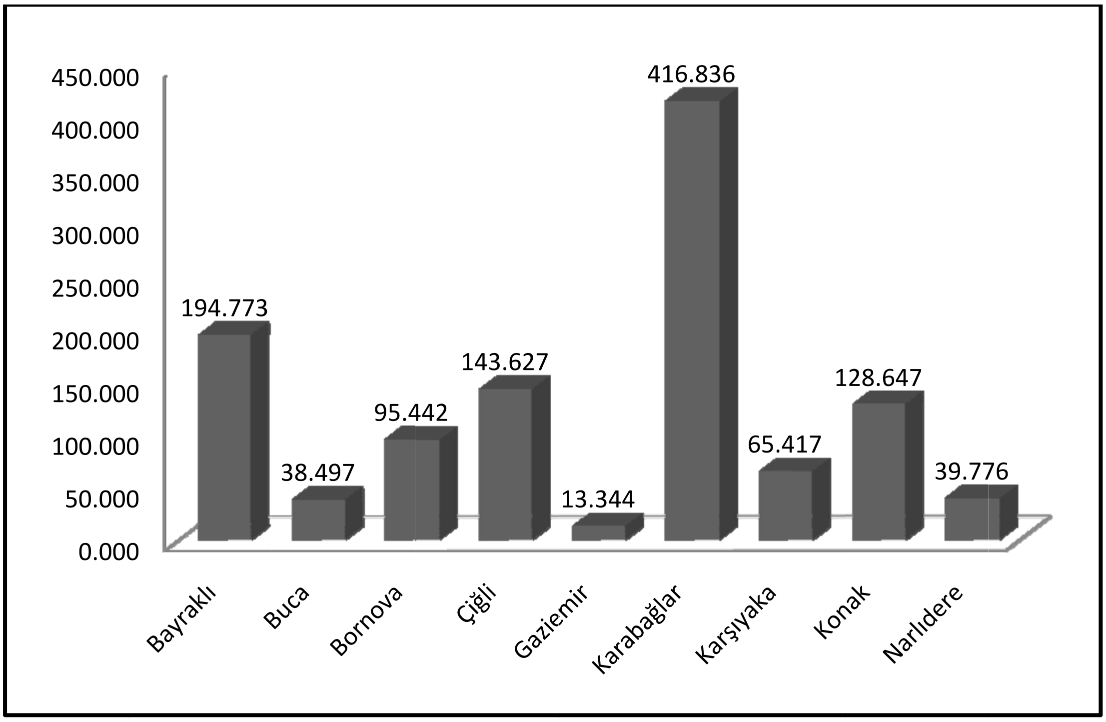


Figure 5.17 The comparative estimations of additional population in districts under Scenario (1)

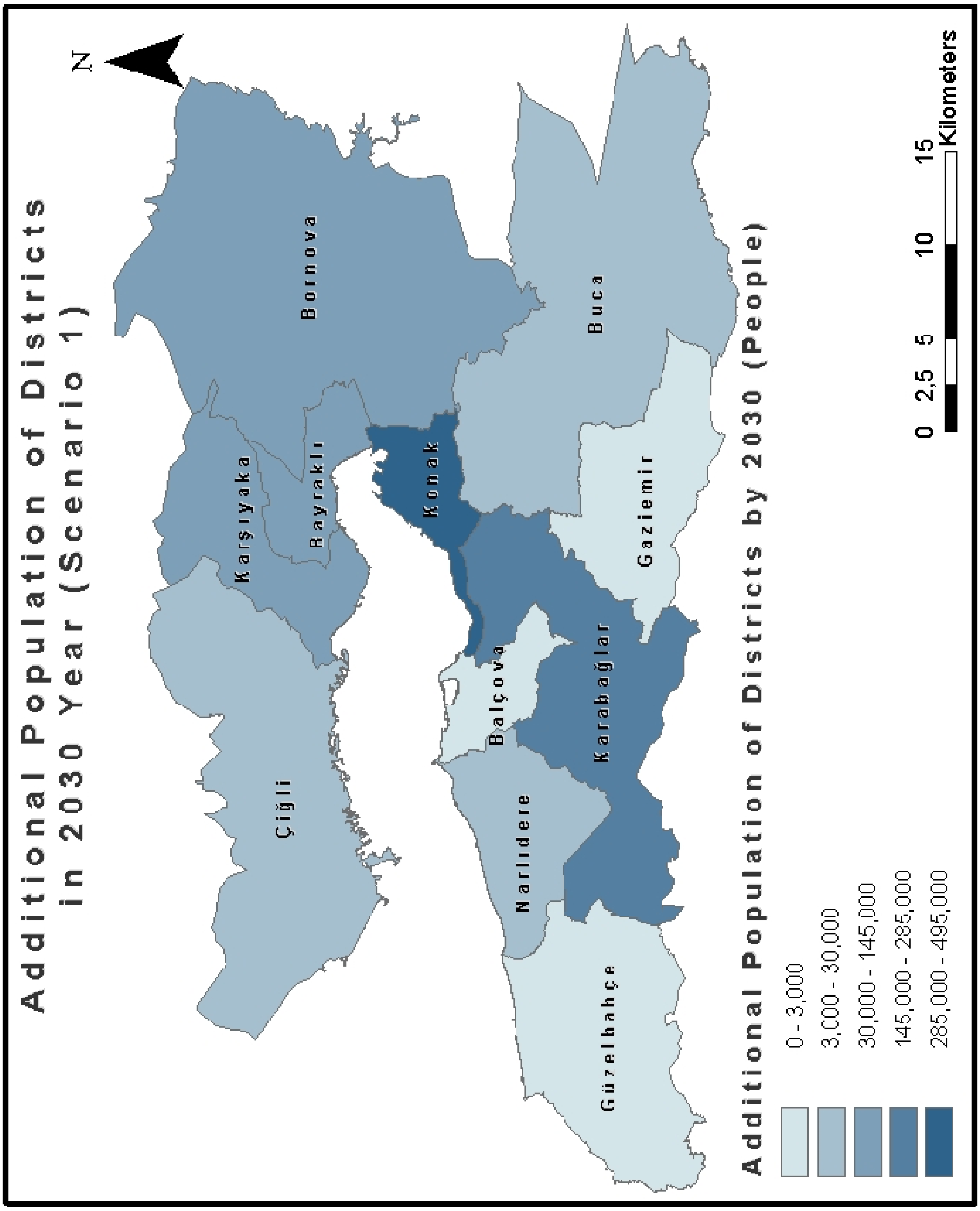


Figure 5.18 The additional population in each district under Scenario (1)

For all districts, the additional population in each district (G_i) is calculated and summed up with the current population values in 2009 year *(P_i^{2009})*, each districts' population for the year 2030 are calculated *(P_i^{2030})* (Çubukçu, 2008).

A comparison is made among the additional population in districts. According to this, the results are parallel with the results of development potential. These two parameters are directly proportional. So, the changes occurred by the time will be similarly. The results of the additional population obtained by the application of model are as follows:

- The additional populations of Karabağlar district is the highest among all the districts. The probable reasons that are similar to the estimations made for the graph in Figure 5.15 have been mentioned. The adequacy of carrying capacity is the issue of a different study for these districts that are more populated.
- In Bayraklı, Bornova, Konak, Karşıyaka, Narlıdere and Çiğli districts, the additional population will be relatively less, according to the graph in Figure 5.17. The reasons can be less renewed neighborhoods located and more employment units located in city center.
- The least additional population will be included in Gaziemir district among all districts. This district will take place in the direction of development in Izmir. Thus, the urban renewal is not be implemented yet in this district.

5.1.2 Scenario (2): The renewal areas within IKBNIPR are not renewed

In comparison to Scenario (1), the total population of the districts in year 2009 *(P_i^{2009})* is 2,626.554 persons and the estimated population *(P_i^{2030})* for year 2030 is 3,762.912 persons. Therefore, the additional population of households(G_T) that will be added to the current population is estimated 1,136.358 persons. The distance parameter is set to 1.98. The data obtained according to the Hansen Model, like the total employment, available residential area, the current population in year 2009 are presented in Table 5.19. The time matrix made among districts in the study area (T*ij)* is shown in Table 5.18.

Table 5.18 The time matrix of districts listed in the study (T*ij)*

Tij (min)	***Bayraklı***	***Buca***	***Bornova***	***Çiğli***	***Gaziemir***	***Karabağlar***	***Karşıyaka***	***Konak***	***Narlıdere***
Bayraklı	18	21	8.68	8.99	30.86	23.68	8.29	16.34	33.09
Buca	20.53	30	11.21	26.62	21.72	14.25	20.23	8.32	19.95
Bornova	8.90	15.80	22	14.20	26.15	18.41	14.70	11.07	27.82
Çiğli	8.70	26.97	14.31	14	36.02	28.20	8.53	20.86	37.61
Gaziemir	30.30	7.61	26.16	36.02	19	10.29	29.62	15.63	8.70
Karabağlar	30.30	19.80	26.16	28.53	18.64	17	22.14	13.10	8.70
Karşıyaka	8.11	20.41	14.67	8.77	29.46	21.64	20	12.53	31.05
Konak	15.69	14.80	11.83	21.41	15.68	13.21	15.02	14	16.76
Narlıdere	32.68	20.30	28.81	38.39	14.57	12.79	32.00	17.06	10

Table 5.19 Total employment, available residential area and current population data of districts in study under Scenario (2)

Districts	***Total Employment (E_i) (People)***	***Available Residential Area(H_i) (People)***	***Current Population Data Under Scenario (2) (People)***
Bayraklı	29693	28031	306427
Buca	31591	58833	412639
Bornova	60060	27887	402453
Çiğli	34520	179640	154397
Gaziemir	13400	30591	121255
Karabağlar	128416	7331	448337
Karşıyaka	29902	40149	304220
Konak	140347	0	411112
Narlıdere	2211	66569	65714

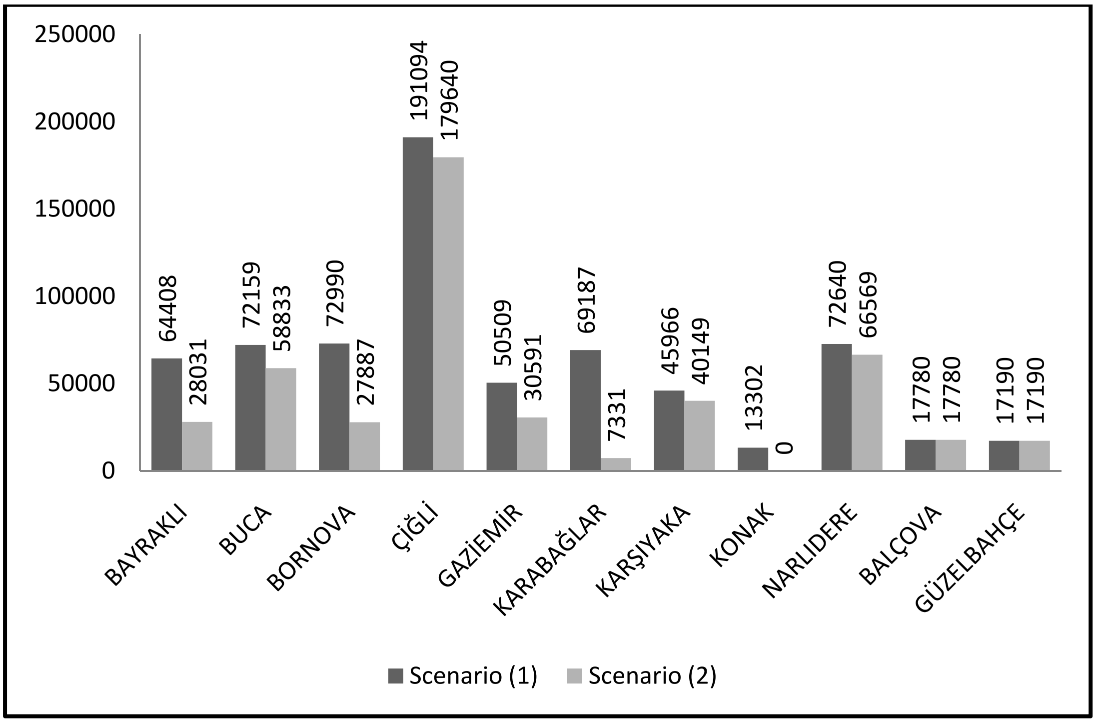


Figure 5.20 The comparison of available residential areas between two scenarios

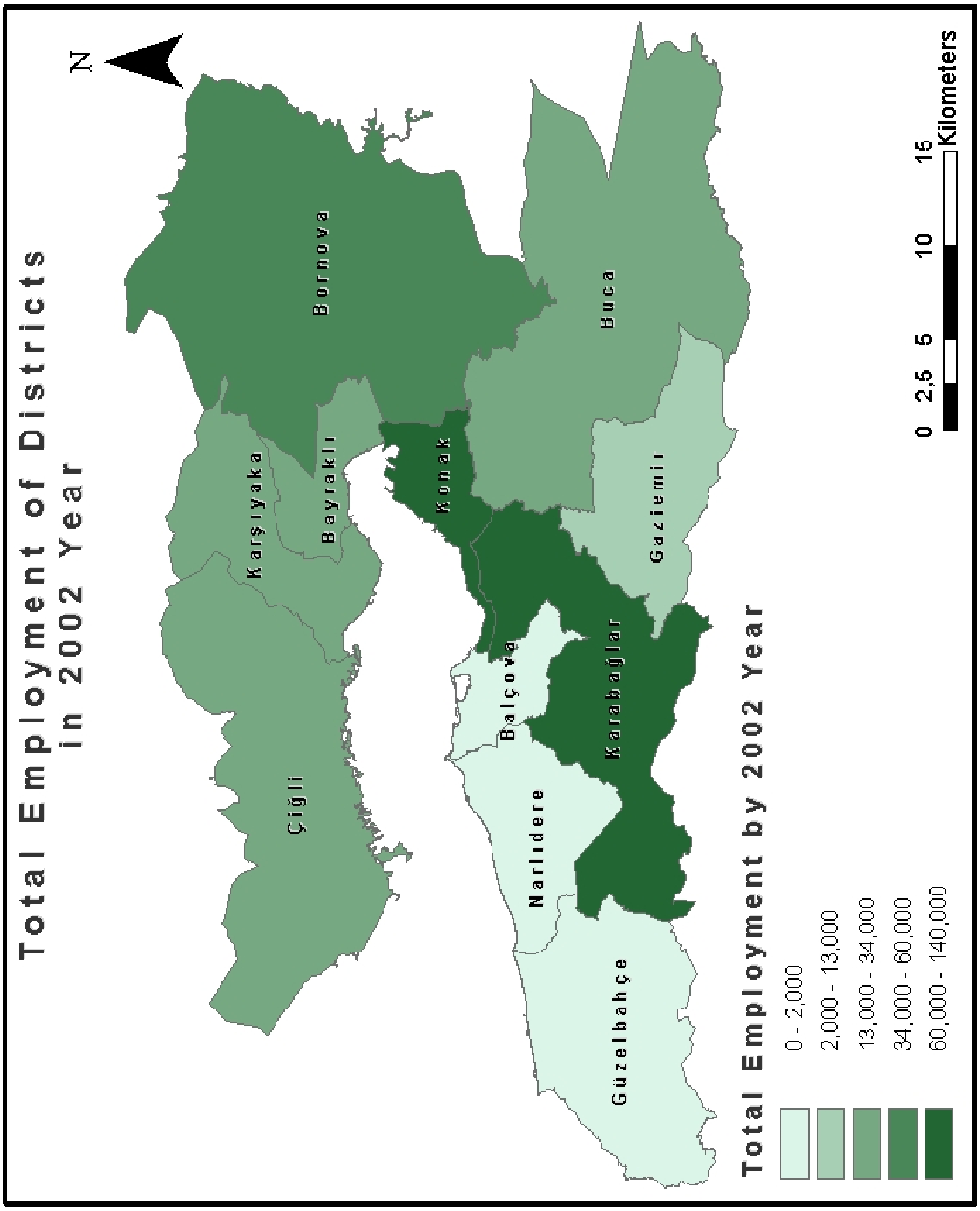


Figure 5.21 The total employment of the districts under Scenario (2)

The total employment of districts under Scenario (2) is figured out in 5.21. The available residential areas in districts under Scenario (2) are shown in Figure 5.22. In addition, the current populations of the districts are pointed in Figure 5.23 and the current populations of the districts under Scenario (2) are pointed in Figure 5.24.

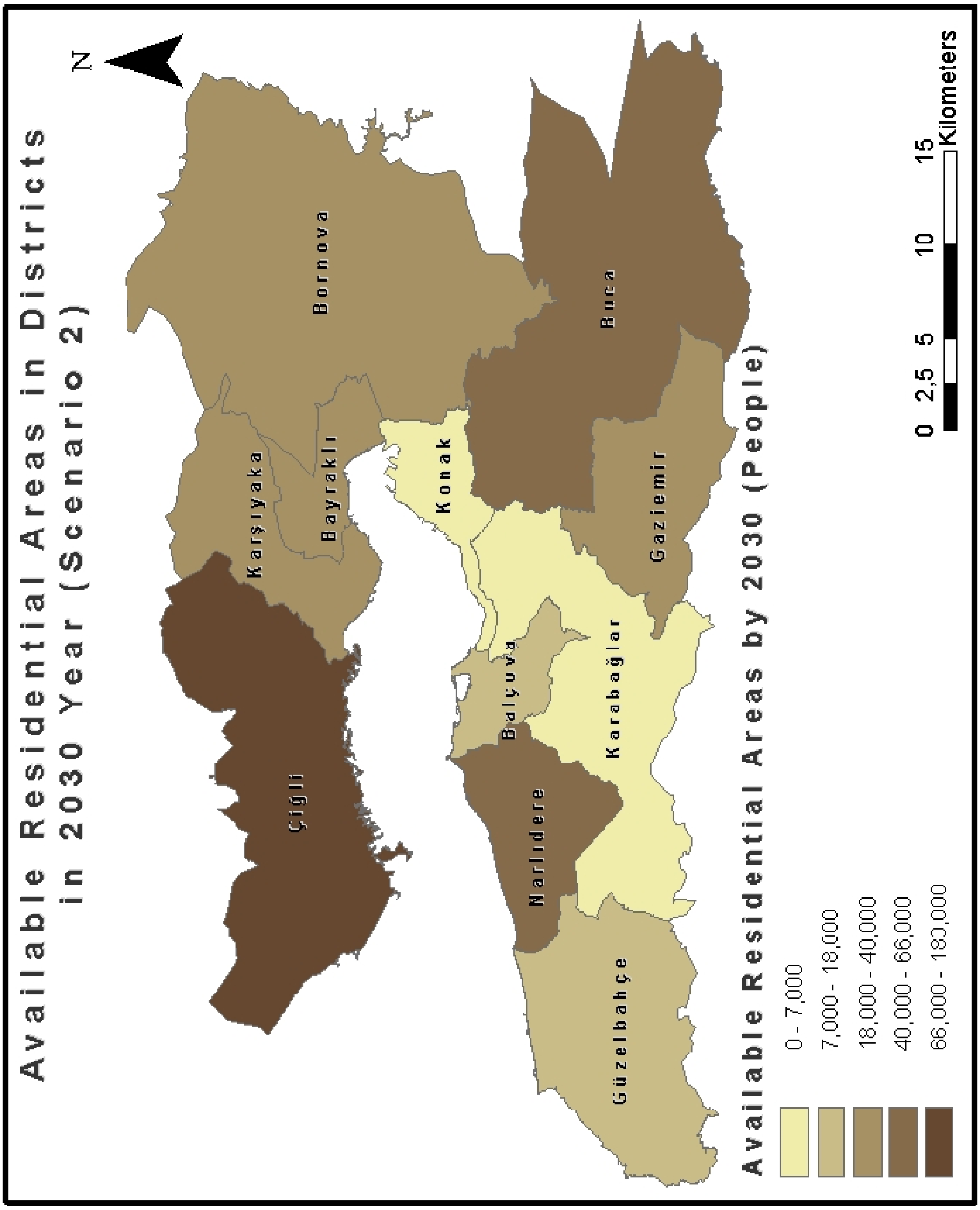


Figure 5.22 The available residential areas in the districts under Scenario (2)

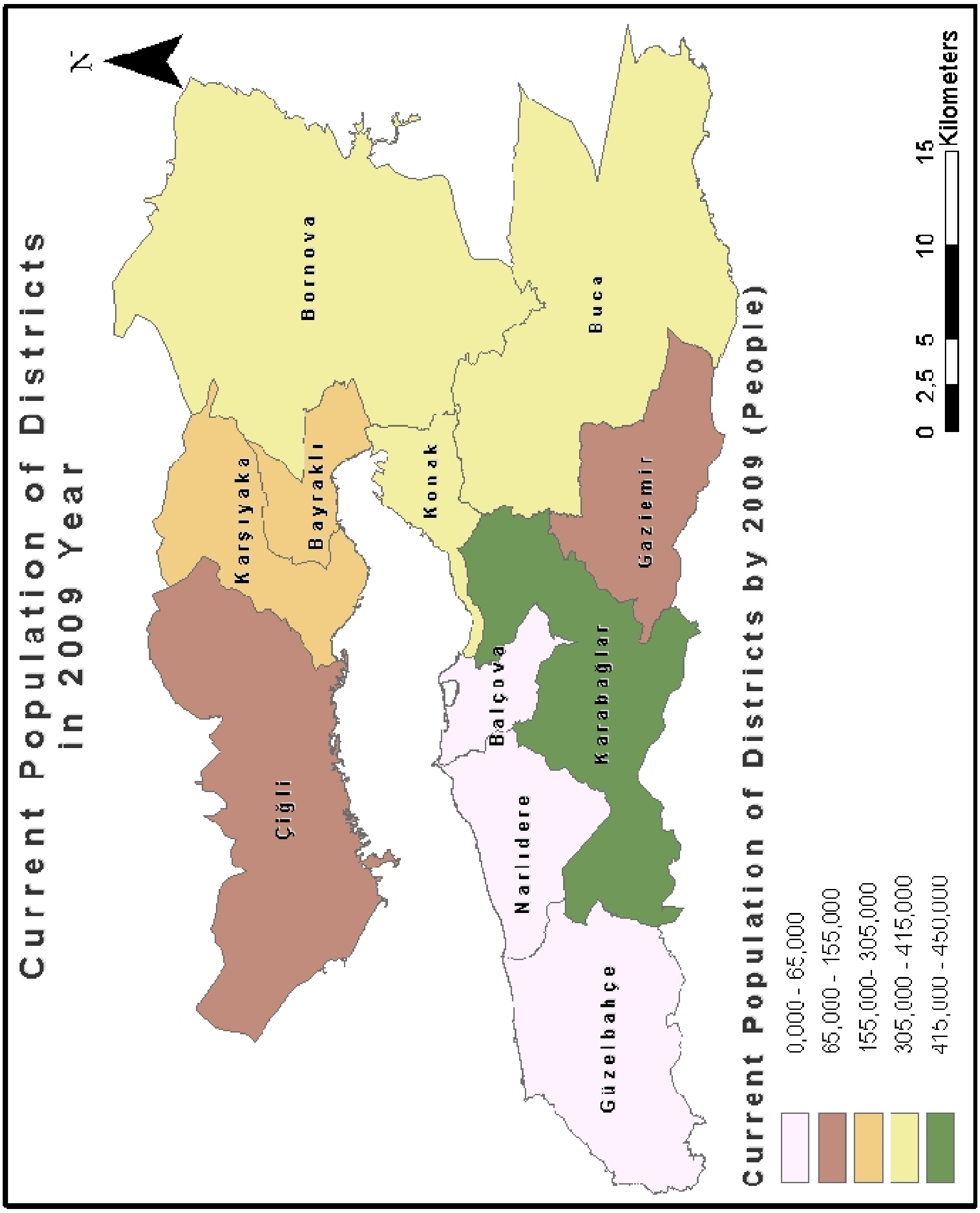


Figure 5.23 The current populations of the districts in 2009 year

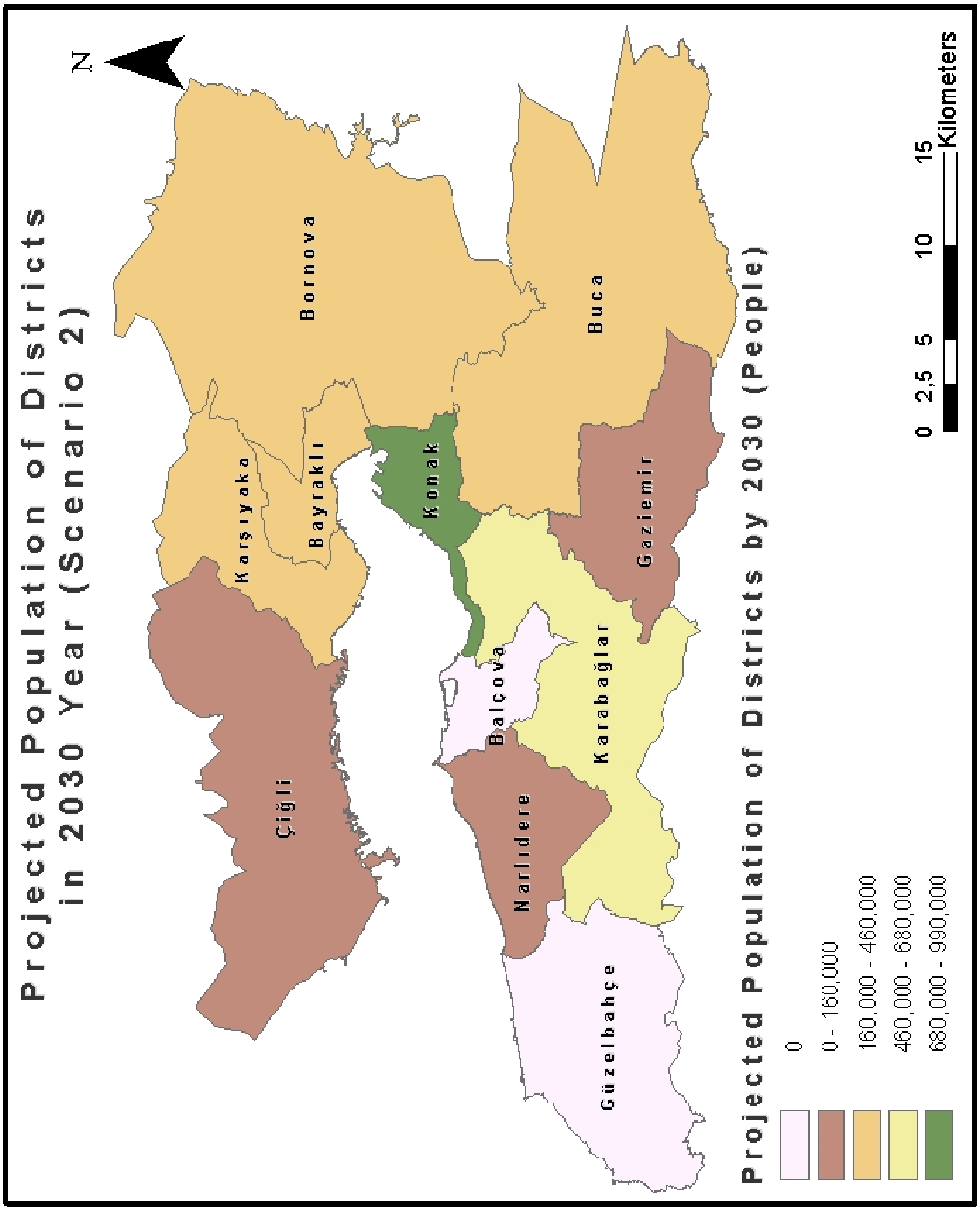


Figure 5.24 The current populations of the districts under Scenario (2)

Similar to Scenario (1), the calculations that include the model's parameters are made. First, the accessibility index (A_i) for all districts in study areas is calculated. Table 5.25 and Figure 5.26 show comparatively the results of calculation for current values under Scenario (2).

Table 5.25The accessibility index values for districts in study under Scenario (2)

Districts	***Accessibility Index (Aj)***
Bayraklı	66.156
Buca	11.671
Bornova	28.606
Çiğli	16.442
Gaziemir	5.779
Karabağlar	131.802
Karşıyaka	31.134
Konak	211.573
Narlıdere	1.144

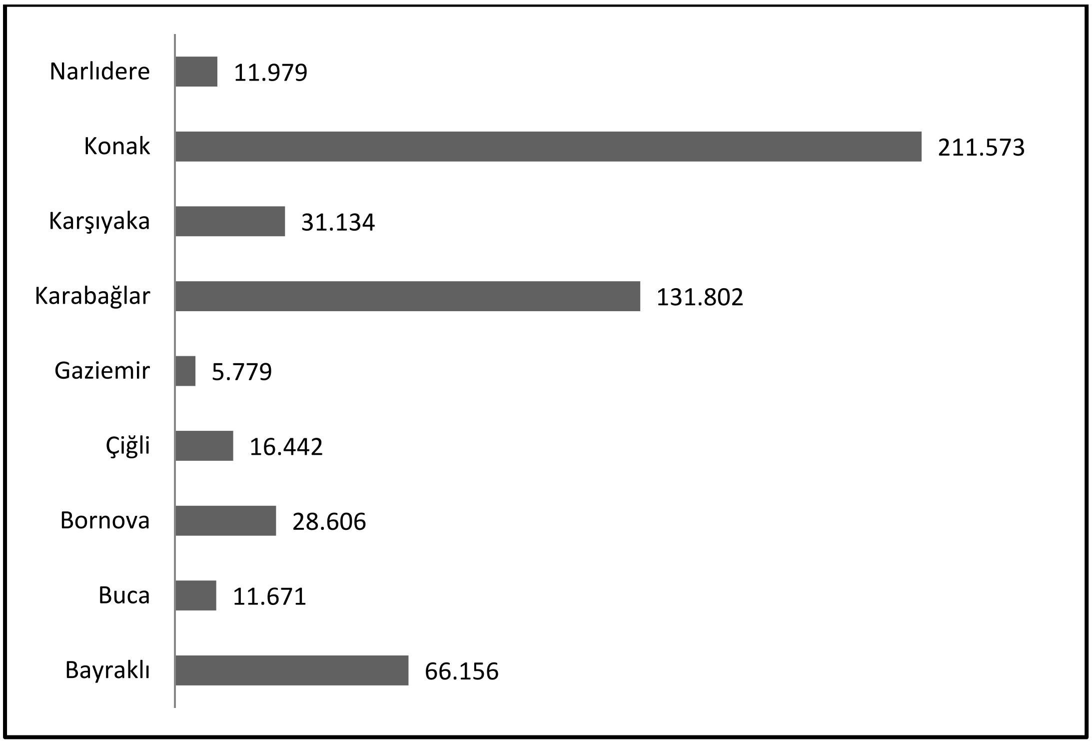


Figure 5.26 The comparative accessibility index values in each district under Scenario (2)

The reasons that are explained in Part 5.1.1 can be accepted here, because there is not any difference between two scenarios for the accessibility index. After the index calculation in accessibility of the districts, the values of development potential of the districts (D_i) are calculated. Table 5.27 shows the development potential values for districts in the study. Figure 5.28 shows the comparative percentage of development potential in each district in the study. Therefore, Figure 5.29 presents the development potential values of the districts under Scenario (2).

Table 5.27 The development potential values for districts in study under Scenario (2)

Districts	***Development Potential (Di)***
Bayraklı	1.854.386
Buca	686.657
Bornova	797.721
Çiğli	2.953.716
Gaziemir	176.797
Karabağlar	966.173
Karşıyaka	1.249.987
Konak	0
Narlıdere	797.436

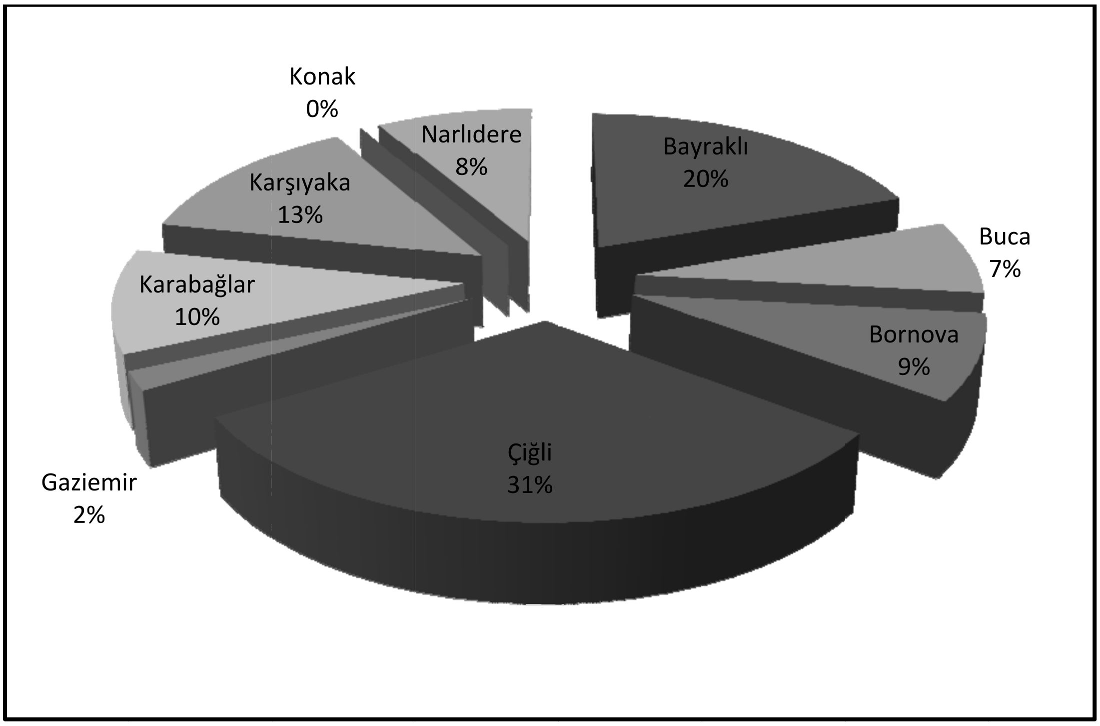


Figure 5.28 The comparative percentage of development potential in districts under Scenario (2)

In terms of the development potential, the highest rate is monitored in Çiğli, Bayraklı and Karşıyaka among all districts. The reasons can be the geographical locations of districts, their importance in terms of urban activities, and many neighborhoods which will be implemented urban renewal or excess demand for employment. On the other side, in Karabağlar, Bornova, Buca and Narlıdere, the rate of development potential is relatively less. The location far from the city center, less neighborhoods which will be renewed or few demand for employment can be reasons for less rate of development potential in these districts. Moreover, the lowest rate is observed in Konak and Gaziemir districts among all of them. They are newly emerging and become urbanized districts in Izmir city. There are not almost any neighborhoods that will be renewed by the time in comparison to the other districts. Figure 5.27 shows the comparative percentage of development potential in districts.

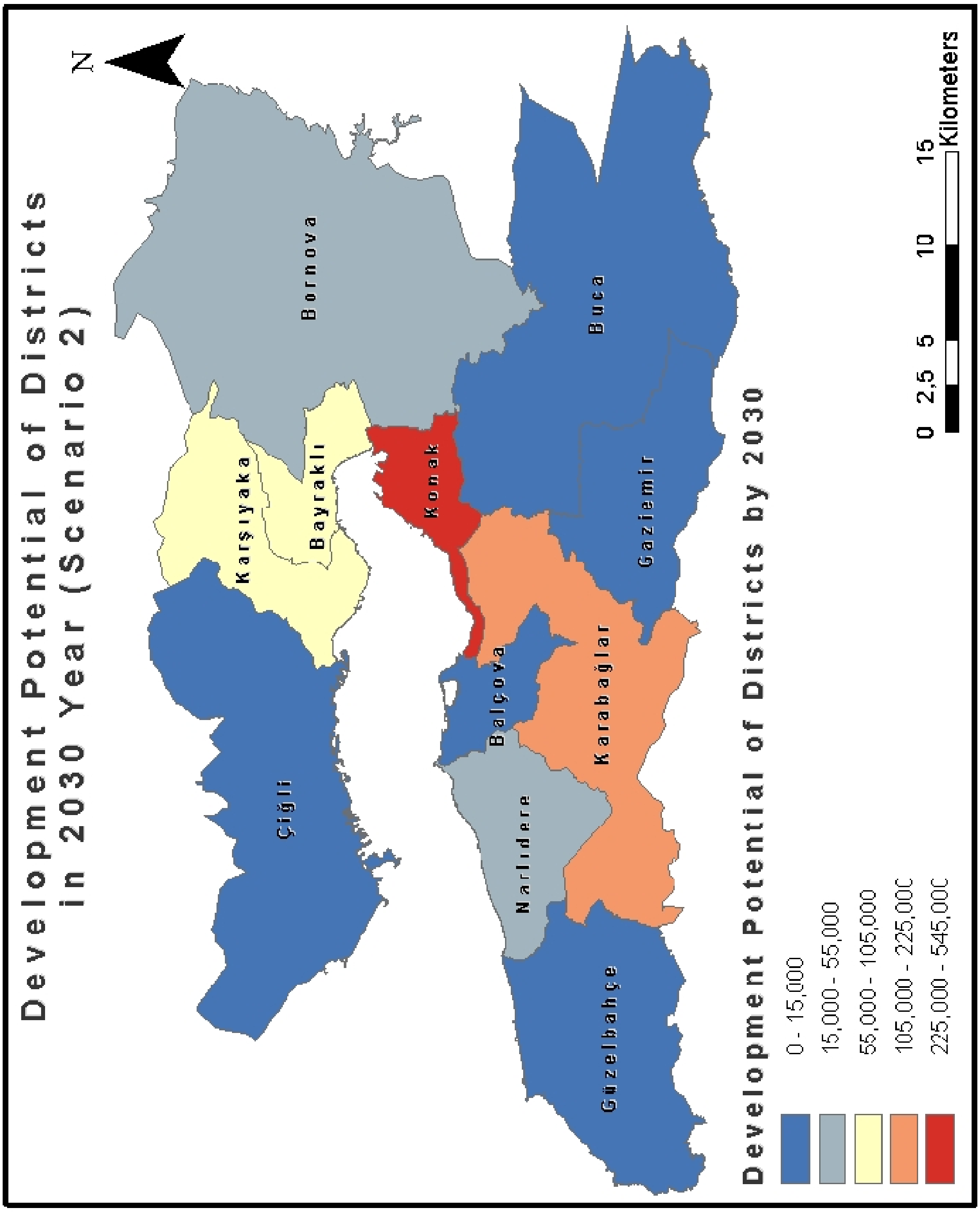


Figure 5.29 The development potential values of the districts under Scenario (2)

In addition to these calculations, the additional shares of the population of the districts (R_i) are calculated in the study. Table 5.30 shows the additional shares of the population of the districts under Scenario (2).

Table 5.30 The additional shares of the population of the districts in study under Scenario (2)

Districts	***Additional Shares of Population (Ri)***
Bayraklı	0,196
Buca	0,072
Bornova	0,084
Çiğli	0,311
Gaziemir	0,019
Karabağlar	0,102
Karşıyaka	0,132
Konak	0,000
Narlıdere	0,084

The values in the table can be interpreted in the following format: For example, 72 per 1,000 people will prefer to settle in the future in Buca district of the city of Izmir. The additional shares of the population of the districts vary according to factors, such as ease of access and transportation, proximity to urban utilities, location of districts from the city center. Therefore, the additional share of the population of Karabağlar district is quite different from the additional shares of the population of Çiğli district. That's why Karabağlar district is closer to the city center than Çiğli district. Table 5.32 shows the current population under Scenario (2), additional population and projected population under Scenario (2) in districts in the study area.

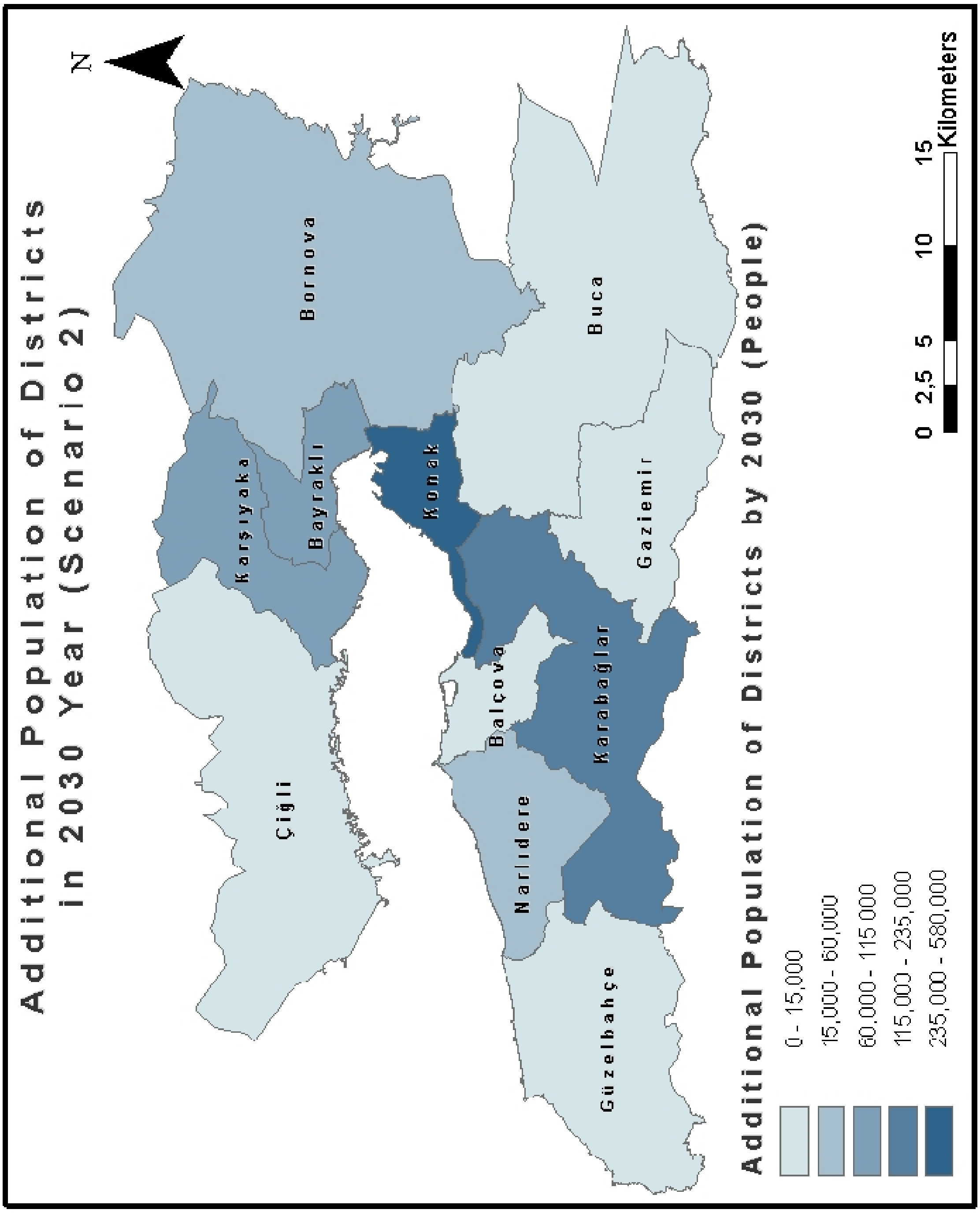


Figure 5.31 The additional population in each district under Scenario (1)

Table 5.32 The current population, additional and projected population under Scenario (2)

Districts	***Current Population Under Scenario (2) (People)***	***Additional Population (People)***	***Projected Population Under Scenario (2) (People)***
Bayraklı	306427	222216	528643
Buca	412639	82284	494923
Bornova	402453	95593	498046
Çiğli	154397	353952	508349
Gaziemir	121255	21186	142441
Karabağlar	448337	115779	564116
Karşıyaka	304220	149789	454009
Konak	411112	0	411112
Narlıdere	65714	95559	161273

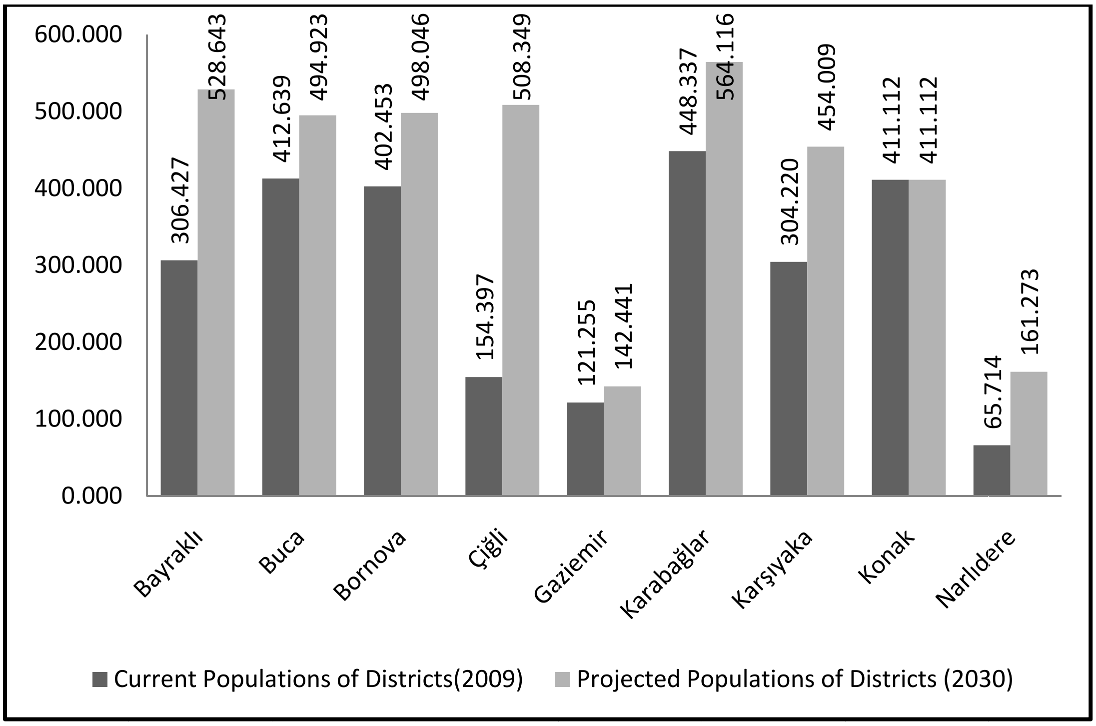


Figure 5.33 The comparative current population and estimations of projected population in each district under Scenario (2)

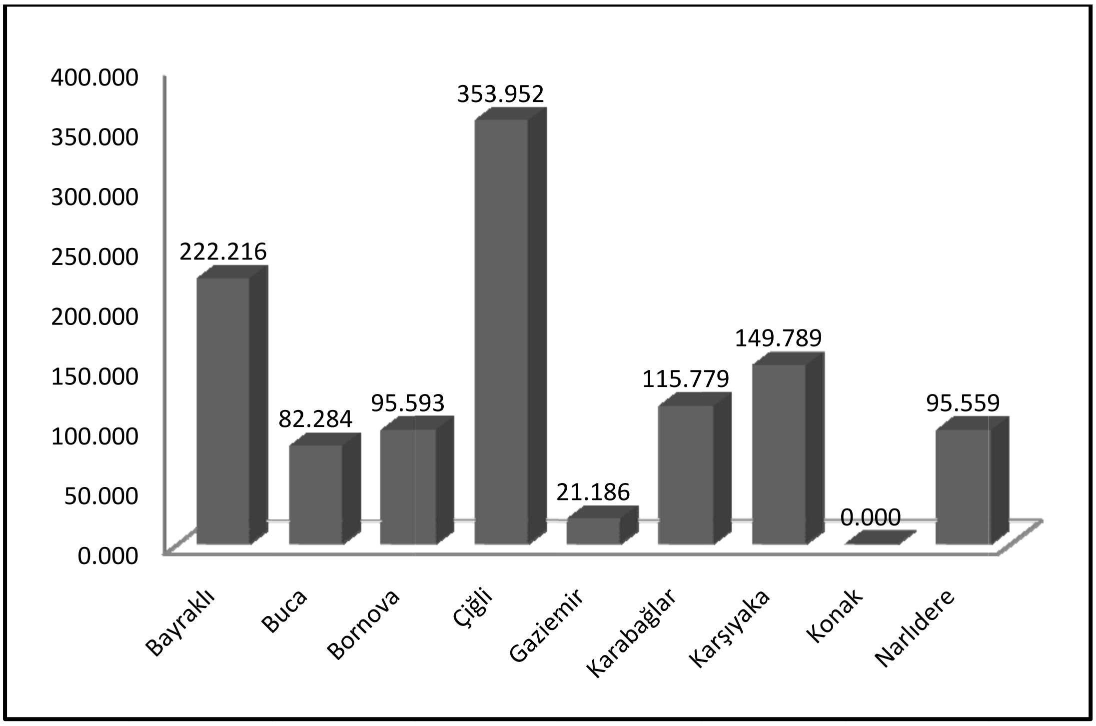


Figure 5.34 The comparative estimations of additional population in each district

In consideration of the situation among districts in terms of additional population, the reasons that have been explained after Figure 5.17 in Part 5.1.1 can be approved. Because in two scenarios, the results after the implementation of model and the factors that are formed the situation of districts are similar. Therefore, the comparison between the results of two scenarios in the study can be made and interpreted. It will be useful to consider the situations that occur in different type of implementations in study area. Moreover, the effects of urban renewal in terms of population and employment will be observed more easily in districts.

At the end of the application of the Hansen model, under Scenario (2), the total population of districts that is expected to come to a total of 11 different areas in nine districts in Izmir metropolitan city. In addition, the model application is expected to happen not only providing the needs of the population for the next addition to the social, cultural, economic and planning as well as recreational areas, but also providing controlled distribution of the population in the urban space. According to the results obtained by the application of the Hansen Model, the planning policies can be developed for the districts and the city considering their nature and the development potentials. These policies are parallel with IKBNIP scaled of 1/25.000 and the decisions contained in the legislation of the Reconstruction.

5.2 The Application of Lowry – Garin Model

In this study, according to the data collected, analyzed and estimated both population and employment, there exist totally 11 different program areas in 9 districts in Izmir metropolitan city. These districts are as follows: Bayraklı, Buca, Bornova, Çiğli, Gaziemir, Karabağlar, Karşıyaka, Konak ve Narlıdere. The total population of Izmir city *(P)* 2.626,554 people and also the total employment is (E_i) 470.140. In Table 5.35, the time matrix of districts in the study (T_{ij}) is presented. Additionally, in Table 5.36, the employment values of districts are included by year 2002.

Table 5.35 The time matrix of districts in study (T*ij)*

Tij (min)	***Bayraklı***	***Buca***	***Bornova***	***Çiğli***	***Gaziemir***	***Karabağlar***	***Karşıyaka***	***Konak***	***Narlıdere***
Bayraklı	18	21	8.68	8.99	30.86	23.68	8.29	16.34	33.09
Buca	20.53	30	11.21	26.62	21.72	14.25	20.23	8.32	19.95
Bornova	8.90	15.80	22	14.20	26.15	18.41	14.70	11.07	27.82
Çiğli	8.70	26.97	14.31	14	36.02	28.20	8.53	20.86	37.61
Gaziemir	30.30	7.61	26.16	36.02	19	10.29	29.62	15.63	8.70
Karabağlar	30.30	19.80	26.16	28.53	18.64	17	22.14	13.10	8.70
Karşıyaka	8.11	20.41	14.67	8.77	29.46	21.64	20	12.53	31.05
Konak	15.69	14.80	11.83	21.41	15.68	13.21	15.02	14	16.76
Narlıdere	32.68	20.30	28.81	38.39	14.57	12.79	32.00	17.06	10

Table 5.36 The employment values of districts for the year 2002

Districts	***Basic Employment (Eb)***	***Service Employment (Es)***	***Total Employment (Ei))***
Bayraklı	7907	21786	29693
Buca	4527	27063	31591
Bornova	10289	49770	60060
Çiğli	15076	19443	34520
Gaziemir	3141	10259	13400
Karabağlar	16873	111543	128416
Karşıyaka	7963	21939	29902
Konak	18441	121906	140347
Narlıdere	1120	1092	2211
TOTAL	***85338***	***384801***	***470140***

To begin with the solution, firstly the rate of population to basic employment (α) and the rate of population to service employment (β) are calculated.

$$\alpha = \frac{Pi}{Ei} = \frac{2626554}{1806159} = 1.4542 \qquad (5.2.1)$$

where,

$\alpha =$ The rate of population to basic employment,

E_i = Total employment in zone *i,*

P_i = Total population in zone *i.*

$$\beta = \frac{Es}{Pi} = \frac{1441984}{2626554} = 0.5490 \tag{5.2.2}$$

where,

$\beta =$ The rate of population to service employment,

E_s = Service employment in zone *i,*

P_i = Total population in zone *i.*

The matrices of calculated rates (α) and (β) can be created as:

$$\alpha = \begin{bmatrix} \alpha & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \alpha & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \alpha & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \alpha & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \alpha & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \alpha & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \alpha & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \alpha \end{bmatrix} = \begin{bmatrix} 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 \end{bmatrix},$$

$$\beta = \begin{bmatrix} \beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \beta & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \beta & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \beta & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \beta \end{bmatrix} = \begin{bmatrix} 0.5490 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.5490 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.5490 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.5490 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.5490 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.5490 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.5490 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5490 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5490 \end{bmatrix}.$$

Therefore, after the calculation of these matrices, the function of work place – home ($a_{ij}^{'}$) is defined as:

$$a_{ij}^{'} = \frac{e^{-0.1\, tij}}{\sum_{j=1}^{n} e^{-0.1\, tij}} \tag{5.2.3}$$

The complete matrix of the function of work place – home ($A^{'}$) can be written as:

$$A^{'} = \begin{bmatrix} 0.0135 & 0.0100 & 0.0036 & 0.0066 & 0.0004 & 0.0077 & 0.0357 & 0.0160 & 0.0003 \\ 0.0105 & 0.0041 & 0.0162 & 0.0057 & 0.0093 & 0.0197 & 0.0108 & 0.0356 & 0.0028 \\ 0.0033 & 0.0181 & 0.0091 & 0.0025 & 0.0060 & 0.0130 & 0.0188 & 0.0270 & 0.0007 \\ 0.0072 & 0.0055 & 0.0025 & 0.0202 & 0.0022 & 0.0049 & 0.0349 & 0.0102 & 0.0001 \\ 0.0040 & 0.0382 & 0.0060 & 0.0022 & 0.0122 & 0.0046 & 0.0042 & 0.0171 & 0.0342 \\ 0.0040 & 0.0113 & 0.0060 & 0.0047 & 0.0127 & 0.0149 & 0.0089 & 0.0221 & 0.0097 \\ 0.0363 & 0.0106 & 0.0189 & 0.0340 & 0.0043 & 0.0094 & 0.0111 & 0.0437 & 0.0004 \\ 0.0170 & 0.0186 & 0.0251 & 0.0096 & 0.0171 & 0.0218 & 0.0182 & 0.0202 & 0.0048 \\ 0.0003 & 0.0026 & 0.0006 & 0.0001 & 0.0190 & 0.0094 & 0.0004 & 0.0046 & 0.0301 \end{bmatrix}$$

Similarly, the function of home – service sector ($b_{ij}^{'}$) can be defined as:

$$b_{ij}^{'} = \frac{e^{-0.1\, tij}}{\sum_{j=1}^{n} e^{-0.1\, tij}} \quad (5.2.4)$$

Additionally, the complete matrix of the function of home – service sector ($B^{'}$) can be written as:

$$B^{'} = \begin{bmatrix} 0.0135 & 0.0100 & 0.0036 & 0.0066 & 0.0004 & 0.0077 & 0.0357 & 0.0160 & 0.0003 \\ 0.0105 & 0.0041 & 0.0162 & 0.0057 & 0.0093 & 0.0197 & 0.0108 & 0.0356 & 0.0028 \\ 0.0033 & 0.0181 & 0.0091 & 0.0025 & 0.0060 & 0.0130 & 0.0188 & 0.0270 & 0.0007 \\ 0.0072 & 0.0055 & 0.0025 & 0.0202 & 0.0022 & 0.0049 & 0.0349 & 0.0102 & 0.0001 \\ 0.0040 & 0.0382 & 0.0060 & 0.0022 & 0.0122 & 0.0046 & 0.0042 & 0.0171 & 0.0342 \\ 0.0040 & 0.0113 & 0.0060 & 0.0047 & 0.0127 & 0.0149 & 0.0089 & 0.0221 & 0.0097 \\ 0.0363 & 0.0106 & 0.0189 & 0.0340 & 0.0043 & 0.0094 & 0.0111 & 0.0437 & 0.0004 \\ 0.0170 & 0.0186 & 0.0251 & 0.0096 & 0.0171 & 0.0218 & 0.0182 & 0.0202 & 0.0048 \\ 0.0003 & 0.0026 & 0.0006 & 0.0001 & 0.0190 & 0.0094 & 0.0004 & 0.0046 & 0.0301 \end{bmatrix}$$

After these calculations of the functions, the distribution of total employment in the study area is calculated with:

$$E = E^{b} * [I - (A^{'}[\alpha][\beta]B^{'})]^{-1} \quad (5.2.5)$$

this formula is used. In the calculation of the total employment, the above formula is performed step by step;

$$A^{'}[\alpha]=\begin{bmatrix}0.0135 & 0.0100 & 0.0036 & 0.0066 & 0.0004 & 0.0077 & 0.0357 & 0.0160 & 0.0003\\ 0.0105 & 0.0041 & 0.0162 & 0.0057 & 0.0093 & 0.0197 & 0.0108 & 0.0356 & 0.0028\\ 0.0033 & 0.0181 & 0.0091 & 0.0025 & 0.0060 & 0.0130 & 0.0188 & 0.0270 & 0.0007\\ 0.0072 & 0.0055 & 0.0025 & 0.0202 & 0.0022 & 0.0049 & 0.0349 & 0.0102 & 0.0001\\ 0.0040 & 0.0382 & 0.0060 & 0.0022 & 0.0122 & 0.0046 & 0.0042 & 0.0171 & 0.0342\\ 0.0040 & 0.0113 & 0.0060 & 0.0047 & 0.0127 & 0.0149 & 0.0089 & 0.0221 & 0.0097\\ 0.0363 & 0.0106 & 0.0189 & 0.0340 & 0.0043 & 0.0094 & 0.0111 & 0.0437 & 0.0004\\ 0.0170 & 0.0186 & 0.0251 & 0.0096 & 0.0171 & 0.0218 & 0.0182 & 0.0202 & 0.0048\\ 0.0003 & 0.0026 & 0.0006 & 0.0001 & 0.0190 & 0.0094 & 0.0004 & 0.0046 & 0.0301\end{bmatrix}$$

$$*\begin{bmatrix}1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542\end{bmatrix}$$

$$A^{'}[\alpha]=\begin{bmatrix}0.0197 & 0.0146 & 0.0052 & 0.0096 & 0.0006 & 0.0111 & 0.0519 & 0.0232 & 0.0004\\ 0.0153 & 0.0059 & 0.0235 & 0.0083 & 0.0136 & 0.0286 & 0.0157 & 0.0518 & 0.0041\\ 0.0048 & 0.0263 & 0.0132 & 0.0037 & 0.0087 & 0.0189 & 0.0273 & 0.0393 & 0.0011\\ 0.0104 & 0.0080 & 0.0036 & 0.0293 & 0.0032 & 0.0071 & 0.0507 & 0.0148 & 0.0002\\ 0.0057 & 0.0556 & 0.0087 & 0.0032 & 0.0178 & 0.0067 & 0.0061 & 0.0249 & 0.0498\\ 0.0057 & 0.0164 & 0.0087 & 0.0069 & 0.0184 & 0.0217 & 0.0130 & 0.0321 & 0.0142\\ 0.0529 & 0.0155 & 0.0274 & 0.0495 & 0.0063 & 0.0137 & 0.0161 & 0.0636 & 0.0006\\ 0.0248 & 0.0271 & 0.0364 & 0.0140 & 0.0248 & 0.0317 & 0.0265 & 0.0293 & 0.0070\\ 0.0005 & 0.0038 & 0.0009 & 0.0002 & 0.0277 & 0.0136 & 0.0005 & 0.0066 & 0.0438\end{bmatrix}$$

$$B^{'}[\beta]=\begin{bmatrix}0.0135 & 0.0100 & 0.0036 & 0.0066 & 0.0004 & 0.0077 & 0.0357 & 0.0160 & 0.0003\\ 0.0105 & 0.0041 & 0.0162 & 0.0057 & 0.0093 & 0.0197 & 0.0108 & 0.0356 & 0.0028\\ 0.0033 & 0.0181 & 0.0091 & 0.0025 & 0.0060 & 0.0130 & 0.0188 & 0.0270 & 0.0007\\ 0.0072 & 0.0055 & 0.0025 & 0.0202 & 0.0022 & 0.0049 & 0.0349 & 0.0102 & 0.0001\\ 0.0040 & 0.0382 & 0.0060 & 0.0022 & 0.0122 & 0.0046 & 0.0042 & 0.0171 & 0.0342\\ 0.0040 & 0.0113 & 0.0060 & 0.0047 & 0.0127 & 0.0149 & 0.0089 & 0.0221 & 0.0097\\ 0.0363 & 0.0106 & 0.0189 & 0.0340 & 0.0043 & 0.0094 & 0.0111 & 0.0437 & 0.0004\\ 0.0170 & 0.0186 & 0.0251 & 0.0096 & 0.0171 & 0.0218 & 0.0182 & 0.0202 & 0.0048\\ 0.0003 & 0.0026 & 0.0006 & 0.0001 & 0.0190 & 0.0094 & 0.0004 & 0.0046 & 0.0301\end{bmatrix}*$$

$$\begin{bmatrix}0.5490 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0.5490 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0.5490 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0.5490 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0.5490 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0.5490 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0.5490 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5490 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5490\end{bmatrix}.$$

$B' \, [\beta] =$

$$\begin{bmatrix}
0.0074 & 0.0055 & 0.0020 & 0.0036 & 0.0002 & 0.0042 & 0.0196 & 0.0088 & 0.0002 \\
0.0058 & 0.0022 & 0.0089 & 0.0031 & 0.0051 & 0.0108 & 0.0059 & 0.0195 & 0.0015 \\
0.0018 & 0.0099 & 0.0050 & 0.0014 & 0.0033 & 0.0071 & 0.0103 & 0.0148 & 0.0004 \\
0.0039 & 0.0030 & 0.0014 & 0.0111 & 0.0012 & 0.0027 & 0.0191 & 0.0056 & 0.0001 \\
0.0022 & 0.0210 & 0.0033 & 0.0012 & 0.0067 & 0.0025 & 0.0023 & 0.0094 & 0.0188 \\
0.0022 & 0.0062 & 0.0033 & 0.0026 & 0.0070 & 0.0082 & 0.0049 & 0.0121 & 0.0053 \\
0.0200 & 0.0058 & 0.0104 & 0.0187 & 0.0024 & 0.0052 & 0.0061 & 0.0240 & 0.0002 \\
0.0093 & 0.0102 & 0.0138 & 0.0053 & 0.0094 & 0.0120 & 0.0100 & 0.0111 & 0.0026 \\
0.0002 & 0.0014 & 0.0003 & 0.0001 & 0.0105 & 0.0052 & 0.0002 & 0.0025 & 0.0165
\end{bmatrix}$$

$A'[\alpha][\beta]B' =$

$$\begin{bmatrix}
0.0197 & 0.0146 & 0.0052 & 0.0096 & 0.0006 & 0.0111 & 0.0519 & 0.0232 & 0.0004 \\
0.0153 & 0.0059 & 0.0235 & 0.0083 & 0.0136 & 0.0286 & 0.0157 & 0.0518 & 0.0041 \\
0.0048 & 0.0263 & 0.0132 & 0.0037 & 0.0087 & 0.0189 & 0.0273 & 0.0393 & 0.0011 \\
0.0104 & 0.0080 & 0.0036 & 0.0293 & 0.0032 & 0.0071 & 0.0507 & 0.0148 & 0.0002 \\
0.0057 & 0.0556 & 0.0087 & 0.0032 & 0.0178 & 0.0067 & 0.0061 & 0.0249 & 0.0498 \\
0.0057 & 0.0164 & 0.0087 & 0.0069 & 0.0184 & 0.0217 & 0.0130 & 0.0321 & 0.0142 \\
0.0529 & 0.0155 & 0.0274 & 0.0495 & 0.0063 & 0.0137 & 0.0161 & 0.0636 & 0.0006 \\
0.0248 & 0.0271 & 0.0364 & 0.0140 & 0.0248 & 0.0317 & 0.0265 & 0.0293 & 0.0070 \\
0.0005 & 0.0038 & 0.0009 & 0.0002 & 0.0277 & 0.0136 & 0.0005 & 0.0066 & 0.0438
\end{bmatrix} *$$

$$\begin{bmatrix}
0.0074 & 0.0055 & 0.0020 & 0.0036 & 0.0002 & 0.0042 & 0.0196 & 0.0088 & 0.0002 \\
0.0058 & 0.0022 & 0.0089 & 0.0031 & 0.0051 & 0.0108 & 0.0059 & 0.0195 & 0.0015 \\
0.0018 & 0.0099 & 0.0050 & 0.0014 & 0.0033 & 0.0071 & 0.0103 & 0.0148 & 0.0004 \\
0.0039 & 0.0030 & 0.0014 & 0.0111 & 0.0012 & 0.0027 & 0.0191 & 0.0056 & 0.0001 \\
0.0022 & 0.0210 & 0.0033 & 0.0012 & 0.0067 & 0.0025 & 0.0023 & 0.0094 & 0.0188 \\
0.0022 & 0.0062 & 0.0033 & 0.0026 & 0.0070 & 0.0082 & 0.0049 & 0.0121 & 0.0053 \\
0.0200 & 0.0058 & 0.0104 & 0.0187 & 0.0024 & 0.0052 & 0.0061 & 0.0240 & 0.0002 \\
0.0093 & 0.0102 & 0.0138 & 0.0053 & 0.0094 & 0.0120 & 0.0100 & 0.0111 & 0.0026 \\
0.0002 & 0.0014 & 0.0003 & 0.0001 & 0.0105 & 0.0052 & 0.0002 & 0.0025 & 0.0165
\end{bmatrix}$$

$A'[\alpha][\beta]B' =$

$$\begin{bmatrix}
0.0016 & 0.0008 & 0.0011 & 0.0014 & 0.0005 & 0.0009 & 0.0013 & 0.0022 & 0.0002 \\
0.0011 & 0.0014 & 0.0012 & 0.0009 & 0.0010 & 0.0013 & 0.0015 & 0.0021 & 0.0006 \\
0.0012 & 0.0011 & 0.0012 & 0.0009 & 0.0008 & 0.0012 & 0.0011 & 0.0022 & 0.0004 \\
0.0014 & 0.0008 & 0.0009 & 0.0014 & 0.0004 & 0.0007 & 0.0013 & 0.0020 & 0.0002 \\
0.0008 & 0.0010 & 0.0011 & 0.0005 & 0.0013 & 0.0014 & 0.0010 & 0.0021 & 0.0014 \\
0.0008 & 0.0011 & 0.0009 & 0.0007 & 0.0009 & 0.0010 & 0.0010 & 0.0017 & 0.0008 \\
0.0017 & 0.0017 & 0.0016 & 0.0015 & 0.0010 & 0.0017 & 0.0032 & 0.0028 & 0.0004 \\
0.0014 & 0.0018 & 0.0014 & 0.0011 & 0.0011 & 0.0015 & 0.0020 & 0.0030 & 0.0009 \\
0.0002 & 0.0008 & 0.0003 & 0.0001 & 0.0008 & 0.0005 & 0.0003 & 0.0007 & 0.0013
\end{bmatrix}$$

$$I-(A'[\alpha][\beta]B')=\begin{bmatrix}1&0&0&0&0&0&0&0&0\\0&1&0&0&0&0&0&0&0\\0&0&1&0&0&0&0&0&0\\0&0&0&1&0&0&0&0&0\\0&0&0&0&1&0&0&0&0\\0&0&0&0&0&1&0&0&0\\0&0&0&0&0&0&1&0&0\\0&0&0&0&0&0&0&1&0\\0&0&0&0&0&0&0&0&1\end{bmatrix}-$$

$$\begin{bmatrix}0.0016&0.0008&0.0011&0.0014&0.0005&0.0009&0.0013&0.0022&0.0002\\0.0011&0.0014&0.0012&0.0009&0.0010&0.0013&0.0015&0.0021&0.0006\\0.0012&0.0011&0.0012&0.0009&0.0008&0.0012&0.0011&0.0022&0.0004\\0.0014&0.0008&0.0009&0.0014&0.0004&0.0007&0.0013&0.0020&0.0002\\0.0008&0.0010&0.0011&0.0005&0.0013&0.0014&0.0010&0.0021&0.0014\\0.0008&0.0011&0.0009&0.0007&0.0009&0.0010&0.0010&0.0017&0.0008\\0.0017&0.0017&0.0016&0.0015&0.0010&0.0017&0.0032&0.0028&0.0004\\0.0014&0.0018&0.0014&0.0011&0.0011&0.0015&0.0020&0.0030&0.0009\\0.0002&0.0008&0.0003&0.0001&0.0008&0.0005&0.0003&0.0007&0.0013\end{bmatrix}$$

$$I-(A'[\alpha][\beta]B')=$$

$$\begin{bmatrix}0.9984&-0.0008&-0.0011&-0.0014&-0.0005&-0.0009&-0.0013&-0.0022&-0.0002\\-0.0011&0.9986&-0.0012&-0.0009&-0.0010&-0.0013&-0.0015&-0.0021&-0.0006\\-0.0012&-0.0011&0.9988&-0.0009&-0.0008&-0.0012&-0.0011&-0.0022&-0.0004\\-0.0014&-0.0008&-0.0009&0.9986&-0.0004&-0.0007&-0.0013&-0.0020&-0.0002\\-0.0008&-0.0010&-0.0011&-0.0005&0.9987&-0.0014&-0.0010&-0.0021&-0.0014\\-0.0008&-0.0011&-0.0009&-0.0007&-0.0009&0.9990&-0.0010&-0.0017&-0.0008\\-0.0017&-0.0017&-0.0016&-0.0015&-0.0010&-0.0017&0.9968&-0.0028&-0.0004\\-0.0014&-0.0018&-0.0014&-0.0011&-0.0011&-0.0015&-0.0020&0.9970&-0.0009\\-0.0002&-0.0008&-0.0003&-0.0001&-0.0008&-0.0005&-0.0003&-0.0007&0.9987\end{bmatrix}$$

The inverse of this formula is:

$$[I-(A'[\alpha][\beta]B')]^{-1}=$$

$$\begin{bmatrix}1.0016&0.0009&0.0011&0.0014&0.0005&0.0010&0.0013&0.0023&0.0002\\0.0011&1.0015&0.0012&0.0009&0.0010&0.0013&0.0015&0.0021&0.0006\\0.0012&0.0011&1.0012&0.0009&0.0008&0.0012&0.0011&0.0022&0.0004\\0.0014&0.0008&0.0009&1.0015&0.0004&0.0008&0.0014&0.0020&0.0002\\0.0008&0.0010&0.0011&0.0005&1.0013&0.0014&0.0010&0.0021&0.0014\\0.0008&0.0011&0.0009&0.0007&0.0009&1.0010&0.0010&0.0017&0.0008\\0.0017&0.0017&0.0016&0.0015&0.0010&0.0017&1.0032&0.0028&0.0004\\0.0014&0.0018&0.0014&0.0012&0.0011&0.0016&0.0020&1.0030&0.0009\\0.0002&0.0008&0.0003&0.0001&0.0008&0.0005&0.0003&0.0007&1.0013\end{bmatrix}$$

Terminating the process, the distribution of the total employment is calculated as:

$$E=E^b*[I-(A'[\alpha][\beta]B')]^{-1} \quad (5.2.6)$$

= [72862 40043 54252 31094 10207 32519 73375 35540 14277] *

$$\begin{bmatrix} 1.0016 & 0.0009 & 0.0011 & 0.0014 & 0.0005 & 0.0010 & 0.0013 & 0.0023 & 0.0002 \\ 0.0011 & 1.0015 & 0.0012 & 0.0009 & 0.0010 & 0.0013 & 0.0015 & 0.0021 & 0.0006 \\ 0.0012 & 0.0011 & 1.0012 & 0.0009 & 0.0008 & 0.0012 & 0.0011 & 0.0022 & 0.0004 \\ 0.0014 & 0.0008 & 0.0009 & 1.0015 & 0.0004 & 0.0008 & 0.0014 & 0.0020 & 0.0002 \\ 0.0008 & 0.0010 & 0.0011 & 0.0005 & 1.0013 & 0.0014 & 0.0010 & 0.0021 & 0.0014 \\ 0.0008 & 0.0011 & 0.0009 & 0.0007 & 0.0009 & 1.0010 & 0.0010 & 0.0017 & 0.0008 \\ 0.0017 & 0.0017 & 0.0016 & 0.0015 & 0.0010 & 0.0017 & 1.0032 & 0.0028 & 0.0004 \\ 0.0014 & 0.0018 & 0.0014 & 0.0012 & 0.0011 & 0.0016 & 0.0020 & 1.0030 & 0.0009 \\ 0.0002 & 0.0008 & 0.0003 & 0.0001 & 0.0008 & 0.0005 & 0.0003 & 0.0007 & 1.0013 \end{bmatrix}$$

= [73345 40498 54688 31507 10512 32968 73989 36369 14470]

The values of total population and employment are known in Izmir city. From this point,

$$Es = E - Eb \tag{5.2.7}$$

this formula is used and the service employment can be figured out. Considering that;

= [73345 40498 54688 31507 10512 32968 73989 36369 14470] – [72862 40043 54252 31094 10207 32519 73375 35540 14277]

= [483 454 436 412 305 448 614 828 192]

Finally, according to the data obtained from the employment and population, a population estimated using the Lowry model. The formula is used to calculate the total projected population as follows:

$$P = E * A' * (\alpha) \tag{5.2.8}$$

$$= [73345\ 40498\ 54688\ 31507\ 10512\ 32968\ 73989\ 36369\ 14470] *$$

$$\begin{bmatrix} 0.0135 & 0.0100 & 0.0036 & 0.0066 & 0.0004 & 0.0077 & 0.0357 & 0.0160 & 0.0003 \\ 0.0105 & 0.0041 & 0.0162 & 0.0057 & 0.0093 & 0.0197 & 0.0108 & 0.0356 & 0.0028 \\ 0.0033 & 0.0181 & 0.0091 & 0.0025 & 0.0060 & 0.0130 & 0.0188 & 0.0270 & 0.0007 \\ 0.0072 & 0.0055 & 0.0025 & 0.0202 & 0.0022 & 0.0049 & 0.0349 & 0.0102 & 0.0001 \\ 0.0040 & 0.0382 & 0.0060 & 0.0022 & 0.0122 & 0.0046 & 0.0042 & 0.0171 & 0.0342 \\ 0.0040 & 0.0113 & 0.0060 & 0.0047 & 0.0127 & 0.0149 & 0.0089 & 0.0221 & 0.0097 \\ 0.0363 & 0.0106 & 0.0189 & 0.0340 & 0.0043 & 0.0094 & 0.0111 & 0.0437 & 0.0004 \\ 0.0170 & 0.0186 & 0.0251 & 0.0096 & 0.0171 & 0.0218 & 0.0182 & 0.0202 & 0.0048 \\ 0.0003 & 0.0026 & 0.0006 & 0.0001 & 0.0190 & 0.0094 & 0.0004 & 0.0046 & 0.0301 \end{bmatrix}$$

$$* \begin{bmatrix} 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1.4542 \end{bmatrix}$$

$$= [7720\ 6309\ 5917\ 6600\ 3735\ 6379\ 10190\ 13602\ 2185]$$

Table 5.37 The comparative employment values in each districts by year 2030

	Employment		
Districts	*Basic Employment*	*Service Employment*	*Total Employment*
Bayraklı	72862,33	200744,88	273609
Buca	40043,19	239378,00	279425
Bornova	54252,46	262419,64	316672
Çiğli	31094,90	40101,32	71197
Gaziemir	10207,68	33340,22	43548
Karabağlar	32519,23	214973,28	247493
Karşıyaka	73375,32	202158,21	275535
Konak	35540,57	234946,35	270487
Narlıdere	14276,93	13922,30	28194
TOTAL	***364172,61***	***1441984,21***	***1806159***

According to Table 5.37, the most increase in the basic employment will be in Bayraklı, Bornova and Karşıyaka districts. On the other hand, the increase in the basic employment will be relatively less in Konak, Karabağlar, Buca, Çiğli, Gaziemir and Narlıdere districts. Figure 5.38 shows the rates obtained by dividing the basic employment values to the total employment values. These rates show the basic employment in each district comparatively.

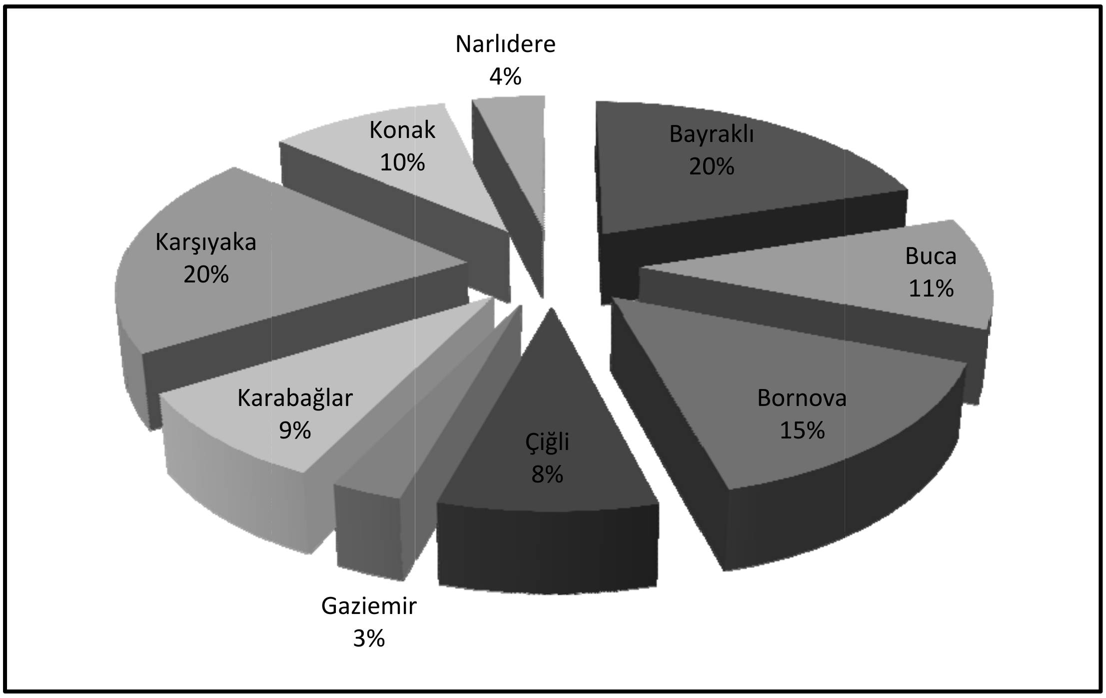


Figure 5.38 The comparative rates of basic employment of each district

In addition, in terms of the service employment, the most increase will be in Bornova, Buca, Karşıyaka, Karabağlar, Konak and Bayraklı districts. However, the increase in the service employment will be relatively less in Çiğli, Narlıdere and Gaziemir districts. Figure 5.39 shows the rates of service employment in each district. Therefore, in Figure 5.40, the graph shows a comparison between the rates of basic and service employment in districts.

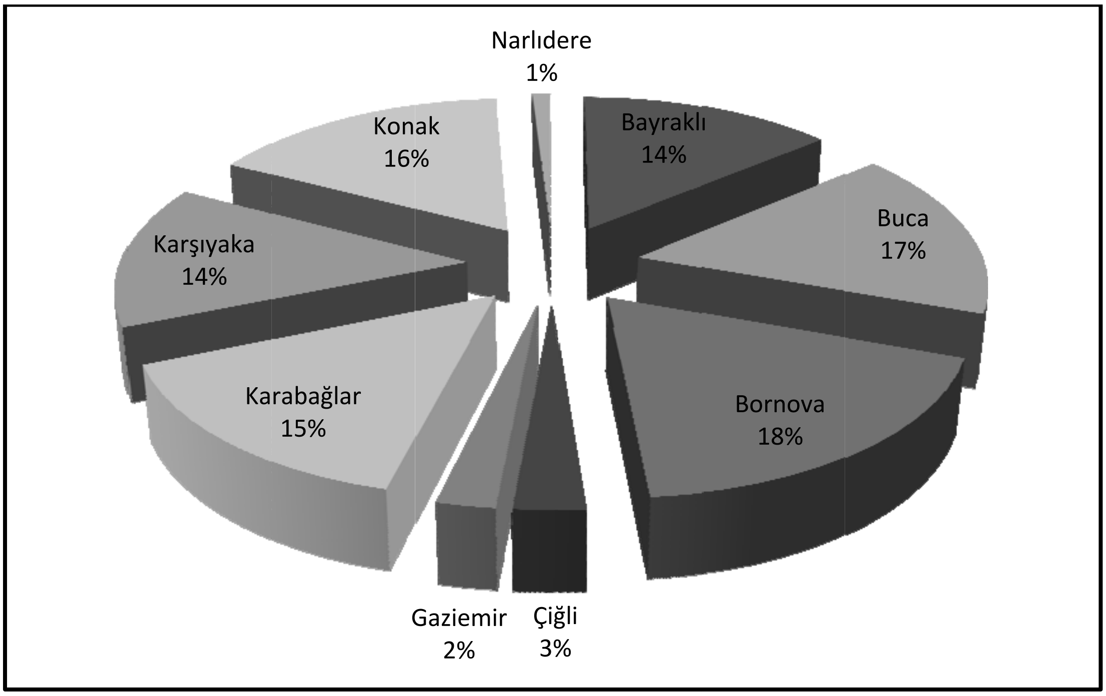


Figure 5.39 The comparative rates of service employment of each district

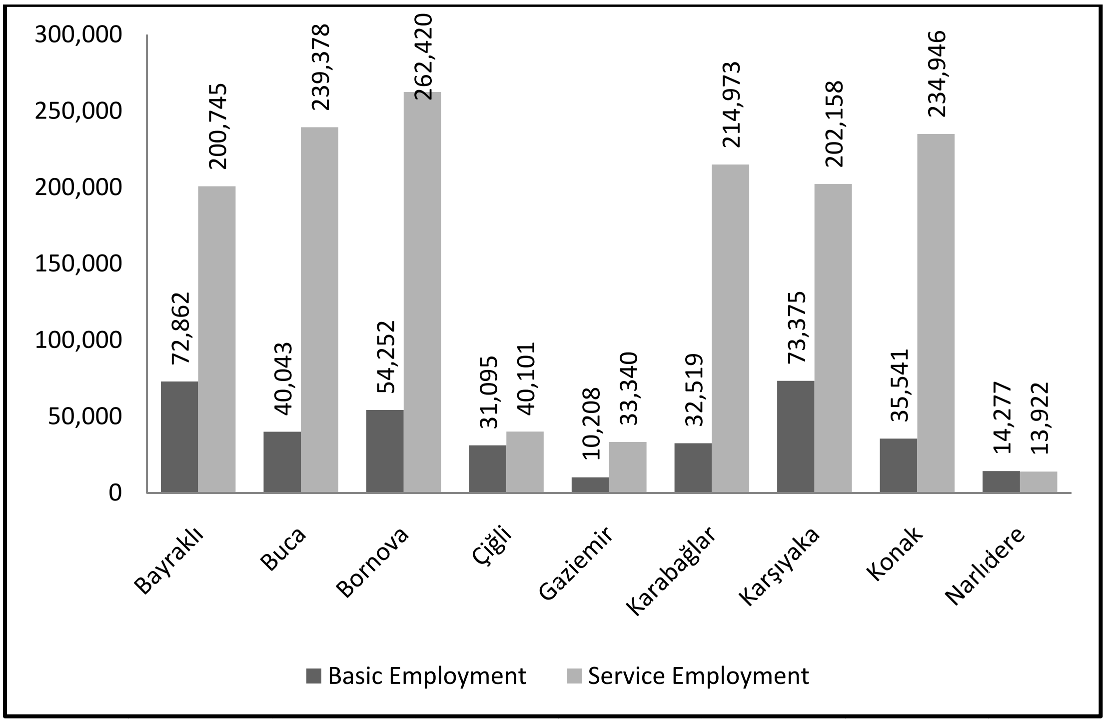


Figure 5.40 The comparison between basic and service employment values of each district

Finally, the increase in the total employment, like the basic employment, will be mostly in Bayraklı, Buca, Bornova, Karabağlar, Konak and Karşıyaka districts. For all that, in Narlıdere, Çiğli and Gaziemir district the employment increase will be less in comparison to other districts. Figure 5.41 shows the rates of the total employment comparatively in districts.

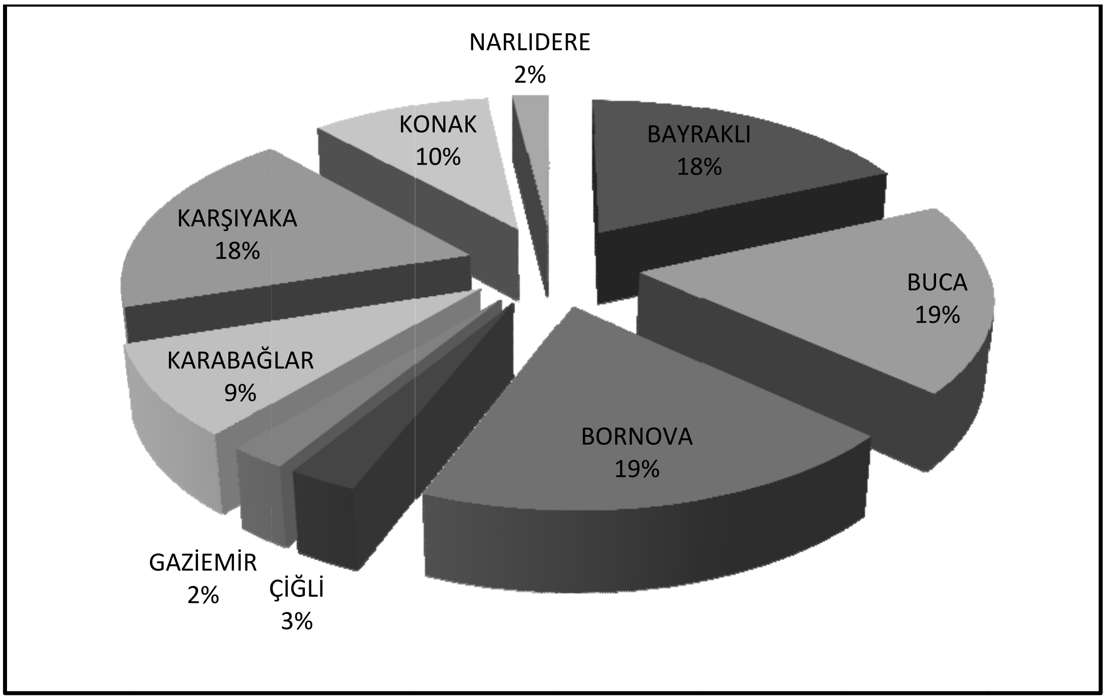


Figure 5.41 The comparative rates of total employment of each district

According to the results obtained, the employment values increase rather in Bornova, Karşıyaka and Bayraklı districts after the implementation of urban renewal. The density of employment units will increase in these districts. If the current growth trend continues, this result occurs. But, providing adequate employment stock is very difficult in these districts. Because the density of population and employment is excess, the accessibility index is high and many urban facilities can be provided in these districts. In case of insufficiency of employment units' stock in metropolitan area, there exist various interventions. The distribution of the facilities in employment among sub-centers according to their branches and the reduction the density of employment in these districts are examples for interventions.

Finally, the comparison between the results of Hansen model and the plan proposals of IKBNIPR is made. There are three different results included scenario (1), scenario (2) and IKBNIPR proposals. In Figure 5.42, the comparison among the result of three different cases is presented.

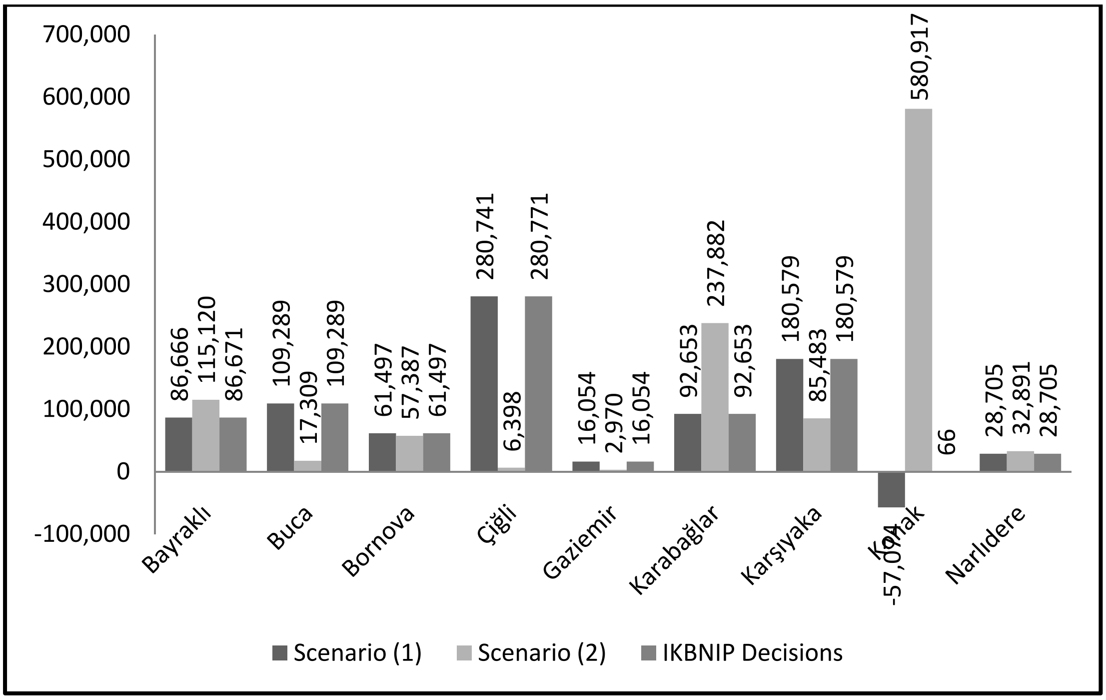


Figure 5.42 The comparison among three cases

Although the proposals of IKBNIPR are not defined as a scenario, a comparison is made all results obtained in the study. It will be an opportunity only to evaluate the results of scenarios implemented Hansen model and IKBNIPR proposals. According to the graph, the results are as follows:

- The population increase will be more in Çiğli, Buca, Bayraklı, Karşıyaka and Karabağlar districts in case of Scenario (1). The current increase trend of population will be critical for the districts after the implementation of urban renewal. For IKBNIPR proposals, these population increase rates are similar to Scenario (1) in these districts. In other words, their results are in parallel to each other. On the other hand, in Gaziemir, Bornova and Narlıdere districts, the urban renewal in Scenario (1) affects the future populations relatively less the other districts. In Konak district, the population will decrease in Scenario (1). The implementation of urban renewal affects the current agglomeration in urban facilities and units of employment in this district.
- In the case of Scenario (2), the population increase will be more in Bayraklı, Bornova, Karşıyaka, Konak and Karabağlar districts. This scenario shows how the population of districts can be increase without any intervention. But,

in Buca, Çiğli, Gaziemir and Narlıdere districts, this increase will be less than. Actually, these results are similar to proposals of IKBNIPR.

- In Gaziemir and Narlıdere districts, the results about population changes are quite different from the other districts. The increase obtained without the application of any models is the least among all the districts. In other words, if the current population trend continues in these two districts, the new development and investments will not realize in the future.

CHAPTER SIX
CONCLUSIONS

The purpose of the study is to assess the distribution of population and employment in Izmir, Turkey under different scenarios taking urban renewal into account. The various implementations of urban renewal exist all over the world. Belfast region (Ireland), Birmingham (United Kingdom), Broughton (Manchester), Glasgow (Scotland), Docklands (London), Ho Chi Minh City (Vietnam), Navab (Iran), Osaka (Japan), Uzundere region (Izmir) and Ankara (Turkey) are the examples for urban renewal implementations. The methods and applicability of urban renewal are not within the scope of the study.

The study covers Izmir city at the district level. The boundary of the study is determined by IKBNIPR proposals. The selected models are applied under two scenarios. These scenarios, as stated in Chapter 1 - Introduction, include:

(1) The renewal areas within IKBNIPR are renewed under proposal planning decisions,

(2) The renewal areas within IKBNIPR are not renewed under proposal planning decisions.

Two models are considered: the Hansen model and the Lowry - Garin model. The Hansen model can be defined a kind of potential gravity model is based on the potential interaction between regions. The Lowry - Garin model is known as the spatial interaction model that integrates with the economic-base concept (Çubukçu, 2008). The results obtained using these models are insufficient to present the probable distribution of employment and population in the future.

According to Scenario (2), the increase of population will be most in Konak, Karabağlar, Bayraklı and Bornova districts. According to Scenario (1), where the renewal areas within IKBNIPR are renewed under proposal planning decisions, the maximum population growth will be in Konak, Bayraklı and Karabağlar districts. Konak, Karabağlar and Bayraklı districts are primary in terms of the development potential, the accessibility index, as well the additional population in the districts.

Figure 6.1 show the graph comparing the additional population under the two scenarios. The comparative results in total population between two scenarios are presented in Figure 6.2.

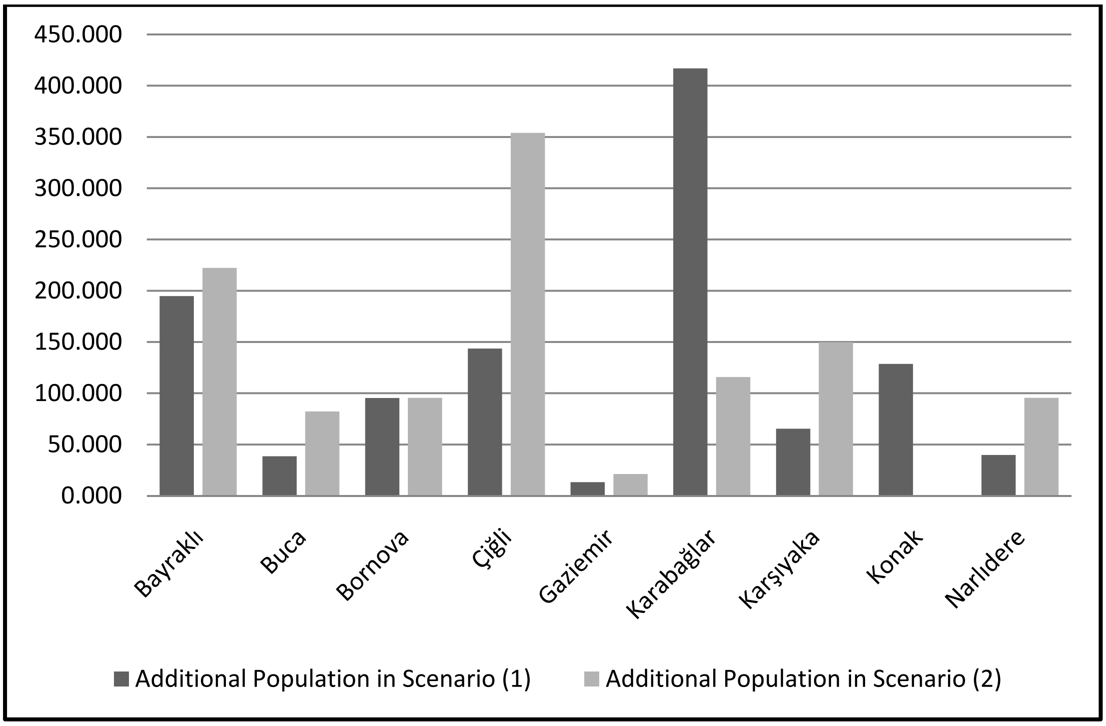


Figure 6.1 The comparative results in additional population between two scenarios

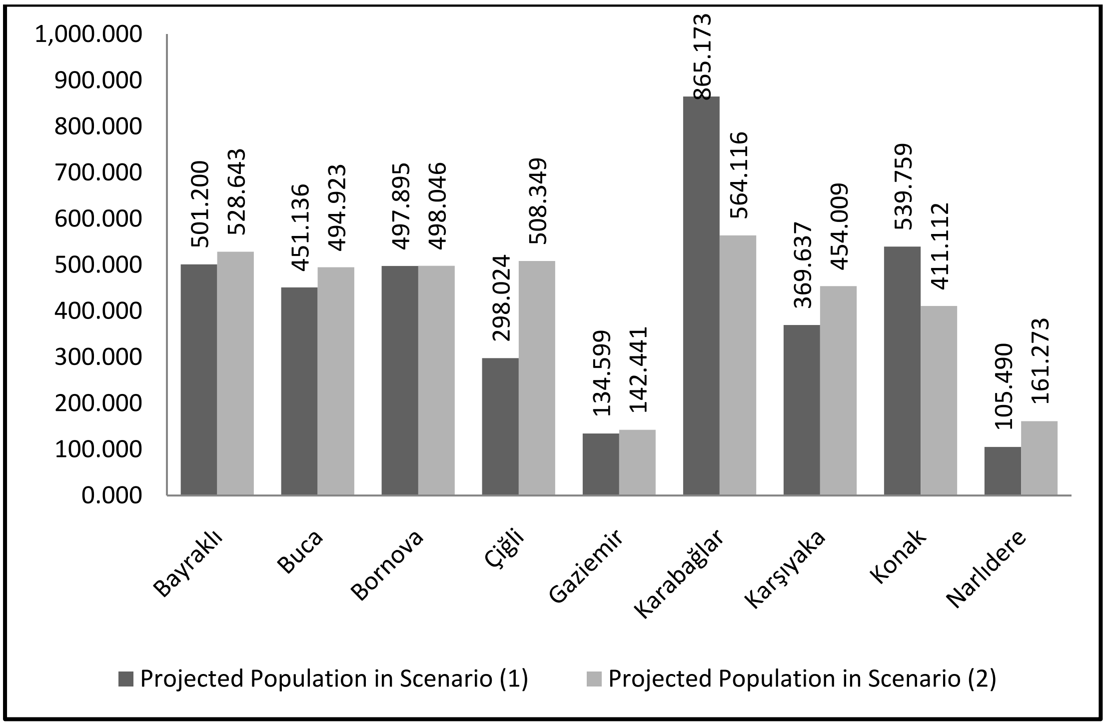


Figure 6.2 The comparative results in total population between two scenarios

According to these results, the population increase in certain districts is more than the other districts. The difference in population increase between scenarios is critical in Karabağlar and Çiğli districts. Not only in the current situation, but also after the implementation of urban renewal, these districts will be as a center of attraction in Izmir. The density in population and the demand for urban facilities will be excess in these districts in the future. On the other hand, in Buca, Gaziemir, Karşıyaka, Konak and Narlıdere, less increase in population of districts is expected. Also, the difference between two scenarios is not excess in these districts. So the implementation of urban renewal will cause sizeable additional population to these districts. But, in Çiğli district, the situation is different. The urban renewal projects change the current population and density in this district significantly (Figure 6.1 and 6.2).

In terms of employment, three sets of results are obtained through the Lowry – Garin model. Using the Lowry - Garin model, the future population and employment at the district level are estimated. The results of this application are obtained by using MatLab software. In Figure 6.3, the comparative results in employment types (basic, service and total employment) in districts are presented. Therefore, the shares by district are presented in Figure 6.4.

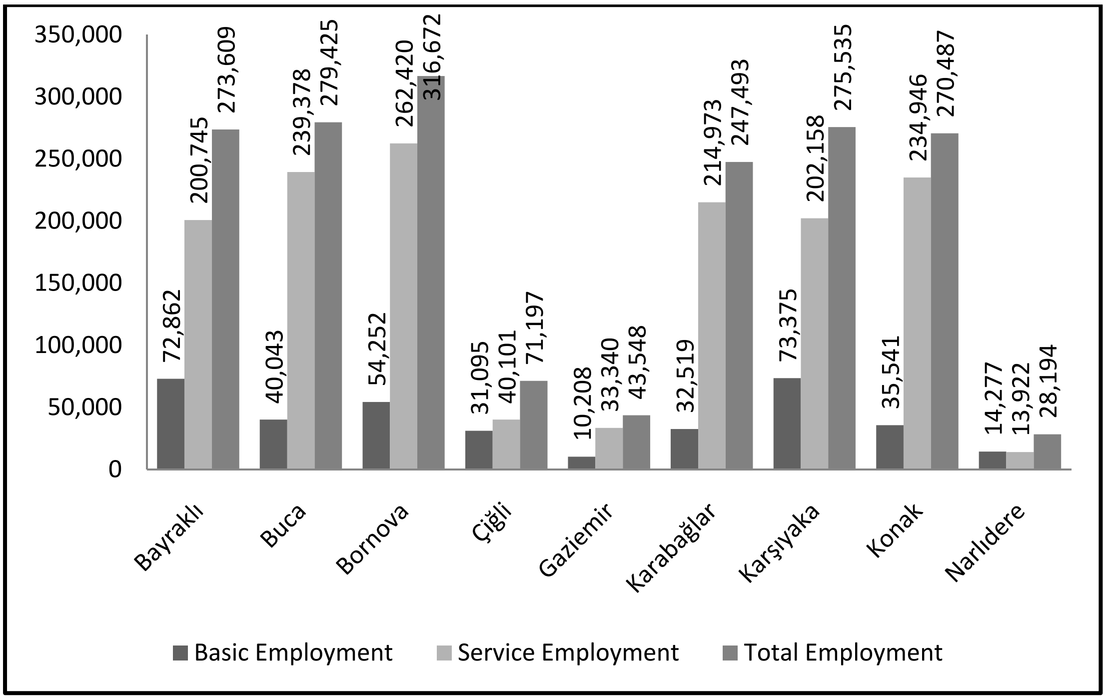


Figure 6.3 The comparative results in employment types in districts

In terms of the results obtained using the Lowry – Garin model, the increase in employment between 2009 and 2030 years are more in Konak, Bornova, Bayraklı, Buca, Karşıyaka and Karabağlar districts than the other ones (Figure 6.5). Also, the difference between employment types is excess in almost all districts, except Narlıdere, Çiğli and Gaziemir districts. The dense of employment in districts are in parallel with the distribution of population. Konak, Karabağlar, Karşıyaka, Bornova, Bayraklı and Buca are examples of this determination.

Although in Narlıdere district, many branches of employment do not exist, so the increases in employment will relatively less than the others. Moreover, the service employment is more than basic employment in Konak district. That's why this situation is different in Konak is the role of service sector is more common to all parts of the city.

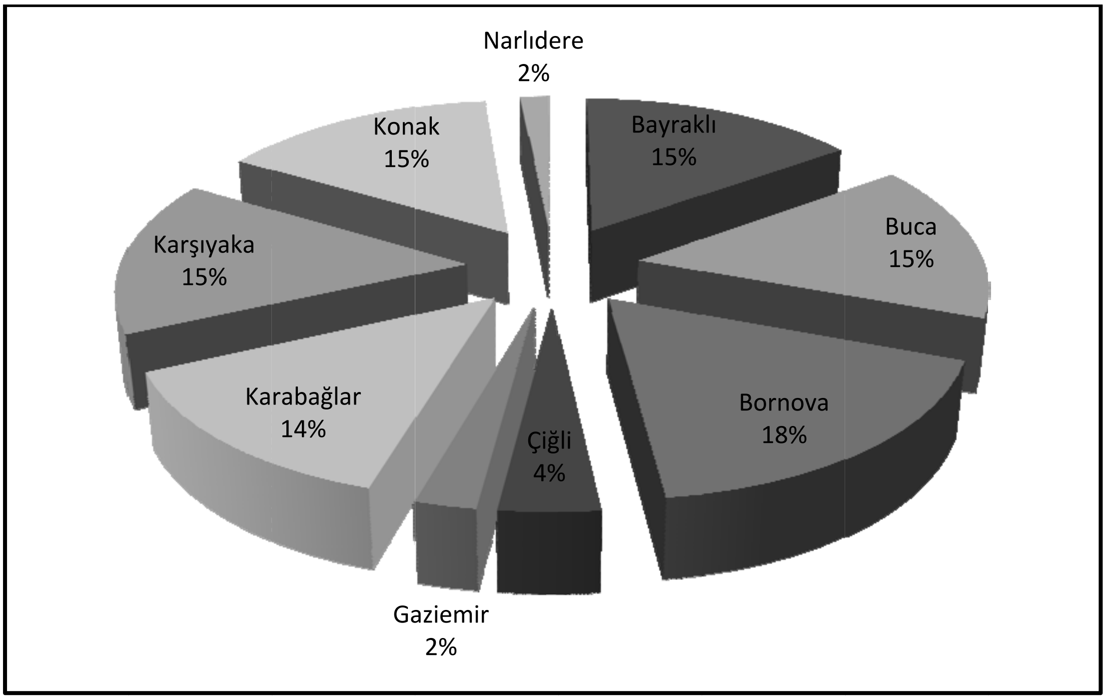


Figure 6.4 The comparative rates of total employment in districts

The total employment in districts varies according to urban facilities and sectoral activities. Any increase in basic employment or service employment affects the total population in districts. In Figure 6.5, the comparison between the changes in employment in districts is presented.

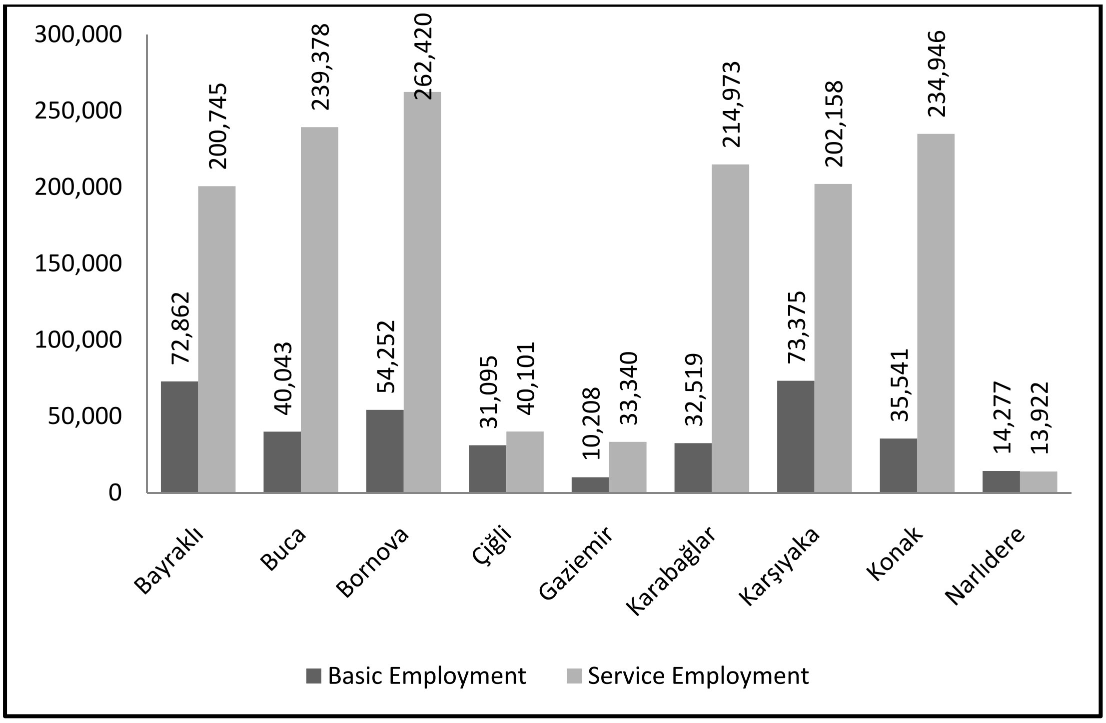


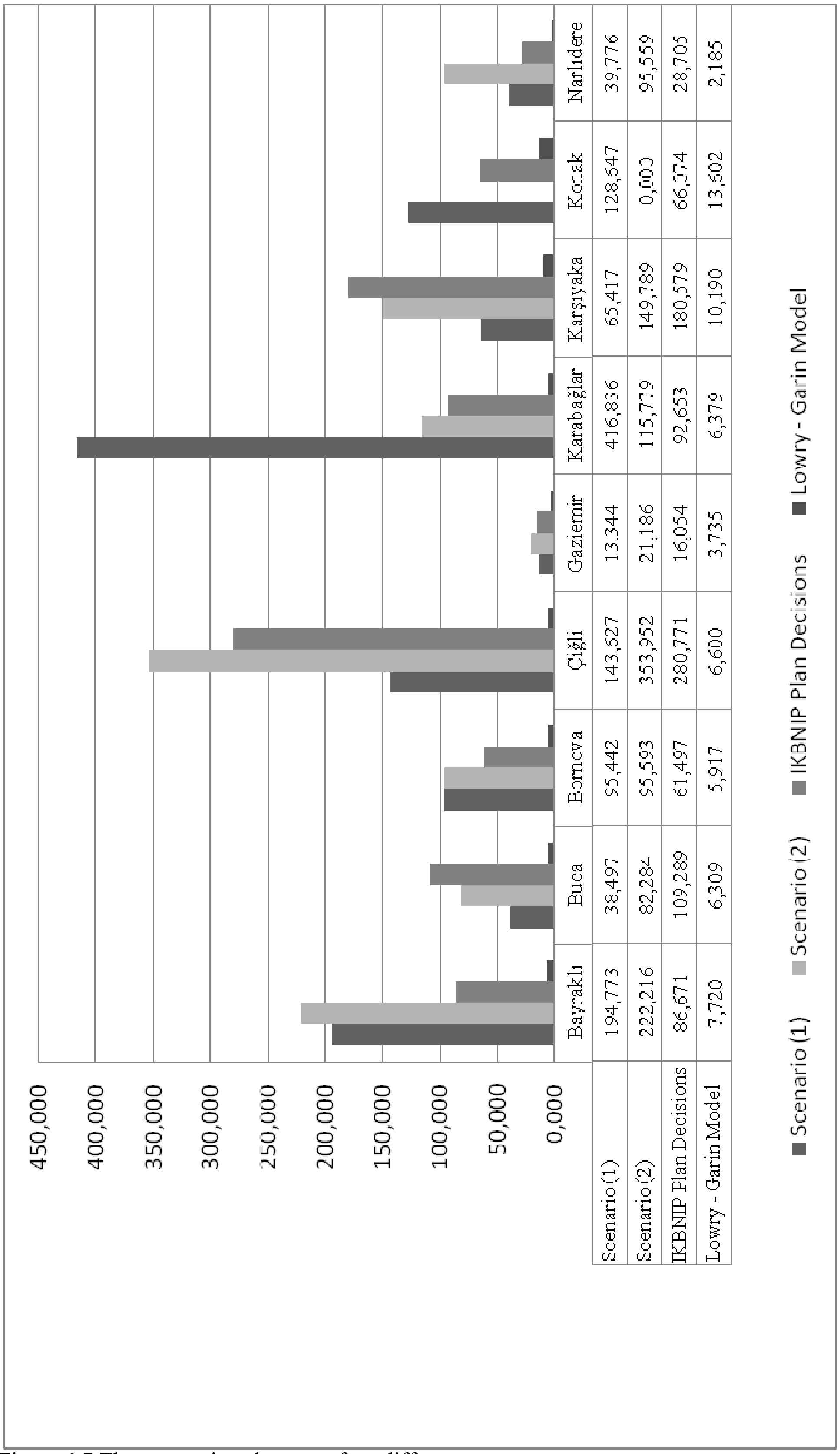
Figure 6.5 The comparison between the changes in employment in districts in the year 2030

The changes in basic and service employment are crucial especially in certain districts. Karabağlar, Bornova, Konak, Karşıyaka, Bayraklı and Buca districts are examples for this. On the other hand, in Çiğli, Gaziemir and Narlıdere any critical changes in employment do not exist.

If a network among sectors and a supply for employment are provided in previous times in a district, the changes in employment will not be critical. Konak is the best example for this condition. However, if the supply for employment units and network between sectors are not provided, each additional intervention causes dramatic changes in employment. Karabağlar and Bayraklı districts are two examples. Table 6.6 shows the comparative population in districts according to cases. Therefore, Figure 6.7 shows the comparison between four different cases.

Table 6.6 The comparative population in districts according to cases

Cases	Values	Bayraklı	Buca	Bornova	Çiğli	Gaziemir	Karabağlar	Karşıyaka	Konak	Narlıdere
Scenario (1)	Current Population (2009)	306.427	412.639	402.453	154.397	121.255	448.337	304.220	411.112	65.714
	Projected Population (2030)	501.200	451.136	497.895	298.024	134.599	865.173	369.637	539.759	105.490
	Difference	194.773	38.497	95.442	143.627	13.344	416.836	65.417	128.647	39.776
Scenario (2)	Current Population (2009)	306.427	412.639	402.453	154.397	121.255	448.337	304.220	411.112	65.714
	Projected Population (2030)	528.643	494.923	498.046	508.349	142.441	564.116	454.009	411.112	161.273
	Difference	222.216	82.284	95.593	353.952	21.186	115.779	149.789	0.000	95.559
IKBNIP Plan Decisions	Current Population (2009)	306.427	412.639	402.453	154.397	121.255	448.337	304.220	411.112	65.714
	Projected Population (2030)	393.098	521.928	463.950	435.168	137.309	540.990	484.799	345.038	94.419
	Difference	86.671	109.289	61.497	280.771	16.054	92.653	180.579	66.074	28.705
Lowry - Garin Model	Current Population (2009)	306.427	412.639	402.453	154.397	121.255	448.337	304.220	411.112	65.714
	Projected Population (2030)	314.147	418.948	408.370	160.997	124.990	454.716	314.410	424.714	67.899
	Difference	7.720	6.309	5.917	6.600	3.735	6.379	10.190	13.602	2.185



	Bayraklı	Buca	Bornova	Çiğli	Gaziemir	Karabağlar	Karşıyaka	Konak	Narlıdere
Scenario (1)	194,773	38,497	95,442	143,527	13,344	416,836	65,417	128,647	39,776
Scenario (2)	222,216	82,284	95,593	353,952	21,186	115,779	149,789	0,000	95,559
IKBNIP Plan Decisions	86,671	109,289	61,497	280,771	16,054	92,653	180,579	66,374	28,705
Lowry - Garin Model	7,720	6,309	5,917	6,600	3,735	6,379	10,190	13,502	2,185

Figure 6.7 The comparison between four different cases

According to the results, in this study, the results of the scenarios obtained using the Hansen model is parallel to the proposals of IKBNIPR. In other words, these results and decisions are not in conflict. Therefore, as a result, the scenario (1) is selected that suggests the implementation of urban renewal in metropolitan city of Izmir.

REFERENCES

Aksu, A. (2007). *Kentsel Dönüşümde Coğrafi Bilgi Sistemi Kullanılması: Üsküdar İlçesi Örnek - Esatpaşaünalan Mahalleleri Örneği.* İstanbul: İstanbul Teknik Üniversitesi, Bilim ve Teknoloji Enstitüsü, Yüksek Lisans Tezi.

Aslam, A.B. (2009). *Introduction to Urban Renewal and Conservation: Definitions, Concepts, Policies/Approaches.* Pakistan: University of Engineering and Technology, Department of City and Regional Planning, Lecture Notes.

Ayhan, İ. & Çubukçu, K.M. (2007). *Hansen Modeli Kullanılarak Adana Ceyhan'daki Nüfus Hareketlerinin İncelenmesi.* 12. Ulusal Bölge Birimi – Bölge Planlama Kongresi, (s. 203 – 213). İstanbul.

Bal, Ö.H. (2008). *İzmir'de Kentsel Dönüşüm Sürecinin İzmir Cennetçeşme Mahallesi Üzerinden İrdelenmesi.* İzmir: Dokuz Eylül Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Butler, C.J. (1972). Gravity Models As Planning Tools: A Review of Theoretical and Operational Problems. *Human Geography*, *54 (1)*, 68 – 78.

Carter, G.F.B. (1994). Geographic Information Systems For Geoscientists: Modelling with GIS. *Computer Methods in The Geosciences*, 13. United Kingdom: London.

Catanese, A.J., & Steiss, A.W. (1970). *Systemic Planning: Theory and Application.* Lexington: Heath Lexington Books.

Chadwick, G.F. (1978). *Systems View of Planning – Towards a Theory of The Urban and Regional Planning Process.* United Kingdom: Pergamon Press Limited.

Colenutt, R.J. (1968). Regional Studies: Building Linear Predictive Models for Urban Planning. *Journal of The American Planning Association, 2 (1),* 139 – 143.

Çolak, N. (2008). *İzmir Karşıyaka-Üçkuyular Köprü Projesinin Nüfus Dağılımı Üzerindeki Olası Etkilerinin Hansen Modeli İle İncelenmesi*. İzmir: Dokuz Eylül Üniversitesi, Şehir ve Bölge Planlama Bölümü, Yüksek Lisans Tezi.

Çubukçu, K.M. (2008). *Planlamada Klasik Sayısal Yöntemler*. Ankara: Ortadoğu Teknik Üniversitesi (ODTÜ) Yayıncılık.

Dayıoğlu, O. (2006). *Kentsel Gelişimde Dönüşüm Projeleri: Süreç ve Aktörlerin Tanımlanması, Zeytinburnu Örneği.* İstanbul: İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Devlet İstatistik Enstitüsü (TUİK) (1985). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri.* İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (1990). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri.* İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (2000). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri*. İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (2002). *İstatistiki Bölge Birimleri Sınıflaması.* İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (2007). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri*. İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (2008). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri.* İzmir: TUİK Matbaası.

Devlet İstatistik Enstitüsü (TUİK) (2009). *Genel Nüfus Sayımı: Nüfusun Sosyal ve Ekonomik Nitelikleri.* İzmir: TUİK Matbaası.

Foot, D.H.S. (1981). *Operational Urban Models: An Introduction*. Routledge.

Garin, R.A. (1966). A Matrix Formulation of The Lowry Model For Intrametropolitan Activity Allocation. *Journal of The American Planning Association, 32 (6),* 361 – 364.

Genç, F.N. (2008). *Türkiye'de Kentsel Dönüşüm: Mevzuat ve Uygulamaların Genel Görünümü*. Yönetim ve Ekonomi *15 (1).* Manisa: Celal Bayar Üniversitesi, İktisadi İdari Bilimler Fakültesi, Kamu Yönetimi Bölümü.

Goldner, W. (1971). The Lowry Model Heritage. *Journal of The American Planning Association, 37 (2),* 100 – 110.

Güvenç, M. (1987). *Ankara: 1985'den 2015'e. Ek II: Ankara Metropoliten Alanında Nüfus ve Servis İstihdamı Dağılımlarının Kestiriminde Yararlanılan Lowry – Garin Tipi Mekansal Etkileşim Modelleri Üzerine*. Ankara: Ortadoğu Teknik Üniversitesi (ODTÜ) Şehir ve Bölge Planlama Çalışma Grubu. Ajans İletim.

Hansen, W.G. (1959). How Accesibility Shapes Land Use. *Journal of The American Planning Association, 25 (2),* 73 – 76.

Haynes, K.E., & Fotheringham, A.S. (1984). *Gravity and Spatial Interaction Models*. Beverly Hills.

Horowitz, A.J. (2004). *Lowry – Type Land Use Models*. Wisconsin: University of Wisconsin.

İzmir Büyükşehir Belediyesi (2006). *1/25000 Ölçekli İzmir Kentsel Bölge Nazım İmar Plan Revizyonu (IKBNIPR) Raporu*. İzmir.

Kaiser, E.J., Godschalk, D.R. and Chapin, F.S. (1995). *Urban Land Use Planning.* Urbana – Campaign: University of Illinois Press.

Kendrick, D., & Taylor, L. (1970). Numerical Solution of Non – Linear Planning Models. *Econometrica, 38 (3).*

Lee, C. (1973). Models in Planning and Introduction to The Use of Quantitative Model in Planning. *Urban and Regional Planning Series (4),* 57 – 89.

Lee, C. (1973). *Models in Planning.* Oxford: Pergamon Press.

Lee, D.B.J. (1973). Reqium For Large – Scale Models. *Journal of The American Planning Association*, *39 (3),* 163 – 178.

Levine, N. (1996). Spatial Statistics and GIS: Software Tools to Quantify Spatial Patterns. *Journal of The American Planning Association*, *62 (3),* 381 – 391.

Lowry, I.S. (1964). *A Model of Metropolis*. Rand Corporation.

Maguire, D.J. (1991). *An Overview and Definition of GIS*. London: Longman.

Öner, Ş. (2007*). Kentsel Yenileme Kapsamında Kentsel Dönüşüm Projelerinin İstanbul Küçükçekmece Kentsel Dönüşüm Projesi Örneğinde İrdelenmesi*. Bartın: Zonguldak Karaelmas Üniversitesi, Peyzaj Mimarlığı Bölümü, Yüksek Lisans Tezi.

Richardson, H.W., & Gordon, P. (1978). A Note on Spatial Multipliers. *Economic Geography*, *54 (4),* 309 – 313.

Salazar, C. R. P. (2010). *Ideal Framework for Urban Renewal* (1). South America: Academic Universidad Austral de Chile.

Tecim, V. (2008). *Coğrafi Bilgi Sistemleri: Harita Tabanlı Bilgi Yönetimi. Coğrafi Bilgi Sistemleri* (3rd ed.). İzmir: Dokuz Eylül Üniversitesi, Fen Bilimleri Enstitüsü.

Thrall, S.E. (1999). Geographic Information Systems (GIS) Hardware and Software. *Journal of Public Health Management and Practice*, *5 (2),* 82 – 90.

Waddell, P. (2002). Modelling Urban Development For Land Use, Transportation and Environmental Planning. *Journal of The American Planning Association*, *68 (3),* 297 – 314.

Wegener, M. (1994). Operational Urban Models: State of The Art. *Journal of The American Planning Association*, *60 (1),* 17 – 29.