

AN ASSESSMENT ON THE LINK BETWEEN SUSTAINABILITY AND
URBAN FORM:
THE CASE OF GAZİANTEP

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ŞEYDA YILMAZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
URBAN DESIGN
IN
CITY AND REGIONAL PLANNING

FEBRUARY 2014

Approval of the thesis:

**AN ASSESSMENT ON THE LINK BETWEEN SUSTAINABILITY AND
URBAN FORM:
THE CASE OF GAZİANTEP**

submitted by **ŞEYDA YILMAZ** in partial fulfillment of the requirements for the degree of **Master of Science in Urban Design in City and Regional Planning, Middle East Technical University** by,

Prof. Dr. Canan Özgen
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Melih Ersoy
Head of Department, **City and Regional Planning**

Assoc. Prof. Dr. Serap Kayasü
Supervisor, **City and Regional Planning Dept., METU**

Examining Committee Members:

Assoc. Prof. Dr. Müge Akkar Ercan
City and Regional Planning Dept., METU

Assoc. Prof. Dr. Serap Kayasü
City and Regional Planning Dept., METU

Assoc. Prof. Dr. Osman Balaban
City and Regional Planning Dept., METU

Assoc. Prof. Dr. Emine Yetişkul Şenbil
City and Regional Planning Dept., METU

Assoc. Prof. Dr. N. Aydan Sat
City and Regional Planning Dept., Gazi University

Date: 03.02.2014

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Şeyda YILMAZ

Signature:.....

ABSTRACT

AN ASSESSMENT ON THE LINK BETWEEN SUSTAINABILITY AND URBAN FORM: THE CASE OF GAZİANTEP

YILMAZ, Şeyda

M.S., in Urban Design in Department of City and Regional Planning

Supervisor: Assoc. Prof. Dr. Serap Kayasü

February 2014, 171 pages

Sustainability ensures a better quality of life and more sustainable world environment now and in the future. Our climate is constantly changing due to some human induced factors. These changes have negative effects on the environment and human life. Lasting solutions to this global problem can only be achieved by sustainability.

Climate change is acknowledged as a serious environmental problem. In recent years, researchers have found a close link between climate change and cities. On the one hand, it is a threat to quality of life in cities by increasing the pressure on cities where cities are exposed to adverse effect of climate change. On the other hand, cities are major contributors to climate change. They are responsible for greenhouse gas (GHG) emission.

Cities can be an important part of the solution to decrease adverse effects of climate change. They must grow and expand sustainably to adapt to and mitigate the impacts of climate change.

The term "sustainability" is mentioned together with the concept of urban form in planning literature. Urban form is encountered as an important tool for managing effects of climate change. It has a profound impact on a city's energy needs, and consequently, its greenhouse gas (GHG) emissions.

This study aims to emphasize importance of design concepts derived from sustainable urban forms which help to reduce the effects of climate change and determine if growth and development of Gaziantep is sustainable or not by using these design concepts that are compactness, sustainable transportation, and mixed land uses.

Key Words: Climate Change, Urban Form, Sustainable Urban Development, Greenhouse Gas Emission

ÖZ

SÜRDÜRÜLEBİLİRLİK VE KENTSEL FORM ARASINDAKİ BAĞLANTI ÜZERİNE BİR DEĞERLENDİRME:

GAZİANTEP ÖRNEĞİ

YILMAZ, Şeyda

Yüksek Lisans, Kentsel Tasarım, Şehir ve Bölge Planlama Bölümü

Tez Yöneticisi: Doç. Dr. Serap Kayasü

Şubat 2014, 171 sayfa

Sürdürülebilirlik, şimdi ve gelecek için daha kaliteli bir hayatı ve daha sürdürülebilir bir çevreyi güvence altına alır. İklimimiz insan kaynaklı bazı faktörler nedeniyle sürekli değişmektedir. Bu değişikliklerin, çevre ve insan hayatı üzerinde olumsuz etkileri var. Bu küresel soruna kalıcı çözümler ancak sürdürülebilirlik ile elde edilebilir.

İklim değişikliği ciddi bir çevre sorunu olarak kabul edilmektedir. Son yıllarda, araştırmacılar iklim değişikliği ve şehirler arasında yakın bir ilişki bulmuşlardır. Bir yandan, iklim değişikliği şehirler üzerindeki baskıyı artırarak şehirlerdeki yaşam kalitesini tehdit etmekte ve şehirler, iklim değişikliğinin olumsuz etkisine maruz kalmaktadırlar. Öte yandan, şehirler iklim değişikliğine büyük ölçüde katkıda bulunmaktadır. Şehirler sera gazı salınımından sorumlu tutulmaktadır.

İklim değişikliğinin olumsuz etkilerini azaltmada şehirler çözümün önemli bir parçası olabilir. Onlar iklim değişikliğinin etkilerini azaltmak ve iklim değişikliğine adaptasyon sağlayabilmek için sürdürülebilir bir şekilde büyüyüp genişlemelidirler.

Planlama literatüründe “Sürdürülebilirlik” kavramı kent formu konsepti ile birlikte anılmaktadır. Kent formu iklim değişikliğinin etkilerini yönetme hususunda önemli

bir araç olarak karşımıza çıkmaktadır. Kent formu şehrin enerji ihtiyacı üzerinde önemli bir etkiye sahiptir ve dolayısıyla şehrin sera gazı salınımında da etkilidir.

Bu çalışmanın amacı iklim değişikliği etkilerini azaltan sürdürülebilir kent formlarından türetilen tasarım konseptlerinin önemini vurgulamak ve derişiklik, sürdürülebilir ulaşım ve karma arazi kullanımı olan bu tasarım konseptlerini kullanarak Gaziantep'in sürdürülebilir bir şehir olup olmadığını belirlemektir.

Anahtar sözcükler: İklim Değişikliği, Kent Formu, Sürdürülebilir Kentsel Gelişim, Sera Gazı Salınımı

To my parents

ACKNOWLEDGMENTS

I would like to express my gratitude to Assoc. Prof. Dr. Serap Kayasü for proposing the problem, her suggestions and comments.

I would like to thank all the lecturers who helped me during my academic education.

TABLE OF CONTENTS

ABSTRACT	v
ÖZ	vii
ACKNOWLEDGMENTS	x
TABLE OF CONTENTS	xi
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS	xvi
CHAPTERS	
1. INTRODUCTION	1
1.1. Aim of the Study	1
1.2. Method of the Study	4
2. SUSTAINABILITY	7
2.1. Emergence of Sustainability	7
2.1.1. Progress prior to the United Nations Conference on the Human Environment	8
2.1.2. From the United Nations Conference on the Human Environment to WCED	10
2.1.3. Progress Following the World Commission on Environment and Development	14
2.2. Climate Change	27
2.3. Climate Change in Different Scales	29
2.3.1. At the global scale	29
2.3.2. At the urban scale	32
2.3.3. At the micro-urban scale	35
2.3.4. At the building scale	36
2.4. Mitigation of Climate Change	37
2.5. Climate Change, City and Sustainability	38
2.6. Assessment	43
3. SUSTAINABLE URBAN FORMS	45
3.1. Sustainable Urban Forms	45
3.1.1. The Neo-Traditional Development	46
3.1.2. The Urban Containment	52
3.1.3. The Compact City	56

3.1.4.	The Eco-City	62
3.1.5.	Assessment	65
3.2.	Design Concepts Derived From Sustainable Urban Forms.....	68
3.2.1.	Compactness.....	69
3.2.2.	Sustainable Transportation.....	73
3.2.3.	Density.....	78
3.2.4.	Mixed land uses	82
3.3.	Assessment	85
4.	A CASE STUDY: GAZIANTEP.....	89
4.1.	Sustainable Development and Climate Change Mitigation in Turkey	89
4.2.	General Information about Gaziantep	97
4.3.	Evaluating sustainability through urban core design concept	101
4.3.1.	Compactness	101
Table 4-6 (continued)	115
4.3.2.	Assessment of Compactness	125
4.3.3.	Sustainable Transportation	126
4.3.4.	Assessment of Sustainable Transportation.....	138
4.3.5.	Mixed-Land Uses	139
4.3.6.	Assessment of Mixed Land Uses	148
5.	ASSESSMENT AND CONCLUSION.....	149
REFERENCES	155

LIST OF TABLES

TABLES

Table 2-1 Sustainable Initiatives (1878-1971).....	9
Table 2-2 Sustainable Initiatives (1972-1987).....	12
Table 2-3 Sustainable Initiatives.....	16
Table 2-4 Distribution of global population by size of settlements, 1977 and 2000 .	33
Table 3-1 Capital costs of infrastructure and land savings in different development scenarios for Denver Metro Region, 2000-2020.....	60
Table 3-2 The contribution of the compact city to urban sustainability	61
Table 3-3 Sectors and aspects of urban development.....	64
Table 3-4 Prominent features of sustainable urban development.	67
Table 3-5 Transportation impacts on sustainability.....	75
Table 3-6 Optimal urban densities	81
Table 3-7 Influence of the density factor of built environment on modes of transportation in American Cities	82
Table 3-8 Types of mix of uses.....	83
Table 3-9 The set of mix-of-use indicators	84
Table 3-10 Sustainable design concept derived from sustainable urban forms	86
Table 4-1 Population Dynamics in the Largest Turkish Cities.....	96
Table 4-2 Export Rank Data	98
Table 4-3 Information about Gaziantep and Turkey.....	100
Table 4-4 Gaziantep's Population thorough years.....	102
Table 4-5 Land Use Area and Population Density.....	113
Table 4-6 Intensity of land-use in global cities.....	114
Table 4-7 Number of motor vehicles	127
Table 4-8 Annual Energy Use and Energy Spent on Mobility in Gaziantep.....	132
Table 4-9 Modal split of journeys (Cities with over 1,000,000 inhabitants).....	147

LIST OF FIGURES

FIGURES

Figure 2-1 Global Greenhouse Gas (GHG) Emissions	29
Figure 2-2 Greenhouse gases emissions, human activities, climate change processes, main climate features, and major threats.....	30
Figure 2-3 Global and Continental Temperature Change	31
Figure 2-4 Urban heat island effect.....	34
Figure 2-5 The Two directions of impact between Climate Change and Our Energy Use.....	36
Figure 2-6 CO2 emissions (including through the use of electricity) IPCC (SRES) scenario	37
Figure 2-7 Population and built-up area growth rate in OECD countries, 2000-2050	39
Figure 3-1 The first neo-traditional town: Seaside in Walton County, Florida and its plan schema.....	48
Figure 3-2 Neo-traditional designs by Duany & Plater-Zyberk (1) and Krier (2)	49
Figure 3-3 Calthorpe’s Conceptual Design Schemes for TODs: Local and Regional Contexts.....	51
Figure 3-4 Regional network of Garden Cities and the diagram illustrating growth of cities	53
Figure 3-5 Evolution of compact city policies	57
Figure 3-6 Arcosanti (1970)-left- and Mesa City_Ground Villages (1971) by P. Soleri.	63
Figure 3-7 CO2 emissions from transport (million metric tons).....	73
Figure 3-8 Growth of VMT, Vehicle Registrations, and Population in the United States relative to 1980 Values	76
Figure 3-9 Advantages and disadvantages of high and low density	78
Figure 3-10 Density and energy consumption	80
Figure 3-11 Dispersed-Separated uses and Mixed use centre.....	85
Figure 4-1 Greenhouse gas emission <i>per capita</i> , 1990-2011	91
Figure 4-2 GHG emission of Turkey	93
Figure 4-3 Direct and Indirect GHG emission	95
Figure 4-4 Map of Gaziantep	99
Figure 4-5 Gaziantep urban plan, zoning and spatial arrangement.....	102
Figure 4-6 Gaziantep’s new governorship building and the official parade area	103
Figure 4-7 Gaziantep urban plan, zoning and spatial arrangement.....	105
Figure 4-8 Gaziantep’s third city master plan.....	107
Figure 4-9 Gaziantep’s fourth city master plan.....	109
Figure 4-10 Additional Master Plans of Gaziantep.....	111

Figure 4-11 The number of motor vehicles: The number of motor vehicles per thousand people in Gaziantep	112
Figure 4-12 Population density by years “Address Based Population Registration System (2007-2012)” /km2 (550/sq. mi)	116
Figure 4-13 Development of macro form in 1930s.....	117
Figure 4-14 Development of macro form in 1950s.....	118
Figure 4-15 Development of macro form in 1960s.....	118
Figure 4-16 Development of the city macro form in 1980s.....	119
Figure 4-17 Development of the city macro form in 1990s.....	120
Figure 4-18 Development of the city macro form in 1990s.....	121
Figure 4-19 Population Density (categorized four types of densities; as 0-100 pph very low, 100-150 pph low, 150-300 pph medium and 300+ pph high density.)....	122
Figure 4-20 Road Death Rate.....	123
Figure 4-21 Number of Traffic Accidents in Gaziantep	124
Figure 4-22 Map of Roads of Gaziantep.....	126
Figure 4-23 Urban Macro form Developments Concerning Transportation	129
Figure 4-24 Growth of motor vehicles for passenger movement in Gaziantep	130
Figure 4-25 Comparison of car ownership.....	131
Figure 4-26 Private Transport Energy Use	133
Figure 4-27 Mobility Distribution among Vehicles.....	134
Figure 4-28 Traffic Volume in the Urban Area of Gaziantep.....	135
Figure 4-29 Map of Light rail transportation system (Planned LRT and the Suburban Rail way Routes).....	137
Figure 4-30 Planned bicycle road	138
Figure 4-31 Landforms of Gaziantep.....	140
Figure 4-32 Land-use Plan.....	141
Figure 4-33 The car ownership rates in the regions of the city.....	142
Figure 4-34 Origin – Destination Scheme	143
Figure 4-35 General view from streets of Gaziantep.....	145
Figure 4-36 Modal Split.....	146

LIST OF ABBREVIATIONS

AFD	: The Agence Française de Développement
CARA	: Consortium for Atlantic Regional Assessment
CBA	: Benefit-Cost Analysis
CEC	: Commission of European Communities
DDT	: Dikloro Difenil Trikloroethan
ECA	: Europe and Central Asia Sustainable Cities Initiative
EEA	: European Environment Agency
EPA	: Environmental Protection Agency
ESMAP	: Energy Sector Management Assistance Program
DHMI	: Federal Highway Administration
GATEM	: Gaziantep Trade and Industry Center
GDSAA	: General Directorate of State Airports Authority
KGM	: General directorate of highways
GHG	: Greenhouse Gas
IEA	: International Energy Agency
IPCC	: Intergovernmental Panel on Climate Change
IUCN	: The International Union for the Conservation of Nature
MEF	: Ministry of Economy and Finance
MEU	: Ministry of Environment and Urban Planning
MFWA	: Ministry of Forest and Water Affairs

MMG	: Metropolitan Municipality of Gaziantep
MOD	: Ministry Of Development
SPO	: State Planning Organization
MSY	: Maximum Sustainable Yield
NTD	: Neo Traditional Development
OECD	: Organization for Economic Co-operation and Development
OIZ	: Organized Industrial Zone
IKA	: Silk road Development Agency
TCDD	: Turkish State Railways
TOD	: Transit-Oriented Development
TUIK	: Turkish Statistical Institute
TRACE	: Tool for Rapid Assessment of City Energy
UN	: United Nations
UNCED	: United Nations Conference on Environment and Development
UNEP	: United Nations Environment Programme
UNFCCC	: United Nations Framework Convention on Climate Change
VMT	: Vehicle Miles Traveled
WCED	: World Commission on Environment and Development
WWF	: World Wildlife Fund

CHAPTER 1

INTRODUCTION

1.1. Aim of the Study

The concept of sustainability has become increasingly important all over the world. The increasing world population and climate change due to human induced causes result in environmental degradation. To protect the world environment and human life, there is an urgent need to make all processes “sustainable”.

Climate change is a major environmental problem. It is generally considered as the increase in earth’s temperature. It has serious consequences like rising temperatures, shifting rainfall patterns, melting glaciers and snow, and rising sea level. Climate change is affecting cities. There are the two-way relationship between climate change and cities. On the one hand, some cities have already started to suffer from the negative side of climate change. On the other hand, cities are important contributors to climate change, such as urban activities blamed for high levels of greenhouse gas emissions. According to PlaNYC, “*Cities are at the forefront of both the causes and effects of climate change. Urban areas are estimated to be the source of approximately 80% of global greenhouse gas (GHG) emissions*” (PlaNYC, 2011). More than half of the world’s population lives in cities, and the number is constantly increasing worldwide; cities must promote more inclusive growth, adapt to climate change, and mitigate the risks of this change.

The sustainability concept should be evaluated in the context of the impact of climate change on cities. The concept is considered as a solution to reduce the climate change impact on cities. Cities must grow in a sustainable manner. Sustainable cities improve quality of life, and at the same time reduce CO2 emissions. Sustainability concept is defined as “*meeting the needs of the present without compromising the ability of future generations to meet their own needs*” (UN, 1987). In other words,

sustainable development ensures a better quality of life for everyone living now and for generations to come and more sustainable world environment. The concept emphasizes the integration of environmental and development objectives.

"This is the kind of development that provides real improvements in the quality of human life and at the same time conserves the vitality and diversity of the Earth. The goal is development that will be sustainable. Today it may seem visionary but it is attainable. To more and more people it also appears our only rational option" (IUCN, UNEP and WWF, 2013).

Then the concept of sustainability is at the center of integration of human and nature.

The United Nations conference on sustainable development (Rio+20) strongly stressed the importance of sustainable development. Urban Form represents a major step in sustainable development. Urban form, significantly influence a city's energy needs, and consequently, its greenhouse gas (GHG) emissions. Much of the literature (e.g. Jenks, Burton and Williams (1996); Williams, Burton and Jenks (2000); Jenks and Burgess (2000) and Jenks and Dempsey (2005) focuses on urban forms to mitigate negative effect of climate change on cities. All authors stated that climate change is one of the greatest challenges of the today's world and countries must develop in sustainable manner.

Sustainable urban forms are widely accepted as key factor to reach sustainable urban development. The conclusions of the debate about mitigation of climate change effects have focused on sustainable urban forms by analyzing urban literature. Sustainable urban forms are centered on the design concepts of compactness supported by high density, mixed land use and sustainable transportation that are derived from sustainable urban forms.

Gaziantep is the sixth largest city and also one of the ten largest conurbations in the country. According to Turkish Statistical Institute, Gaziantep had the largest population growth rate between 1990 and 2010, with 4.25%. In the 1980s; Gaziantep had a population of around 800.000 people. By now, the population has grown to over 1.7 million (TUIK, 2011). Historically, Gaziantep has always been an industrial

center of South Anatolia and also can be considered to be one of the Anatolian Tigers and the economic gateway to the Middle East. As such, it has a significant opportunity to not only become a more sustainable city, but also become a regional center of innovation, providing best practices for other cities in the area (ECA, 2011).

This thesis presents sustainable development as a solution to reduce the intensifying impact of climate change on cities by analyzing sustainable urban forms in literature. The thesis also examines the underlying interactions and relationships between sustainable urban form and design concept derived from sustainable urban forms. Besides, it focuses on core design concepts particularly within the context of mitigation of adverse climate change effect. Then, it debates whether the urban development process of Gaziantep is sustainable or not. The city is analyzed with design concepts in the context of mitigation of adverse climate change effect by conducting in-depth interviews and literature review. These concepts are derived from an extensive literature survey on sustainable urban forms. The core concepts are compactness, sustainable transportation, and mixed land uses.

Collecting data is one of the most challenging aspects of the thesis. Although 'sustainability' has been common among European cities since 1960s, Turkey become familiar with the term sustainability after United Nations Conference on Human Settlements (Habitat II) held in Istanbul in 1996. Since the term 'sustainability' is new in Turkey, no database is available about it. In addition, although Gaziantep is the sixth largest city in Turkey, it is very difficult to get data about the city. Data about the city were collected using "Seek Understanding and Interpretation" method, one of the key characteristics of in-depth interviews. All collected data would be analyzed in the theoretical framework. These data assist in reaching conclusion drawn regarding this study. In-depth interviews with local people and employees of public institutions (Environment and Urban Provincial Directorate, Gaziantep Governorship, MMG, Silk Road Development Agency; all specializing in developing, implementing and/or consulting on Gaziantep) help to get the data about Gaziantep. The interviews create backbones of the thesis. Data from different interviews can be analyzed for using comparative purposes.

To briefly summarize, this study defines the concepts of sustainable urban development and climate change and the concept offers a solution to climate change, reviews sustainable urban forms, presents sustainable design concept derived from sustainable urban forms and evaluates urban sustainability of the city of Gaziantep by using these sustainable design concepts. This evaluation may help to guide the succeeding planning studies of Gaziantep and to improve its planning practice.

1.2. Method of the Study

There are significant negative effects of the climate change on environment and cities. Reducing these adverse effects of the climate change by using tools related to urban sustainability will be discussed in the specific case of Gaziantep in chapter five.

The methods of case study, one of the different qualitative research designs, will be used to investigate and answer the research question. Case study method in the context of qualitative research constitutes the backbone of the study. Theoretical framework, in-depth interviews that create the infrastructure of the thesis and the case study will be the main approach for obtaining the conclusions. The previous studies are also analyzed due to their evaluation methods and techniques.

The major principle of designing the methodology of the study is to achieve an integration of separate subtitles about the issue of sustainable urban forms and design concepts related to urban sustainability within a theoretical framework.

In order to obtain an introductory outlook, first, informative and broad explanation is given on historical development of sustainability. Some important milestones of the development of sustainability at global scale will be stated in this chapter. Climate change, its causes and effects and cities that are dealing with the effects of climate change are summarized in same chapter. Furthermore, mitigation of climate change and the concept of sustainable urban development in light of reduction of negative effects of climate change are explained in Chapter 2.

Within the third chapter of the study, different approaches to sustainable urban forms are determined by looking into their historical background, principles, advantages and disadvantages. Then, this study aims to demonstrate design concepts derived from sustainable urban forms according to different views by explaining each concept. At the end of the chapter, core design concepts will be obtained as a result of an extensive literature survey on sustainable urban forms.

In the fourth chapter, the city of Gaziantep is taken as the case study area of the thesis. The major reason for choosing Gaziantep resulted from the fact that the city of Gaziantep has approximately 1,2 million habitants and has been facing an important urbanization given a high demographic growth because of its economic attractiveness and the fact that Metropolitan Municipality of Gaziantep voluntarily took the initiative to be committed in an approach to elaborate an environment friendly urban policy and aware of the reduction of greenhouse gas (GHG) emissions (AFD, 2011). The city is also one of the pioneer cities of sustainable urban development in the country. This study investigates whether urban development of Gaziantep is sustainable or not through core design concepts derived from sustainable urban forms.

Before evaluating urban sustainability of Gaziantep in terms of each core design concepts, general information about history of sustainable urban development in Turkey, growth rates of GHG emissions and policies for reducing climate change effects at global level are given. Then Gaziantep will be assessed with regards to each core design concepts; compactness, sustainable transportation and mixed land uses.

The final stage of the study reveals that Gaziantep is not a sustainable city. But it represents a major advance in sustainable development in Turkey.

CHAPTER 2

SUSTAINABILITY

2.1. Emergence of Sustainability

Sustainability or Sustainable Development has been commonly defined as

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.”*

in World Commission on Environment and Development, better known as the Brundtland Commission, publishes *Our Common Future* in 1987. Sustainable development ensures a better quality of life for everyone living now and for generations to come and more sustainable world environment. Sustainable development consists of the quality of people's lives and the state of our communities influenced by a combination of economic, social and environmental factors. Lasting solutions to global problems can only be achieved by sustainability. After Brundtland Commission in 1987, the definition of sustainable development endorsed five years later at the Earth Summit in Rio (Jones, 2006).

There are some important milestones of the development of sustainability at global scale. It is categorized into three historical periods: Progress prior to the United Nations Conference on the Human Environment, from the United Nations Conference on the Human Environment to World Commission on Environment and

Development, Progress Following the World Commission on Environment and Development.

2.1.1. Progress prior to the United Nations Conference on the Human Environment

‘Sustainability’ is defined as the capacity to endure. The term also means that Ecosystems on Earth remains diverse and productive. For human, sustainability implies the right to manage natural resources. It refers to social justice issues within the context of sustainability in the community. In 1878, in his essay on the principle of population, Thomas Malthus specified that increase in world population pressured on natural resources. He also noted that world population increased exponentially while available resources grow arithmetically. At this rate, famine plagues, and war would appear because population growth would surpass food production. After the Second World War, Maximum Sustainable Yield (MSY) was widely used. The concept of MSY is based on production exists that can be harvested in permanency without altering the population (Vehkamäki, 2013). Then, Benefit-Cost Analysis (CBA) is very important in decision making, because holistic approach of the monetary costs was first applied in the United States Flood Control Act. It also protects welfare or promotes sustainable development. After that, in 1962 Rachel Carsens stated that DDT has detrimental effect on environment and he offered to ban pesticides to protect environment. In the following year, Garrett Hardin came up with an economics theory as the tragedy of the commons. Hardin emphasized human population growth, the use of the Earth's natural resources, and the welfare state in his theory. According to the theory, a natural resource was shared by many individuals. If natural resources remain constant, population continually increases and finite resources will eventually run out (Hardin, 1968). In the same year, Paul R. Ehrlich published the book of The Population Bomb. The author discusses population and environment related issues. Ehrlich pointed out that the population explosion puts pressure on economies and resources. Overpopulation will lead to disasters (Ehrlich, 1968). In 1971, a complex set of environmental problems

has emerged. These problems threatened strategic natural resources. Hence, OECD recommended Polluter Pays Principle.

Table 2-1 Sustainable Initiatives (1878-1971)

Source: Kelly C. , no date

Sustainable Initiatives (1878-1971)			
Date	Event	Description	Sources
1878	Thomas Malthus	<i>An essay on the principle of population</i> This essay noted that populations increased exponentially while available resources grow arithmetically. Malthus predicted that this will inevitably lead to famine, plagues, and war, because population growth would surpass food production.	http://www.ac.wvu.edu/~stephan/malthus/malthus.0.html
	Maximum Sustainable Yield (MSY)	Widely used after the second world war to restrict fishing	
1936	The United States Flood Control Act	This Act introduced welfare economics into the practical world of decision making. It initiated the idea of CBA. Projects could be assessed on the basis of calculating their net benefit and then in the context of the entire social assessment of that net benefit.	Source: D W Pearce and CA Nash (1993) The social Appraisal of Projects. A text in Cost Benefit Analysis.

Table 2-1 (continued)

1962	Origins of spring	Rachel Carsens Article considered the detrimental effect pesticides were having on the environment, and especially on birds and was influential in the eventual banning of DDT	Rachel Carsens(1962) Origins of spring
1968	Tragedy of the commons	Publicized by Garret Hardin in his 1968 Science article "The Tragedy of the Commons"	http://www.science.org/sciext/sotp/pdfs/162-3859-1243.pdf
1968	The population Bomb	Paul R. Ehrlich predicted disaster in 'the population bomb' for humanity due to overpopulation and the population explosion.	Paul Ehrlich (1968) The population bomb
1971	Polluter pays the principle	OECD recommends that those causing pollution should pay the costs in a bid to unite the environment and economic elements.	http://www.oecd.org/dataoecd/48/63/19827587.pdf

2.1.2. From the United Nations Conference on the Human Environment to WCED

The United Nations Conference on the Human Environment (1972) is considered as a starting point for concept of sustainable development. In 1972 the United Nations Conference on the Human Environment held in Stockholm, the first major conference on which international environmental issues and the development of environmental politics was specified. The outcome document of this conference

stated that *“The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.”* (UN, 1972). A result of this conference was the establishment of the United National Environment Program (UNEP) was set up whose mission was to *“provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations”*(UNEP).

In the 1970s, a rising world population and the finite resources were becoming more problematic. In the spring of 1972, a book called *The Limits to Growth* showed that the world was moving too fast in the wrong direction. The purpose of this book was to examine growing population, limited resources and rising pollution.

Then, in 1976, the United Nations Habitat Conference on Human Settlements, also known as Habitat I and the largest conference on human problems at that time, offered solution via sustainability. For the first time, the world community discussed urban problems including clean water, sanitation, poverty and homelessness and accelerating human migration from rural to urban areas at the conference. From the mid 1970s to the 1980s the political importance of the environment declined. According to Munds (1992), there are several reasons for this including; the economic recession in the mid 1970s and the lack of fully integration of the environmental awareness into the economic planning system.

After that, *World Conservation Strategy*, one of the major events in the history of the term sustainable development, was published by The International Union for the Conservation of Nature (IUCN) in 1980. This strategy emphasizes the integration of environmental and development objectives. The terminology ‘development that is sustainable’ is appeared for the first time. The strategy stated that:

“This is the kind of development that provides real improvements in the quality of human life and at the same time conserves the vitality and diversity of the Earth. The goal is development that will be sustainable. Today it may seem visionary but it is attainable. To more and more people it also appears our only rational option” (IUCN,UNEP and WWF, 2013).

World Conservation Strategy did not provide holistic view of sustainability. It just offered conservation. After seven years, the holistic view was realized in Our Common Future.

Table 2-2 Sustainable Initiatives (1972-1987)

Source: Kelly C. , no date

Sustainable Initiatives (1972-1987)			
Date	Event	Description	Sources
1972	United Nations Conference on the Human Environment	Conference held in Stockholm in 1972. The conference theme was “Only one Earth”. It produced 109 recommendations and divided the responsibilities between the existing bodies of WHO, WMO, UNESCO, FAO UNEP was charged with coordinating the work. It only considered the environmental aspects and in particular pollution	http://www.unep.org/Documents/Default.asp?DocumentID=97&ArticleID=1503
1972	Limits to growth paper	They concluded that: 1) If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result	Meadows, D.H., Meadows D L., Randers, J and Behrens W W (1972) Limits to growth: A report for the club of Rome’s Project on the predicament of

Table 2-2 (continued)

		<p>will be a rather sudden and uncontrollable decline in both population and industrial capacity.</p> <p>2. It is possible to alter these growth trends and to establish a condition of ecological and economic stability</p> <p>That is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his Individual human potential.</p>	<p>Mankind. Universe Books, New York City</p> <p>http://www.clubofrome.org/docs/limits.rtf</p>
1973	OPEC oil crisis	This fuels the limits to growth debate	
1974	CFC crisis	Rowland and Molina publish in journal Nature that continued use of CFC gases at an unaltered rate would critically deplete the ozone layer	www.ourplanet.com/imgversn/92/rowland.html
1976	HABITAT	First global meeting to link the environment and human settlement	<p>http://www.unhabitat.org/</p> <p>www.undp.org/un/habitat/back/van-decl.html</p>

Table 2-2 (continued)

1980	World Conservation strategy	The phrase ‘Sustainable development’ was first used Or rather ‘development that is sustainable’	IUCN(1980) The world conservation strategy, IUCN, Morges, Switzerland www.iucn.org/
1984	International conference on Environment and Economics (OECD) in ;London	This conference concluded that environment and economics should be mutually reinforcing. This conference led to the Brundtland report	

2.1.3. Progress Following the World Commission on Environment and Development

The term sustainable development was popularized in *Our Common Future*, a report published by the World Commission on Environment and Development in 1987. Also known as the Brundtland report, *Our Common Future* included the basic definition of sustainable development: "*economic and social development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs*" (UN, 1987). The Brundtland report stated that the requirement for economic, social and environmental development should be considered together to attain sustainable development in the future. In the next years, sustainability was defined more than once (See table 2.3).

Then, some of the ideas from the Brundtland report were used in the *Common Inheritance: Britain’s Environmental Strategy*, an important document in British

policies. It proposed the integration of economic growth with environment improvements.

After that, the next critical event, the first UN Conference on Environment and Development (UNCED), commonly used as “the Earth Summit”, was held in Rio de Janeiro in June 1992 on environment and development issues. The summit represents a big step forward for sustainable development. It described a strategy that integrated human, nature and the economic, social and environmental pillars. The First Principle of the Rio Declaration is: *"Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature"* (UN, 1992).

Then, the second United Nations Conference on Human Settlements (Habitat II), held in Istanbul in 1996, dealt with important changes about human settlement. It drew attention to the need for urbanization guide to attain sustainable development of the world's cities, towns and villages in the 21st century.

Sustainable development required an evolution in urban areas for which the importance of sustainable development policies began to increase in early 1990s. The term sustainable urban development was emerged in the mid-1990s. In 2004, The Hong Kong Declaration was important in terms of integrating sustainable development into city and regional planning.

One of the latest initiatives towards sustainable development is United Nations conferences on climate change. The conferences stated that climate change is one of the greatest challenges of today's world, and countries must provide plans for reducing carbon emission and for using clean energy. In February 2009, the 25th session of the Governing Council / Global Ministerial Environment Forum (GC/GMEF) of the United Nations Environment Programme (UNEP) was held. Many issues were discussed such as world environmental situation, biodiversity, chemicals management (including mercury), waste management, environmental law, etc (UNEP, 2009). Then G20 Summit met on June 26-27, 2010 in Toronto, Canada. The summit promoted the framework for strong, sustainable and balanced growth (G-20 Toronto Summit, 2010). The latest initiative was Rio+20 corporate

sustainability forum: innovation and collaboration for the future we want. The forum organized in June 2012 in Rio de Janeiro. It aimed to bring greater scale and quality to corporate sustainability practices and achieve comprehensive, harmonious and sustainable development. There was over 2,000 participants representing business as well as investors, governments, local authorities, civil society and UN entities. The mayor of Gaziantep Dr. Asım Güzelbey was the only leader from Turkey in the forum (UNCSD, 2012).

Table 2-3 Sustainable Initiatives

Source: Kelly C. , no date; Edited by author

Sustainable Initiatives			
Date	Event	Description	Sources
1987	Our Common Future/Bruntland Report and World Commission on Environment and Development (WCED)	Brundtland Commission published a seminal report, <i>Our Common Future</i> , which coined and defined the term "sustainable development," fusing environmental and economic sensibilities. The definition: <i>"Economic and social development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs"</i> . Thus bringing together the three aspects of environmental, economic and social development.	Brundtland Our Common Future A Readers guide by Don Hinrichsen

Table 2-3 (continued)

		<i>'sustainable development is dependent on each nation achieving its full economic potential while enhancing the environmental resource base upon which development must be based'</i>	
1987	Montreal Protocol	International agreement to adopt measures for tackling a global environment problem. It was implemented partly due to the discovery of the Antarctic ozone hole in late 1985, and the need to implement stronger measures to reduce the production and consumption of a number of CFCs and some Halogens	http://www.unep.ch/ozone/pdfs/Montreal-Protocol2000.pdf
1988	Intergovernmental Panel on Climate Change formed (IPCC)	It was set up to assess the technical issues that were being raised. Its first report stated that global warming should be taken seriously	http://www.ipcc.ch/
1989	Lynam and Herdt definition of sustainability	The capacity of system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by the historical level of variability	Lynam, J K and Herdt, R W (1989) 'Sense and sustainability: sustainability as an objective in international agricultural

Table 2-3 (continued)

			research’, Agricultural Economics, Vol 3, pp381-398
1990	This common inheritance: Britain’s Environmental Strategy	The ideas from the Bruntland report ‘ <i>Our Common Future</i> ’ was taken up in the UK's first comprehensive strategy, the White Paper on the Environment <i>This Common Inheritance.</i>	HMSO (1990) This common inheritance: a summary of the white paper on the environment
1990	Definition of sustainability	Pearce and Turner (1990) ...maximising the net benefits of economic development, subject to maintaining the services and quality of natural resources over time.	
1991	Definition of sustainable development	ICUN(1991) Development that improves the quality of human life while living within the carrying capacity of supporting ecosystems.	IUCN (International Union for the Conservation of Nature), UNEP(United Nations Environment Programme) and WWF (World Wild Life Fund)(1991) Caring for the earth: a strategy for sustainable living, IUCN, Gland, Switzerland

Table 2-3 (continued)

1992	Rio Earth Summit	<p>The Earth Summit was inspired by the Bruntland report in 1987. Between 1990 and 1992 Agenda 21 was developed to stand as a blueprint for sustainable development in the world. It considered the interaction between economic, social and environmental trends. The commission for Sustainable development (CSD) was set up to ensure that Agenda 21 would have an impact at all levels of governance. Agenda 21 recognized the role of stakeholders in implementing this blueprint.</p>	<p>Agenda 21 http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm CSD http://www.un.org/esa/sustdev/csd/about_csd.htm</p>
1992/1993	United National framework on Climate change (UNFCCC)	<p>Introduced to fight global warning at Rio in which it was adopted. The United Kingdom signed the Framework Convention on Climate Change in June 1992 at the Rio Earth Summit and ratified it in December 1993</p>	<p>www.unfccc.de</p>
1992	European Communities Green paper	<p>Green Paper on the Impact of Transport on the Environment - A Community Strategy for "Sustainable Mobility". COM (92) 46, 20 February 1992</p>	<p>http://aei.pitt.edu/archive/00001235/01/transport_environment_gp_cOM_92_46.pdf</p>

Table 2-3 (continued)

1993	Hardins laws of human ecology	3 1 – ‘we can never do merely one thing’ (interconnectedness of society). 2 – ‘there’s no away to throw to’ (an effluent society) 3 – The impact of any group or nation on the environment is represented qualitatively by the relation: I = P A T (I = Impact, P = size of population, A is the per capita affluence (measured by per capita consumption) and T is the measure of the damage done by the technologies that are supplying the consumption.	
1994	Aalborg Charter	Charter of European Cities & Towns Towards Sustainability	http://www.aalborg.dk/engelsk/information+about+aalborg/aalborg+charter.htm
1995	Creation of the World business council for sustainable development (WBCSD)	It was formed in 1995 from the world international conference on environmental management (WICEM) and the Business council on sustainable development (BCSD) The World Business Council for Sustainable Development (WBCSD) is a coalition of 170 by a shared commitment to	http://www.wbcd.ch/templates/TemplateWBCSD5/layout.asp?MenuID=1

Table 2-3 (continued)

		international companies united sustainable development via the three pillars of economic growth, ecological balance and social progress.	
1995	World summit for social development	This summit expressed a commitment to eradicate poverty	www.un.org/esa/socdev/wssd/index.html www.unhchr.ch/html/menu5/socdev95.htm
1995	First conference of the parties (cop-1) to the FCCC (UNFCCC)	First conference for all the countries who ratified the convention from the Rio Summit	www.unfccc.de
1997	Kyoto Climate change Protocol	Governments met in Kyoto, Japan to look at the problem of global warming. Previous agreements had tried to limit emissions of carbon dioxide to the levels they were in 1990. Many countries had failed to achieve even this small reduction. The UK and Germany met these targets. At Kyoto, a new set of targets for the reduction of greenhouse gases was agreed. By 2012, emissions of six major greenhouse gases must be reduced to below 1990 levels for the target period 2008-2012.	http://unfccc.int/resource/protintr.html

Table 2-3 (continued)

1998	The EU White paper Developing the citizens network	Communication of 10 July 1998 from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions: “Developing the citizens’ network – Why local and regional passenger transport is important and how the European Commission is helping to bring it about”.	http://europa.eu.int/s cadplus/leg/en/lvb/12 4215.htm
2001	Mobility 2001 World mobility at the end of the twentieth Century and its sustainability	World Business Council for Sustainable development publication. This report considered current mobility patterns in the world at the start of the 21 st century and then identified those factors that were threatening future sustainable mobility. It produced a sustainability scorecard for the developed and developing world to assess measures which should be increased decreased.	http://www.wbcd.c h/plugins/DocSearch /details.asp?type=Do cDet&DocId=MTg1

Table 2-3 (continued)

<p>2002</p>	<p>Johannesburg World Summit on Sustainable Development</p>	<p>Johannesburg declaration on sustainable development included the following statement <i>‘Thirty years ago in Stockholm we agreed on the urgent need to respond to the problem of environmental deterioration. Ten years ago at the united national conference on environment and development, held in Rio de Janeiro we agreed that the protection of the environment and social and economic development are fundamental to sustainable development, based on the rio principles. To achieve such development we adopted the global programme entitled Agenda 21 and the Rio declaration on Environment and Development, to which we affirm are commitment</i></p>	<p>http://www.johannesburgsummit.org/</p>
--------------------	---	--	--

Table 2-3 (continued)

<p>2003</p>	<p>Sustainable Communities: building for the future ODPM (2003)</p>	<p>Housing and the local environment are vitally important. But communities are more than just housing. They have many requirements. Investing in housing alone, paying no attention to the other needs of communities, risks wasting money - as past experience has shown.</p> <p>A wider vision of strong and sustainable communities is needed to underpin this plan, flowing from the Government's strong commitment to sustainable development. The way our communities develop, economically, socially and environmentally, must respect the needs of future generations as well as succeeding now. This is the key to lasting, rather than temporary, solutions; to creating communities that can stand on their own feet and adapt to the changing demands of modern life. Places where people want to live and will continue to want to live.</p>	<p>http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/page/odpm_comm_022184.hcsp</p> <p>http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/pdf/odpm_comm_pdf_023261.pdf</p>
--------------------	---	--	---

Table 2-3 (continued)

<p>2004</p>	<p>Mobility 2030 meeting the challenges to Sustainability</p>	<p>World Business Council for Sustainable Development This report followed on from the earlier 2001 and looked ahead to mobility in 2030. It produced 12 indicators for sustainable development. This report used the 3 pillars of sustainability as a guide for producing its indicators</p>	<p>http://www.wbcsd.ca/plugins/DocSearch/details.asp?type=DocDet&DocId=NjA5 NA</p>
<p>2009</p>	<p>United Nations Environment Programme Report of the Governing Council Twenty-fifth session</p>	<p>The twenty-fifth session of the United Nations Environment Programme (UNEP) Governing Council/Global Ministerial Environment Forum was held at UNEP headquarters, Nairobi, from 16 to 20 February 2009. Discussing issues about Globalization and the environment in the Forum.</p>	<p>http://www.chem.unep.ch/mercury/GC25/GC25Report_English.pdf</p>
<p>2010</p>	<p>The G-20 Toronto Summit Declaration</p>	<p>The summit aims to create strong, sustainable and balanced global Growth.</p>	<p>http://www.g20.utoronto.ca/2010/g20_declaration_en.pdf</p>

Table 2-3 (continued)

2010	United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)	Committee discussed social issues; environment and sustainable development; information, communication and space technology; poverty reduction and development; statistics; trade and investment; and transport and tourism.	http://www.unescap.org/
2011	United Nations Economic Commission for Europe	Committee promotes economic cooperation among its member states. it provides collective policy direction in the area of environment and sustainable development	http://www.unece.org/fileadmin/DAM/publications/Annual%20Reports/topics/annual_report_2011_EN_web.pdf
2012	United Nations conference on climate change	The conferences stated that climate change is one of the greatest challenges of the today's world and countries must provide plans for reducing carbon emission and to use clean energy.	http://unfccc.int/2860.php
2012	Rio+20 Corporate Sustainability Forum	The forum aimed to bring greater scale and quality to corporate sustainability practices and achieve comprehensive, harmonious and sustainable development.	http://www.uncsd2012.org/index.php?page=view&nr=534&type=13&menu=23

The Industrial Revolution began in the late 18th and early 19th centuries. Industrial revolution triggered off pollution, resource consumption (including energy resources) and population growth. In the early 20th century, these effects increasingly continued. In the late 20th century, environmental problems became global. In the 1990s, scientist agreed that carbon dioxide related to human activity caused climate changes. Human induced impacts were bringing serious global warming. Later, sustainable initiative aimed to reduce negative effects of climate change. Intergovernmental Panel on Climate Change (IPCC) was established in 1988. The IPCC published its first assessment report in 1990. It aims to cut Human-induced climate change, offer options for adaptation and mitigation. According to IPCC Assessment Report 5 (AR5), *"It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."*

Climate change affects environment adversely, correspondingly human health. Sustainability is an important tool to prevent the negative effects. Sustainability is considered as a tool for mitigation of climate change. In the following section, information about climate change, its causes and effects will be given.

2.2. Climate Change

Climate is defined as the composite or generally prevailing weather conditions of a region, as temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds, throughout the year, averaged over a series of years. In other words, it is the meteorological conditions characteristically prevail in a particular region.

Climate change refers to any significant change in averages and extremes in the weather of a region or of the planet as a whole over time. It is measured by changes in temperature, precipitation, wind, storms and other weather indicators (UN-Habitat, 2012).

There are two main causes. First one is natural causes like solar activity and volcanic eruptions. In general, climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes. Second one is anthropogenic processes which

can cause changes in climatic conditions and it is accepted as the reason of current climate change.

Natural causes are

- Volcanoes
- Tectonic plate movement
- Changes in the sun

In terms of natural processes, natural causes referred to global climate variability. But, recent climate changes cannot be explained by natural causes alone.

Human induced causes are related to any human activity that releases “greenhouse gases” into the atmosphere. Increase in burning of fossil fuels and destruction of natural ecosystems are main anthropogenic causes. Carbon dioxide is the most important anthropogenic GHG. Increasing amount of carbon dioxide in the atmosphere causes global climate change. IPCC states that anthropogenic global greenhouse gas (GHG) emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 (IPCC, 2007).

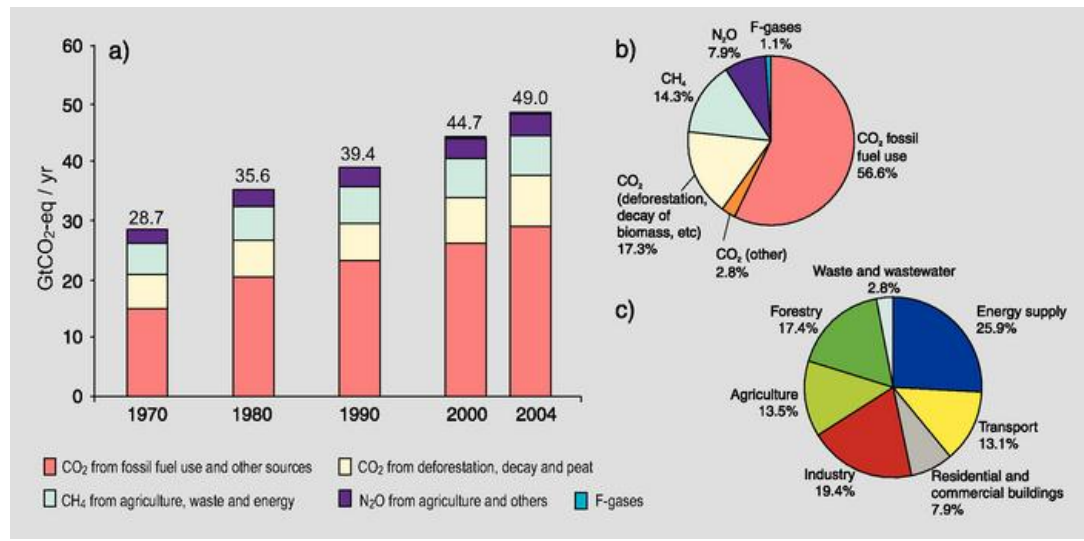


Figure 2-1 Global Greenhouse Gas (GHG) Emissions

(a) Global annual emissions of anthropogenic GHGs from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of carbon dioxide equivalents (CO₂-eq). (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO₂-eq. (Forestry includes deforestation)

Source: IPCC, 2007

2.3. Climate Change in Different Scales

Human affects the environment adversely by contributing to climate change. Also, human is strongly influenced by the negative effects of climate change. These bidirectional effects are taken place in different ways at different scales. According to Schiller et al (2006) there are four different scales. These are global scale, urban scale, micro-urban scale and building scale.

2.3.1. At the global scale

Global climate change has already had observable effects on the environment. Glaciers have shrunk, sea level rise became faster; biodiversity loss, hurricanes and other storms are likely to become stronger.

Non-renewable energy, the first energy humankind used, is derived from finite resource. Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas. Fossil fuels are mainly made up of Carbon. When they are burned, they release a lot of carbon compounds (carbon dioxide and other greenhouse gases) into the atmosphere. These gasses damage the environment in many ways. Carbon dioxide keeps heat in Earth’s atmosphere. The process called the “greenhouse effect.” Furthermore, the gases cause air, water and land pollution. Earth’s natural greenhouse effect makes life possible and is necessary to live. However, human activities, like the burning of fossil fuels and deforesting, have intensified the natural greenhouse effect, causing global climate change.

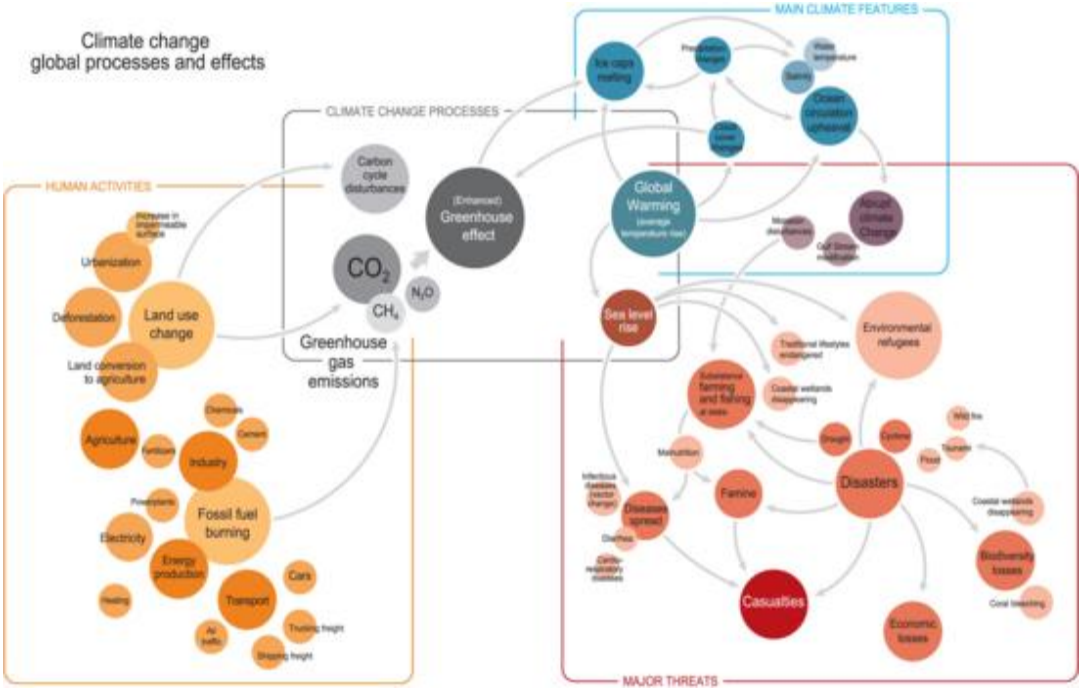


Figure 2-2 Greenhouse gases emissions, human activities, climate change processes, main climate features, and major threats

Source: UNEP/GRID-Arendal, 2008

In 4th Assessment Report (2007) The Intergovernmental Panel on Climate Change stated “most of the observed increases in global average temperatures since the mid-20th century are very likely due to the observed increase in anthropogenic (those caused by human activity) greenhouse gas concentrations” (IPCC, 2007).

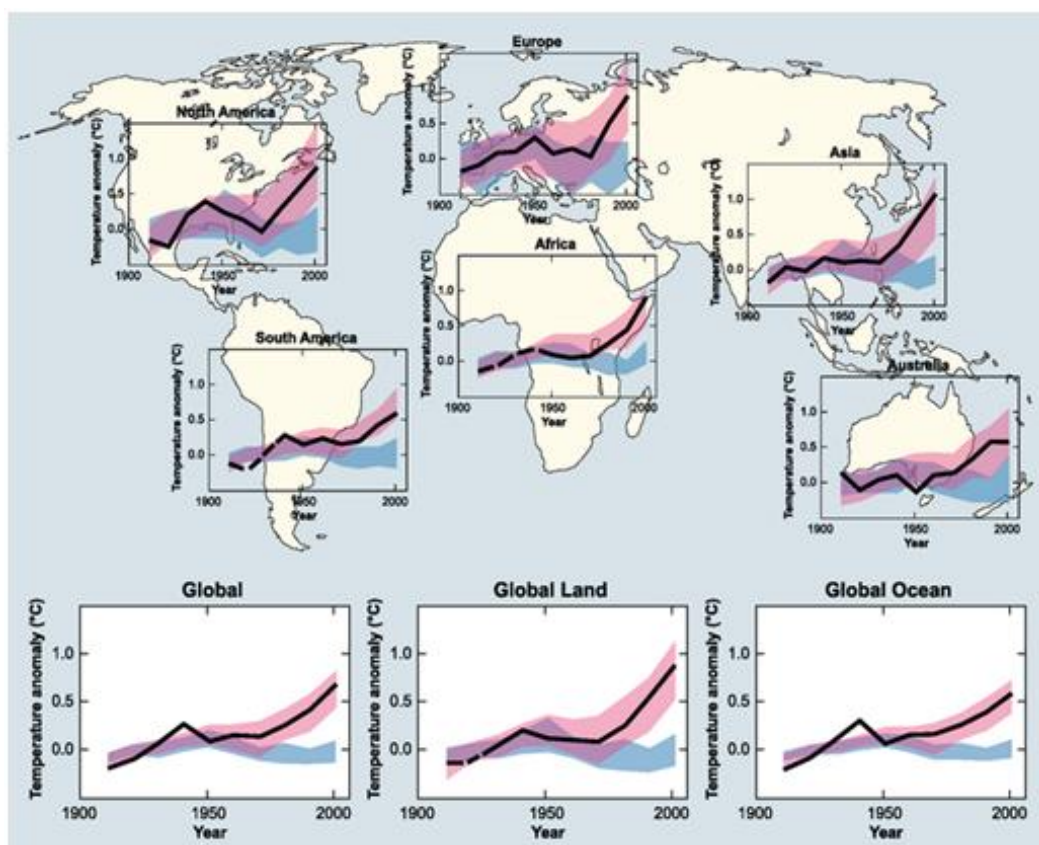


Figure 2-3 Global and Continental Temperature Change¹

Source: IPCC, 2007

¹ Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

Temperature is the most important indicator of climate change. Over the past 50 years the global average temperature increased by 0.65°C. No region is immune to rising temperatures, though some have witnessed sharper increases than others. Over the next 100 years the Earth's surface temperature is expected to increase between 1 and 4°C depending on the action taken (UN-Habitat, 2012).

2.3.2. At the urban scale

Rural to urban migration is happening on a massive scale due to different factors. Some of these factors are the much better standards of living in urban areas compared to rural areas and lack of resources in rural areas. The United Nations Environment Programme (UNEP) states that;

The rapid increase in the world's urban population associated with the slowing of rural population growth has led to a major redistribution of the population over the past 30 years. By 2007, one-half of the world's population will live in urban areas compared to little more than one-third in 1972, and the period 1950 to 2050 will see a shift from a 65 per cent rural population to 65 per cent urban (UNCHS , 2001).

This leads to increase in air temperature called as urban heat island effect and change in land use and emission of atmospheric pollutants in urban areas.

Table 2-4 Distribution of global population by size of settlements, 1977 and 2000

Source: UNCHS , 2001

Distribution of global population (%) by size of settlement, 1975 and 2000								
	rural areas		<1 million		1-5 million		>5 million	
	1975	2000	1975	2000	1975	2000	1975	
2000								
world	62.1	53.0	25.1	28.5	8.0	11.6	4.8	6.9
developed regions	30.0	24.0	46.8	48.1	13.9	18.5	9.3	9.5
developing regions	73.2	60.1	17.6	23.7	6.0	10.0	3.2	6.3

The direct effects of a warming earth influence megacities. Due to these effects, megacities face a lot of urban illnesses like urban sprawl, rural-urban migration, climate induced migration, resource scarcity. The urban ills drive the growth in greenhouse gas (GHG) emissions. Furthermore, unplanned settlements in megacities lead to urban heat island effects. H. Akbari (2005) points out that “*Urban areas are significantly warmer than its surrounding rural areas due to increase in human population’s activities. Air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings.*”

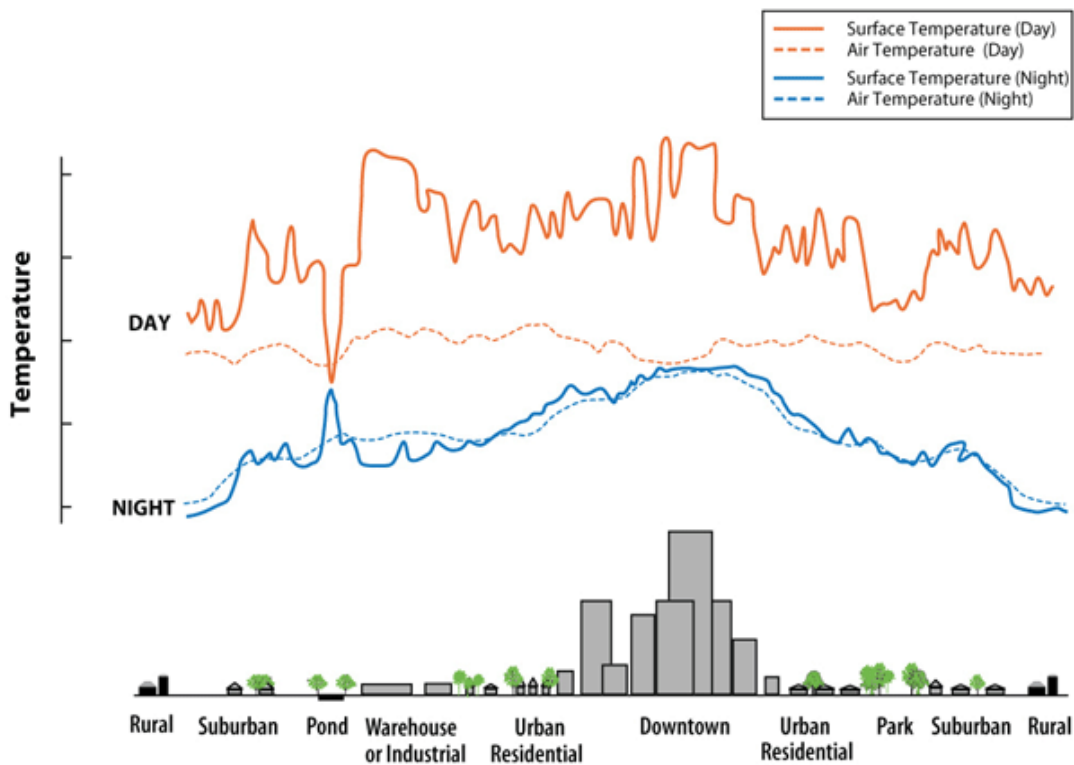


Figure 2-4 Urban heat island effect²

Source: (CARA)

Different land use areas have different surface and atmospheric temperatures. Surface temperature changes difficultly compared to air temperature during day and night. Urban heat island effect is increasing temperature of both the atmosphere and surfaces in urban areas. Owing to the greater absorption of buildings and hard surfaces, urban areas have higher average temperature.

“As the air temperature rises, so does the demand for air-conditioning (a/c). This leads to higher emissions from power plants, as well as increased smog formation as a result of warmer temperatures. In the United States, we have found that this increase in air temperature is responsible for 5–10% of urban

² Note: The temperatures displayed above do not represent absolute temperature values or any one particular measured heat island. Temperatures will fluctuate based on factors such as seasons, weather conditions, sun intensity, and ground cover.

peak electric demand for a/c use, and as much as 20% of population weighted smog concentrations in urban areas” (Akbari, 2005).

Aside from the effect on air temperature, this phenomenon also affects local wind patterns, the development of clouds and fog, the humidity, and the rates of precipitation.

2.3.3. At the micro-urban scale

Micro-urban level contributes to climate change, but effects of this phenomenon are felt more at the global scale. This level consists of all urban elements like streets, blocks. They are considered as an inseparable part of the climate change solution. Urban form is as a key component of managing climate change as well as livability of cities. It significantly influences a city's energy needs by changing improve ventilation, natural lightening in building interior as creating more open form of urban development thus results in modifications in environmental condition of urban spaces like wind regime, shading of outdoor space and access to winter sun. These factors affect outdoor comfort and quality of public space. Energy that correlates directly to greenhouse gas emission plays an important role for sustainable urban development. Predominantly, sprawl cities are responsible for more than half of those emissions as consumers of electricity. Urban form also affects individuals' travel behavior and consequently greenhouse gas emission. In other words, emission reduction targets imply reproducing sustainable urban form in cities. While assessed at the micro-urban level, urban forms are major contributors to climate change through greenhouse emission. To avoid serious climate change, highly attractive metropolitan regions must grow in sustainable manner.

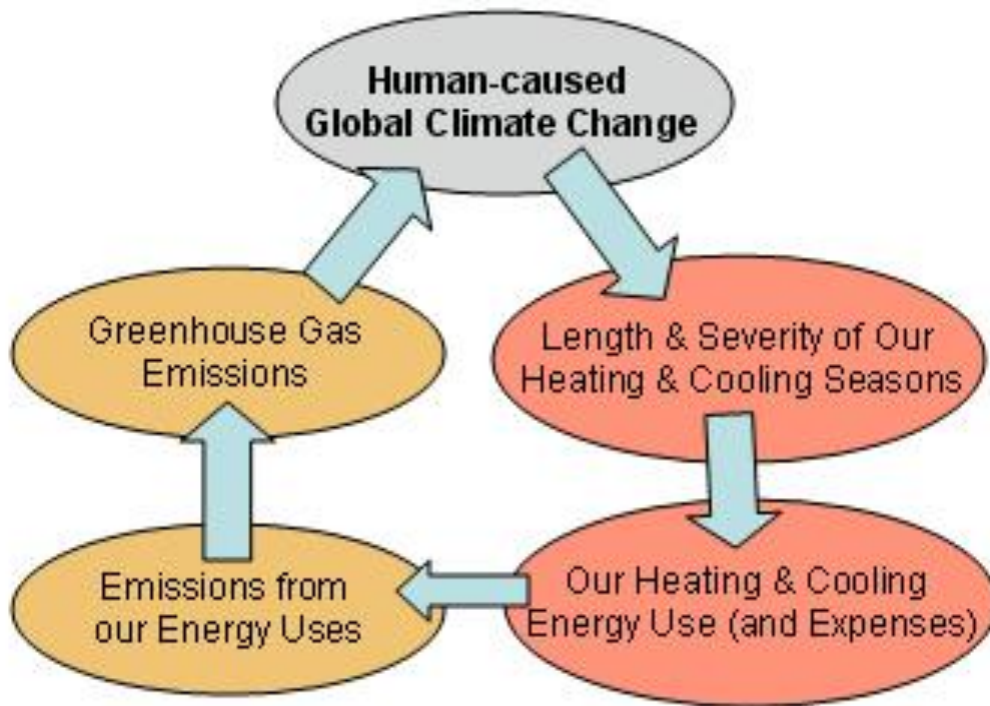


Figure 2-5 The Two directions of impact between Climate Change and Our Energy Use

Source: CARA, no date

2.3.4. At the building scale

The building scale is the lower level of where the climate change begins. As in all other levels, energy related greenhouse gas emission is the most important parameter. The climate of earth is changing, largely due to greenhouse gas emissions resulting from increasing energy demand. Buildings are the significant consumers of this energy. Buildings are responsible for 40% of all energy consumption and about 30% of global annual greenhouse gas emissions (UNEP, 2009).

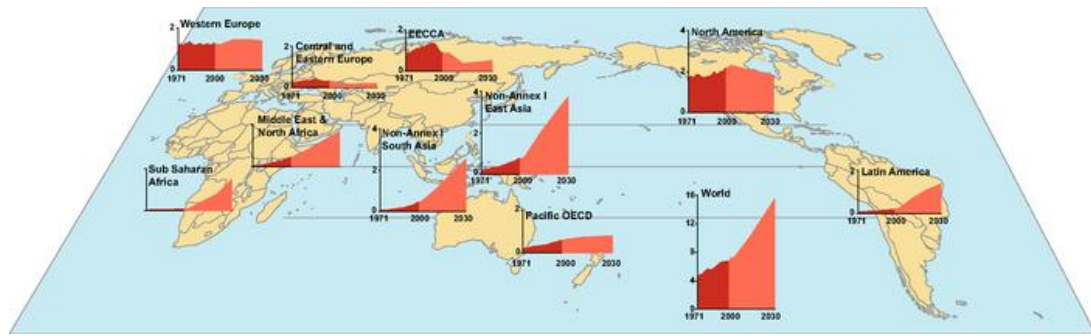


Figure 2-6 CO₂ emissions (including through the use of electricity) IPCC (SRES) scenario ³

Source: IPCC, 2007

The graph includes ten world regions. The scenario shows a range of projected CO₂ emissions related to buildings from 8.6 GtCO₂ emissions in 2004 to 15.6 GtCO₂ emissions in 2030 representing an approximately 30% share of total CO₂ emissions in the scenario (IPCC, 2007). Furthermore, settlement of buildings is important in terms of resilience to climate change. Increasing intensity of building settlement affects interior air quality of the building. These are closely linked to artificial heating and cooling. Therefore, building produces energy-related carbon dioxide emission by using non-renewable energy.

2.4. Mitigation of Climate Change

Climate change mitigation means efforts to reduce or prevent anthropogenic emissions of greenhouse gases (GHGs). OECD (2010) defines it as “*mitigation focuses on reducing the amount of change through reducing emissions or removing greenhouse gases from the atmosphere through sequestration*”. Climate change mitigation is closely linked to sustainable development. There is a bidirectional relationship between sustainable development and climate change. On the one hand,

³ Note: Dark red – historic emissions 1971–2000 based on Price et al. (2006) modifications of IEA data. Light red – projections 2001–2030 data based on Price et al. (2006)

climate change influences environment and human living conditions and thereby also is the basis for social and economic development; while on the other hand, society's priorities on sustainable development influence both GHG emissions that are causing climate change and the vulnerability (IPCC, 2007). Environmental, economic and social development challenges can contribute to the emission of greenhouse gases, while climate change can undermine the components of sustainable urban development (UN-Habitat, 2012).

2.5. Climate Change, City and Sustainability

City was first defined by sociologist Louis Wirth in his paper, "Urbanism as a way of life" (Wirth, 1938). There are four characteristics of the city;

- Permanence,
- Large population size,
- High population density,
- Social heterogeneity.

All above characteristics was specified in terms of demography. City is basically considered as urban settlement. UN states that;

While the origin of cities dates back thousands of years, the city as we know it today dates back a few hundred years. Following industrial revolution, large numbers of people moved to cities in search of jobs, mostly in factories, and since then there has been an unprecedented growth in the number and size of cities worldwide. This process is called "urbanization". Urbanization is measured by the percentage change in a city's population from year to year. This is called the rate of "urban growth". On a global scale, the most rapid urban growth in history has taken place over the past 50 years. Whereas in 1950 fewer than 30% of people lived in a city, today 50% of humanity is urban dwellers (UN, 1996).

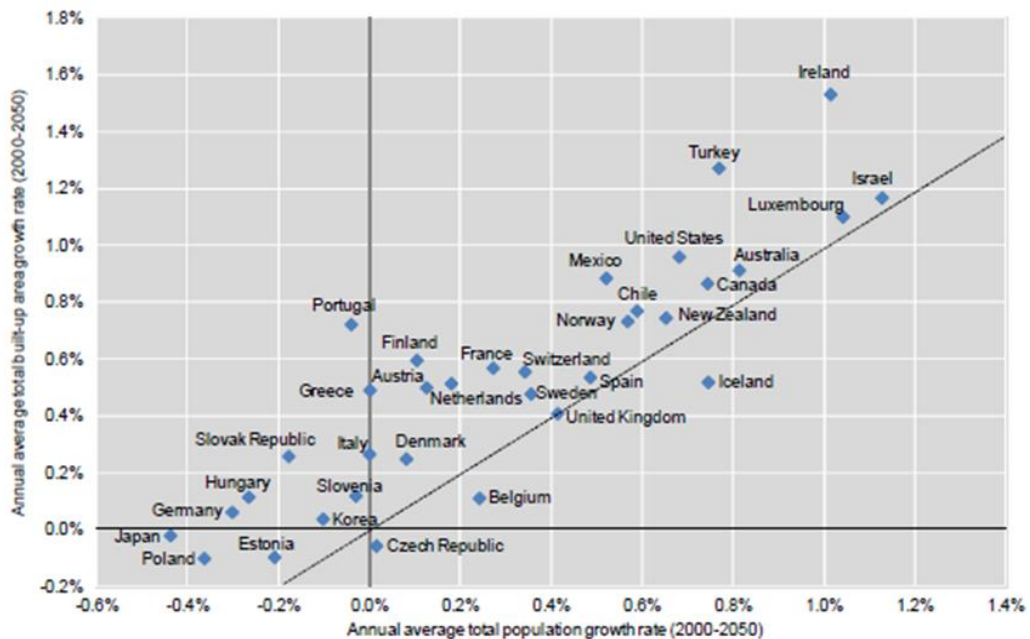


Figure 2-7 Population and built-up area growth rate in OECD countries, 2000-2050

Source: OECD, 2012

Cities are heavily vulnerable to climate change. Vulnerability is defined by the IPCC as; the degree, to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. In this respect, vulnerability is seen as the function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC, 2001).

According to Breheny (1992),

“The world’s cities are the major consumers of natural resources and the major producers of pollution and waste. Thus, if cities can be designed and managed in such a way that resource use and pollution are reduced, then a major contribution to the solution of the global problem can be achieved.”

People in urban areas across the world are affected by the rise in sea levels, increased precipitation, floods, storms, extreme heat and cold and the spread of diseases.

Climate change will be more destructive in urban areas. While cities are adversely affected by climate change, they are also major contributors to climate change, producing majority of carbon dioxide and significant amounts of other greenhouse gas emissions. An emphasis on the role of cities in achieving sustainability was made in the Green Paper on the Urban Environment (CEC, 1990).

Cities are responsible for the majority of greenhouse gas emission that causes climate change. Struggling climate change impacts on all scales, cities combine to make sustainable energy, land use, transportations, use of natural resources that are critically important. All of these can be succeeded with sustainable development.

Sustainable development has also impact on quality of human life. Generally, quality life is mentioned as; moving towards sustainability means moving towards a world where human activities are less harmful for environmental life and thereby for their own life, and moving towards the world that respects all people and all living things (Mulligan, 2011). Starting point of sustainable development is quality life for communities rather than individual. It was also defined as "*improving the quality of human life while living within the carrying capacity of supporting eco-systems.*" in Caring for the Earth (1991). Sustainable development is considered as equality within generations. This development is not only preserving nature but also maintaining opportunities for human development. Sustainability offer community a healthier life.

According to Elkin et al (1991), sustainable urban development must aim to produce a city that is 'user-friendly' and resourceful, in terms of not only its form and energy-efficiency, but also its function, as a place for living. Sustainable urban development is achieved with sustainable urban form. Cervero (1998) states in the book of the Transit Metropolis that urban form affects travel behavior, air quality; premature loss of farmland, wetlands, and open space; soil pollution and contamination; global climate.

One of the five key sectors determined by UN habitat, in which urban responses to mitigation of climate change have been concentrated, is urban form. Other sectors are built environment, urban infrastructures, transportation and carbon sequestration.

Urban form sector contributes more than other parameters to urban sustainability.(UN-Habitat, 2011) Because, this sector is more closely linked to mitigation of negative effects of climate change on cities.

Spatial dimension of cities is generally ignored, which is widely missing political theory although it is the main source of pollution and environmental degradation. It is widely accepted that global sustainability objectives can be achieved when planning and designing cities, by limiting resource consumption and pollution (Breheny M. , 1992). So, the role of cities and planning them becomes much more crucial to achieving sustainable urban development. Jabareen (2004) points out the emergence of “sustainable development” as a popular concept that has revived discussion about the form of cities. According to Jabareen (2006), there are different spatial levels as the regional and metropolitan levels, the city level, the community level, the building level. These different levels show us that there is no convenient urban form in the context of sustainability. There are different approaches to urban sustainability. Haughton (1997) stated four model cities to ensure sustainability.

1. *Self-reliant cities - Intensive internalization of economic and environmental activities, circular metabolism, bioregionalism and urban autarky*
2. *Redesigning cities and their regions- planning for compact, energy efficient city regions*
3. *Externally dependent cities- excessive externalization of environmental costs, open system, linear metabolism and additional carrying capacities*
4. *Fair-shares cities- balancing needs and rights equally in regulation of the flows of environmental value and compensation systems* (Haughton, 1997).

This classification offer a framework to specify particular sustainability solutions produced in political and ideological context of cities. At national level, the UK produced its first Sustainable Development Strategy in response to the call made at

Rio in 1994. The strategy includes basic strategies which have been example for different European urban planning practices later. The issue;

- *“... to optimize the use for development of vacant urban land to reclaim and develop derelict or contaminated land,*
- *to protect as far as possible, the countryside for its landscape, wildlife, agricultural, recreational and natural resource value,*
- *to maximize access on facilities for individuals and to markets for business, while minimizing the amount of travel required.”(DoE, 1994).*

Sustainability strategies emphasize urban structure; especially the issues of land use and urban transportation are highlighted. As stated in ‘The UK Strategy’, these quotations are crucial in terms of being first guideline about sustainable urban development patterns and urban forms.

- *“Tendency to move out of town centers into suburbs and villages with more commuting into town to work,*
- *Significant increase in car use that led to changes in the pattern of retail and commercial development, to congestion in some urban areas and the loss of vitality in city centers.*
- *Increasing travel to work, for leisure often by car, causing congestion, pollution and noise.*
- *Additional residential development away from town centers, often on previously open land.*
- *Increasing car ownership (strengthen by land use policies in the past) resulted in more land being used for road building. This will directly lead to more land for aggregate provision” (DoE, 1994).*

Sustainable urban development should include the following principles for developed and developing countries:

- *“Reducing the physical separation of activities of activities which has arisen from decentralization and sprawl.*

- *Integrating transport and land use policies from the need to encourage public transport.*
- *Locating trip attractors close to public transport, creating cyclist and pedestrian based urban spaces.*
- *Enhancing higher urban densities to conduct lower energy consumption.*
- *Strengthen policies to provide environmental benefits against undefined/uncertain urban development -saving agricultural and valuable natural areas” (Breheny M. , 1992).*

2.6. Assessment

There is a close relationship between cities and climate change. In one hand, cities are exposed to negative effects of climate changes; on the other hand they are major contributor to climate change. Climate change affects environment adversely, correspondingly human health. Sustainability is an important tool to prevent the negative effects. Cities must grow in a sustainable manner. There are different approaches to provide sustainable urban development. One of the approaches is sustainable urban forms. Urban forms are the physical layouts of the city. They dominate other issues related to city life. In the following chapter, different approaches to sustainable urban forms will be analyzed. Then, design concepts, which are derived from sustainable urban forms and are core requirements in sustainable urban development, will be determined.

CHAPTER 3

SUSTAINABLE URBAN FORMS

3.1. Sustainable Urban Forms

Spaces, places, boundaries of city constitute its forms. Briefly, urban forms are physical layout of the city. They can help to define city life. Anderson et al (1996) describes urban form as the spatial distribution model of human activities in a certain juncture of time. Urban form can have important impacts on environment. Urban form has been accepted as an important tool to achieve sustainable urban development. Adverse impacts of climate change can be decreased by using these forms. They directly affect energy consumption, correspondingly amount of carbon dioxide emissions from building, transportation and other sectors that cause climate change. Basically, there are three priorities for the development of urban form:

- *“Transportation priorities: Extension of road and transit infrastructure.*
- *Economic priorities: Economies of Greenfield developments or redevelopment processes.*
- *Cultural priorities: Socio-cultural perception of urban space”*
(Kostof, 1991)

Basic components of urban form like land use pattern and transportation structure have an important effect on urban sustainability. According to Burton (2000), nearly 70% of delivered energy is subject to be influenced by land use planning. According to Ravetz (2000), spatial planning has an effect on urban sustainability at the range of 15%. In such a framework, components of urban form including housing, transport and infrastructure are taken into consideration with their indirect effects on emissions, energy use and material usage.

There are different approaches to urban form to attain sustainability. The sustainable urban forms can correspond to different combination of sustainable design concepts. In other words, each sustainable form offers particular design concepts in order to ensure urban sustainability. They underline some of the design concepts and disregard others. Sustainable forms aroused as a reaction to some urban problem and they were formed by these problems. Therefore, the forms provide a solution to only these problems. Sustainable urban forms have supported strongly two or three design concepts. However, design concepts are essential tools for achieving sustainable development. The design concepts are key factors in determining whether a city is a sustainable or not.

This chapter includes several sustainable urban forms and design concepts derived from sustainable urban forms. Sustainable urban forms are analyzed in terms of their development and design concepts. Then, design concepts which are derived from sustainable urban forms are examined.

When examining sustainable urban forms in sustainable development and planning literature, there are four models as stated in the article of “Sustainable Urban Forms Their Typologies, Models, and Concepts”. They are the neo traditional development, the urban containment, the compact city and the eco-city (Jabareen Y. R., 2006).

3.1.1. The Neo-Traditional Development

Urban areas faced many problems like traffic congestion, high house costs and fiscal problem in 1980s. Neo traditional development (NTD) emerged as a solution to these problems. Neo traditionalists’ main strategies are decreasing traffic congestion, supplying affordable housing and preventing suburban sprawl.

When examining NTD in term of historical background, McNally & Ryan (1992) point out Trends in Suburban Subdivision Design as;

- Traditional Gridiron at Pre 1928,
- "Garden City" at 1928-1945,

- Build-out at 1945-1960,
- Planned-Unit-Development,
- Cluster development at 1960-1980,
- Neo-traditional Neighborhood Design at 1980 to present.

First, Traditional Gridiron was based on the gridiron street pattern. This trend has been criticized for leading to monotonous. Second, Garden City has emerged as a reaction to uncontrolled land consumption. This trend promotes self-contained communities protected from uncontrolled expansion by surrounding greenbelt. Third, build out movement reactions against the formless, placeless development due to Increasing Urban sprawl and automobile dependency decreased the importance of urban core. Fourth, Planned-Unit-Development was a higher level of regulation and planning than previous ones. Fifth, Neo-traditional Neighborhood Design is called as "Traditional Neighborhood Development", "Neo-traditional Neighborhood Design", "Pedestrian Pockets", and "Transit-Oriented Developments. But all of them have same concept.

Pearson (1990) states that there are five factors to determine for this type of development. Mixed-use core, the plans including employment centers, sense of community, pedestrian-friendly environments, sense of tradition are characteristics of NTD. First, mixed-use core means gathering of related land uses closer within "walking distance". The core includes retail, services and residents. Second, the plans including employment centers implies that people live and work in close areas. Third, creating sense of community is one of the NTD proposals. McMillan & Chavis(1986) have defined sense of community as a feeling of belonging that members have, a feeling that members matter to one another and the group, and a shared faith that member's needs will be met through their commitment to be together. Fourth, this development has been influenced by the increase in the automobile usage in the mid-20th century. So, NTD aims pedestrian-friendly environments to reduce negative impact of automobile. Fifth, NTD has generated a sense of tradition by using front porches, detached and set-back garages.

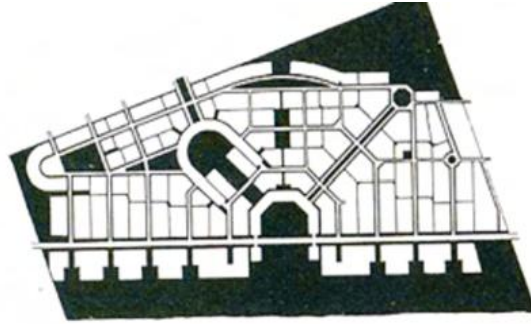


Figure 3-1 The first neo-traditional town: Seaside in Walton County, Florida and its plan schema

Source: Duany & Plater-Zyberk, 1991; Gillham O. , 2002

Duany (1991) states that The Traditional Neighborhood has several positive consequences:

- By providing streets and squares of comfortable scale and defined spatial quality, neighbors, walking, come to know each other and to watch over their collective security.
- By providing a full range of housing types and work places, age and economic classes are integrated and the bonds of an authentic community are formed.
- By providing suitable civic buildings and spaces, democratic initiatives are encouraged and the balanced evolution of society is secured.



Figure 3-2 Neo-traditional designs by Duany & Plater-Zyberk (1) and Krier (2)

Source: Duany & Plater-Zyberk, 1991; Krier, 1984

According to literature review, Neo-Traditional Development includes neo-traditional development, new urbanism, urban villages, hamlets, compact communities, transit-oriented development, pedestrian pockets, and the revitalization of existing traditional towns. But Jabareen (2006) has defined types of NDT as New Urbanism, Transit-Oriented Development and Urban Villages.

○ Traditional Neighborhood Design

New urbanism (also called Traditional Neighborhood Design (TND)) is the best known approach among the others. New Urbanism has emerged as an alternative to conventional development. It aims to reform the design of the built environment and provides better quality of life and life standards. It encompasses fixing and infilling cities, also creating new compact areas. Traditional Neighborhood Developments - TNDs- are characterized by,

- *Relatively compact subdivision of urban land comparing contemporary ones in U.S,*
- *Emphasize on walking rather than auto-dependence,*
- *Mixed-land use,*
- *Traditionally narrow roads, common greens and squares,*

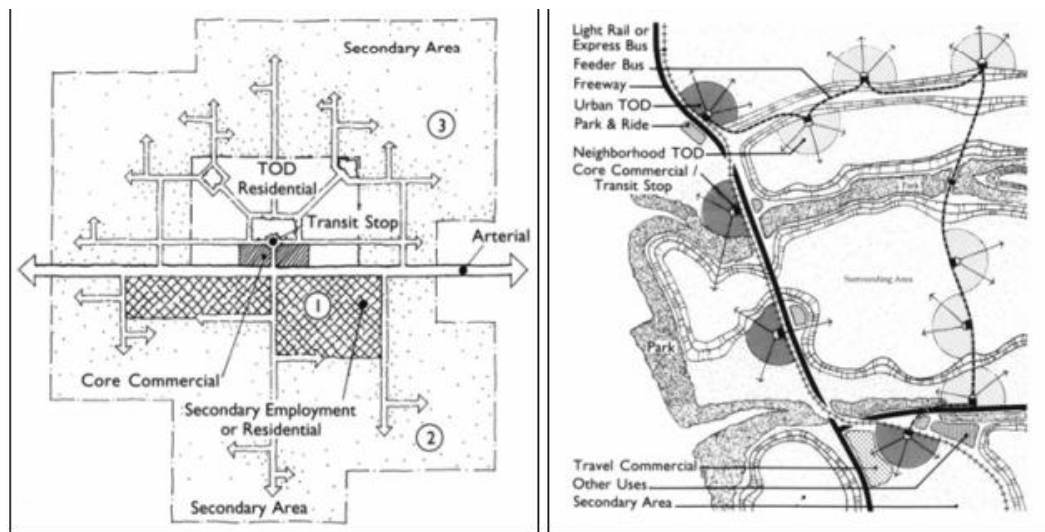
- *Neo-historical (attached and detached) housing on small lots*
(Gillham O. , 2002)

This movement focused on creating well-planned, mixed-use compact cities. There is not any minimum building setback. Density is important for the movement.

- Transit-Oriented Development

Transit-Oriented Development approach is an alternative to urban sprawl and car-dependent sprawl type development. Calthorpe, the pioneer of TODs idea, has defined Transit-Oriented Development as a "balanced, mixed-use area within a quarter mile walking radius of a transit station. She identified TOD as,

- *To organize growth on regional level to be compact and transit supportive,*
- *To place commercial, housing, jobs, parks and civic uses within walking distance of transit stops,*
- *To creating pedestrian-friendly street networks directly connects local destinations,*
- *To provide a mix of housing types, densities and costs,*
- *To Preserve sensitive habitat, riparian zones and high quality open space,*
- *To making public spaces the focus of building orientation and neighborhood activity,*
- *To encourage infill and redevelopment along transit corridors within existing neighborhoods (Calthorpe, 1993).*



TOD as a Walkable Scale Community TOD as Part of a Regional Network

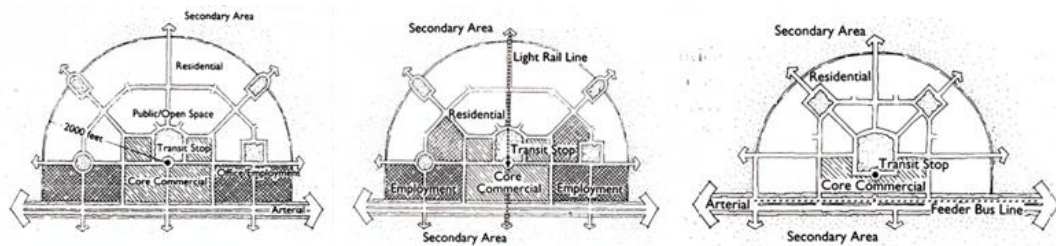


Figure 3-3 Calthorpe’s Conceptual Design Schemes for TODs: Local and Regional Contexts

Source: Calthorpe, 1993

- o Urban Village

Urban Village is a British type of neo-traditional development. Urban village is a settlement between urban and rural spaces. It has the characteristics of both urban and rural. According to Aldous (1992), urban villages have features as high density; mixed use; mix of housing tenures, ages, and social groups; high quality; and being based on walking.

Generally, a person who advocates this movement like Duany and Pearson claim that Neo traditional development promotes reducing the need for travel and thorough

preventing urban sprawl, creating a sense of community rather than modern suburban developments.

On the contrary, opponents like Audirac, Sherman claims that people don't want to live in compact, high density development, and this plan is a physical deterministic and autocratic 'designer knows best' attitude that pervades these urban design manifestos.

Breheny (1991) says that it is clear that the efficiency of the centralized compact city is not yet proven, as the advocates of the compact city would have us believe. Further debate and research is required.

3.1.2. The Urban Containment

Urban sprawl is uncontrolled spreading of a city. Therefore it means low density and automobile dependency. Urban sprawl is one of the most important issues to block sustainable development. The Dictionary of Geography defines urban containment as *“the policy of limiting sprawl by restricting out-of-town development.”* Urban containment strategies are intended to prevent urban sprawl by forbidding most urban development on the outside, so, it influences the rural areas and edge of town usually.

Urbanization process is the migration of the rural population towards cities. It requires a large amount of land. So this rapid population growth causes urban sprawl. Gillham (2002) specifies that more than 95 percent of U.S. population was located in suburbs during the 1970s and 1980s. Effects of Urban sprawl are decentralized city, automobile dependency, thereby increase in air pollution.

Wasserman (2008) and Angel et al (2011) states that urban containment emerged as a reaction to increased automobile travel and congestion, high levels of pollution, loss of farmland, duplicative infrastructure at high costs to society, limited employment

accessibility, concentrated poverty, and many other undesirable outcomes in metropolitan areas.

Pendall, Martin & Fulton (2002) point out that greenbelts, urban growth boundaries, and urban service areas are different strategies for implementing urban containment.

- Greenbelts

Urban extension is restricted by greenbelts. These greenbelts may be farming, forestry and recreation areas. They provide preventing low density development out of urban areas and also provide air cleansing flood control etc. Greenbelt was popularized with the work of Ebenezer Howard and his book, Garden Cities of Tomorrow (1960).

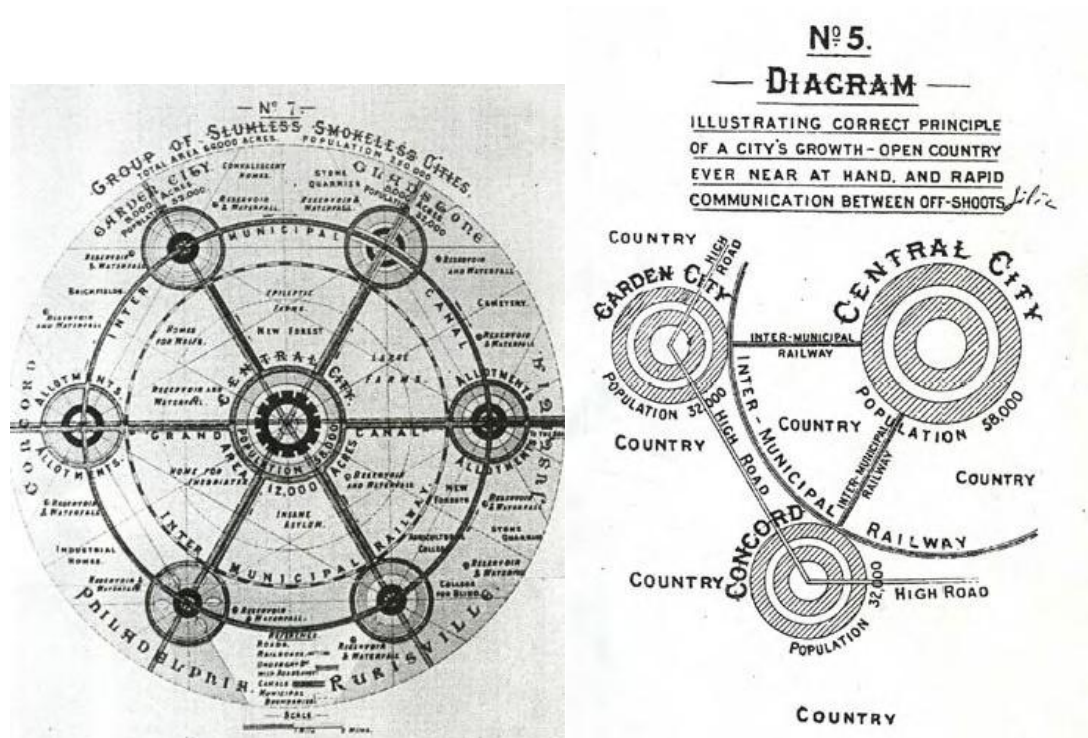


Figure 3-4 Regional network of Garden Cities and the diagram illustrating growth of cities

Source: Howard, 1960; Ward, 2002

According to plan schemas, the town occupies 2,500 hectares and surrounded by 12,500 hectares of greenbelt of agricultural land (Howard, 1960). Greenbelt is a planning tool for controlling urban growth. Clusters of garden cities are linked by railways. Each city has a core. There are public buildings and a garden at the center surrounded by residential areas. People who live in the city could walk everywhere within the settlement (Howard, 1960). To Mumford, “...*For Garden City, as conceived by Howard, is not a loose indefinite sprawl of individual houses with immense open spaces over the landscape: it is rather compact, rigorously confined urban group in.*”(Mumford, 1960).

- Urban Growth Boundaries

Greenbelts and urban growth boundaries are used to achieve the same goal. An urban growth boundary is a physical boundary that separates urban and rural areas unlike greenbelts that are designated to accommodate growth for a specified period of time (20 to 30 years) (Pendall, Jonathan, & William, 2002). The inside of this boundary can be zoned for urban use; the outside can be zoned for rural uses.

- Urban Service Areas

Urban service areas identify suitable areas for future urban development. Urban service areas resemble urban growth boundaries in terms of preventing urban sprawl. But they are also more flexible than greenbelts because they are easier to move.

Urban containment has two main purpose; promoting compact and contiguous development patterns that can be served as public services and preserving open space agricultural land and environmentally sensitive areas that are not suitable for urban development (Nelson & Duncan , 1995).

Galster et al (2000) states that there are eight distinct dimensions to measure urban sprawl.

These are;

1. Density: the average number of residential units per square mile of developable land in an urban area.
2. Continuity: the degree to which developable land has been developed at urban densities in an unbroken fashion.
3. Concentration: the degree to which development is located in relatively few square miles of the total urban area.
4. Compactness: the degree to which development has been "clustered" to minimize the amount of land in each square mile of developable land occupied by residential or nonresidential uses.
5. Centrality: the degree to which residential and/or nonresidential development is located close to the central business district of an urban area.
6. Nuclearity: the extent to which an urban area is characterized by a mononuclear (as contrasted with a poly nuclear) pattern of development.
7. Diversity: the degree to which two different land uses exist within the same micro-area, and the extent to which this pattern is typical of the entire urban area.
8. Proximity: the degree to which different land uses are close to each other across an urban area. Galster et al (2000)

Urban containment can achieve restricting urban sprawl. The indicators above may help define design concepts for urban containment. Furthermore, urban containment and traditional neighborhood development share similar characteristics. They are same in terms of a response to sprawl. Hence, design concepts are very similar.

The primary idea of urban containment is encouraging urban development inside, discouraging development outside of this area. So inside of urban area, compactness, density, diversity and mixed land use are important for this model.

Proponents argue that urban containment will do a better job of preserving open space, widening transportation options, improving accessibility, integrating the races, and enhancing incomes than the status quo; unlike, opponents may concede some

points but they argue that containment raises housing prices, reduces location choices, and generally reduces quality of life (Nelson , 2004).

3.1.3. The Compact City

Increase in urban sprawl, unsustainable transportation and other causes which increase CO₂ emission forced people to find sustainable solutions. The concept of the compact city emerged as a reaction to all these problems. Compact city offers relatively high residential density, reducing driving and mixed-use developments, reducing the average lot sizes, redesigning streets and neighborhoods to be more pedestrian friendly, thereby low energy consumption and reduced air pollution.

Origin of compact city concept is fortress cities that were built in order to provide protection against enemies in the 16th century. Within time, this concept evolved into protecting green areas and preventing urban sprawl. Then greenbelt policy was emerged at 18th and 19th century. Industrial revolution started towards to the end of the nineteenth century. Industrial revolution influenced cities adversely. Ebenezer Howard created a famous urban planning model called the “Garden City”. This city was surrounded by a green belt and spread agricultural and recreational zone. In 1960s, major cities established policies to restrict urban expansion. Simultaneously, terms of quality of life, livability and diversity was mentioned with urban development. Although not using directly the term of compact city, all arguments reflected the concept. The term of compact city was first coined by George Dantzig and Thomas L. Saaty (1973). Today, the term come into use with sustainability to reduce negative effects of global warming.

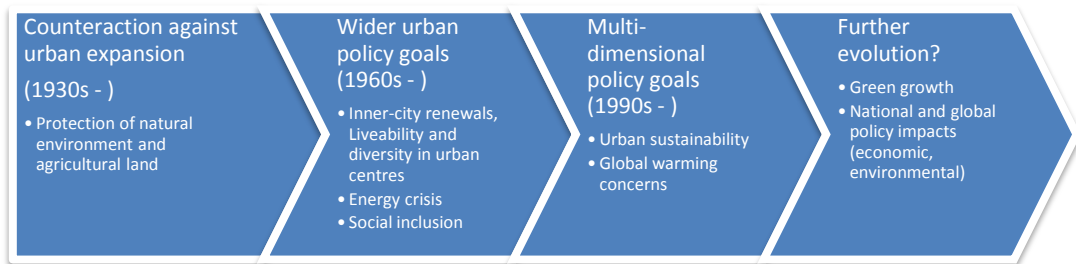


Figure 3-5 Evolution of compact city policies

Source: Matsumoto, 2011

To Newton, compact city is one of the five archetypal urban forms:

a. Dispersed city- scattered low-density suburban development of population and employment based on road transportation.

b. Compact city- high population and employment density of an inner group of suburbs with connected public transport.

c. Edge city- Linked high-density population, employment and housing nodes with orbital freeways.

d. Corridor city- Growth along linear corridors radiating from central city, with public transport infrastructure.

e. Fringe city- continuous growth predominantly on the periphery of the city (Newton P. , 2000).

Compact City is assumed to be located in more desired areas. Major advantages are:

- Possibility for building a modern metropolis in a natural setting.
- Availability of cost saving settlement schema.
- Conservation of use of time with shrinking distances.
- Conservation of the use of land by limited city size.
- Conservation of use of energy by less petroleum dependent transport pattern and combined energy systems.

- Flexible construction techniques to adjust city to changing social needs.
- Efficient urban service system by permission to consolidation and centralization of services.
- Elimination of pollution by recycling, filtering and waste management techniques which are possible in compact urban form (Dantzig & Saaty, 1973).

Compact city is also the major prerequisite of quality of life. Masnavi relates compact city paradigm with four elements of the quality of life in a positive perspective,

- Good accessibility to facilities- equity in access to the range of facilities and services of the city,
 - Reducing need to travel- decreasing journey length by private car,
 - Health- improving public life through reducing pollution of emissions from vehicles,
 - Social interaction- increasing social contact in frequent used public places (Masnavi M. R., 2000).

There are extensive literature about compact city and their characteristics. Matsumoto (2011) specifies that characteristics of compact city concept are;

- Dense and contiguous development patterns. Density involves how intensively urban land is utilized, and contiguity particularly concerns the location of new development at the urban fringe. In a compact city, urban land is densely utilized and the border between urban and rural land use is distinct. However, public spaces including squares, streets and parks are also essential elements. The density and location of development are major physical (or morphological) characteristics of the compact city. Simple morphological models can help clarify these two characteristic.

- Urban areas linked by public transport systems. This involves how effectively urban land is utilized. Public transport systems facilitate mobility in urban areas, which enable urban areas to function effectively.
- Accessibility to local services and jobs. This concerns how easily residents can attain local services such as grocery stores, restaurants and clinics as well as neighborhoods jobs. In a compact city, land use is mixed and most residents have access to these services either on foot or using public transport (Matsumoto, 2011).

OECD (2012) describes characteristics of compact city as follows; dense and proximate development patterns, urban areas linked by public transport system and accessibility to local services and job. Compact city is provided by compactness, density, sustainable transportation, mixed land use.

Within last twenty years, forms of cities with sustainability have come into widespread use as a result of increased environmental awareness. Debates started on whether these forms really contribute to sustainability or not. Compact city concept is one of these forms.

Proponents argue that;

First, compact cities are argued to be efficient for more sustainable modes of transport. The population densities are high enough to support public transport and to make it feasible to operate. Also, the theory is that because compact cities have high density and include mixed use, people can live near to their work place and leisure facilities. Hence, the demand for travel is reduced and people can walk and cycle easily.

Second, compact cities are seen as a sustainable use of land. By reducing sprawl, land in the countryside is preserved and land in towns can be recycled for development.

Third, in social terms, compactness and mixed uses are associated with diversity, social cohesion and cultural development. Some also argue that it is an equitable form because it offers good accessibility.

Fourth, William et al (2000) states that compact cities are economic when infrastructure, such as roads and street lighting, are used cost-effectively per capita. The costs of building local roads decreased approximately 25%. Hence, compact development can create a %50 to 75% reduction in road length (Livingston, Ridlington, & Baker, 2003).

Table 3-1 Capital costs of infrastructure and land savings in different development scenarios for Denver Metro Region, 2000-2020

Source: Livingston, Ridlington, & Baker, 2003

Impact	Dispersed	Compact	Corridor	Satellite
Capital Cost (Roads and Utilities)	\$5.4 billion	\$1.1 billion	\$1.6 billion	\$2.0 billion
Saving (compared to dispersed)	0%	80%	70%	63%
Land Consumed(square miles)	850	650	750	750
Total Urbanized Land				
Potentially Prime Agricultural	100.8	42.8	52.7	66.3
Wildlife Habitat	181.8	71.8	97.4	109.7
Woodland	28.Nis	06.Haz	15.Tem	14.Oca
Infrastructure Cost/Acre	\$9,926	\$2,644	\$3,333	\$4,166

Owens points out that compact city provide energy saving indirectly as:

- The shape of the urban area can lead to variations in energy demand at the range of 20%.
- By means of intensification and centralization of trip destinations, with facilitating transit systems, energy savings of 20% can be achieved.
- High density and mixed land uses -compact urban form-enables combined heat and power systems, which increases the efficiency of domestic energy use by 100% (Owens, 1986).

Table 3-2 The contribution of the compact city to urban sustainability

Source: OECD, 2012

Sub-characteristics of the compact city	Contribution to urban sustainability		
	Environmental benefits	Social benefits	Economic benefits
1. Shorter intra-urban travel distances	- Fewer CO ₂ emissions - Less pollution from automobiles	- Greater accessibility due to lower cost	- Higher productivity due to shorter travel time for workers
2. Less automobile dependency	- Fewer CO ₂ emissions - Less pollution from automobiles	- Lower transport costs - Higher mobility for people without access to a car - Improved human health due to more cycling and walking	- Development of green jobs/ technologies
3. More district-wide energy utilisation and local energy generation	- Less energy consumption per capita, fewer CO ₂ emissions	-	- Development of green jobs/technologies - More energy independence
4. Optimum use of land resources and more opportunity for urban-rural linkage	- Conservation of farmlands and natural biodiversity - Fewer CO ₂ emissions due to shorter food travel mileage	- Higher quality of life due to more recreational activities	- Rural economic development (urban agriculture, renewable energy, etc.)
5. More efficient public service delivery	-	- Public service level for social welfare maintained by improved efficiency	- Lower infrastructure investments and cost of maintenance
6. Better access to a diversity of local services and jobs	-	- Higher quality of life due to access to local services (shops, hospitals, etc.)	- Skilled labour force attracted by high quality of life - Greater productivity due to more diversity, vitality, innovation and creativity

Opponents argue that;

First, urban intensification which increases population density will decrease per capita car use, with benefits to the global environment, but will also increase concentrations of motor traffic, worsening the local environment in those locations where it occurs (Melia, Parkhurst, & Barton, 2011).

Second, density is an important concept for compact city. Most often, dense cities are unhealthy. After Industrial revolution, city population increased sharply. The cities became less healthy as they became denser.

Third, Neo-traditional planning did emerge from critiques of segregated land uses. New urbanism seeks to bring uses into proximity and mix uses in town centers, thus enhancing choice and livability. Yet close inspection of most neo-traditional plans reveals that segregation of uses still occurs. Commercial and civic uses dominate the center, and housing remains on the periphery (Neuman, 2005).

3.1.4. The Eco-City

Eco city is the perfect unison of nature and city life. Eco city which uses local materials, and local energy, air and water flows minimizes harmful effects of human on environment. So, as specified in Development, eco-city is an ecologically healthy city. Urban Ecology, defines an 'eco-city' as "*a human settlement that enables its residents to live a good quality of life while using minimal natural resources*" (International Ecocity Standards, 2010).

The term 'eco-city' was coined by Richard Register, founder of Urban Ecology. He has advocated that there must be a link between ecological principles and old cities must be redesigned. But the concept of Eco cities is not new. In 1970, arcossanti was built. It is an experimental town that has been developed by Paolo Soleri. This city is the study of the concept of arcology, which combines architecture and ecology.

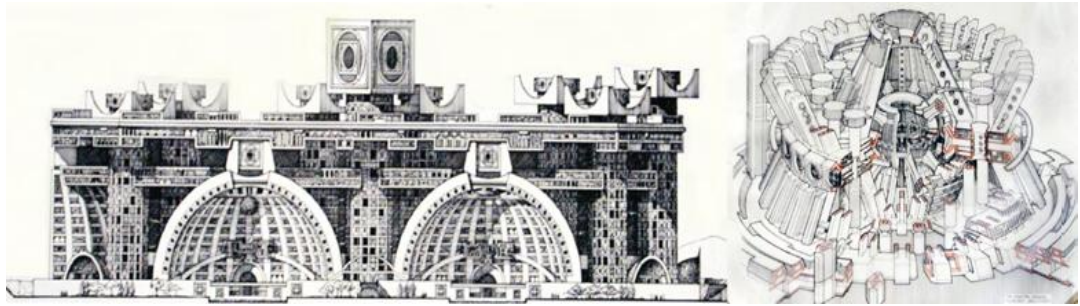


Figure 3-6 Arcosanti (1970)-left- and Mesa City_Ground Villages (1971) by P. Soleri.

Source: <http://www.arcosanti.org/archives/orginaldrawings/arcology/main.html>

“...The natural landscape is thus not the apt frame for the complex life of society. Man must make the metropolitan landscape in his own image: a physically compact, dense, three-dimensional, energetic bundle, not a tenuous film of organic matter.”

And then he addresses the verticality in space:

“...Physical freedom, that is to say, true reaching power, is wrapped around vertical factors...Around vertical factors, megapoly and suburbia can contract, moving from flat gigantism toward human and solid scale...”(Soleri, 1996).

Arcosanti is a prototype in the desert region of Arizona, the U.S. It includes 340 hectares agricultural and biological areas to be preserved. When being completed, Arcosanti will have the community of 6000 people with the density of 875 persons per hectare –10 times the population density of NY (Grierson, 2003). It contains homes, offices, parks, schools etc. within one structure. Hence, he aims to create greater sense of community (Grierson, 2003).

There are three types of city development. Firstly, new development covers vacant area. Secondly, expansion of urban area development means that eco city spreads from an urban area. Thirdly, retro-fit development is the mostly used Eco-City development type. This type constructs existing infrastructures.

In Richard Register's vision of ecological cities, sprawling, low density cities are transformed into networks of high and medium density urban settlements of limited size separated by green space; with most people living within walking or cycling distance of their workplace (Ecological Cities, 2007).

Four sectors are regarded as important for urban development: urban structure, transport, energy and material flows, and socio-economy.

Table 3-3 Sectors and aspects of urban development

Source: Schubert, 2001

URBAN STRUCTURE	TRANSPORT	ENERGY AND MATERIAL FLOWS	SOCIO- ECONOMY
-Demand for land /density -Land use (mixed use) -Public space -Landscape / green spaces, water -Urban comfort -Buildings	-Transport of persons -Slow modes / public transport -Transport of persons -Individual motorized travel -Transport of goods	-Energy -Water(supply, treatment) -Waste -Building materials	-Social Issues -Economy -Costs

Urban Structure refers to the physical reality of the city considered as an interconnected system. Associated aspects of Eco city planning: demand for land, land use, landscape/green space, urban comfort, public space, buildings

Transport refers to the physical and virtual movement of people, goods and data into, through and out of the city. Associated aspects of Eco city planning: slow modes / public transport, individual motorized transport, transport of goods

Energy & Material Flows refers to the movement or flow of energy and materials in space and through different urban and physical systems. Associated aspects of Eco city planning: energy, water, waste, building materials

Socio-Economy refers to those human activities determining the social processes and economic life of the city. Associated aspects of Eco city planning: social issues, economy, costs (Gaffron, Huisman, & Skala, 2005).

Generally, Eco-City proponents argue that Eco-City is the perfect solution for the future in preventing the urban sprawl that threatens regional ecologies worldwide. In contrast opponents argue that while many cities around the world are currently struggling to budgetary issues, the high cost of the technological integration is necessary for eco-city development. But Eco city are gainful in the long-run economic model.

3.1.5. Assessment

Urban form can have important effects on environment. It has been accepted as a significant factor to ensure urban sustainability. Negative effects of climate change can be decreased through these forms by affecting energy consumption directly, correspondingly amount of carbon dioxide emissions from building, transportation and other sectors causing climate change. There are different approaches to urban form to attain sustainable urban development. Sustainable forms emerged as a reaction to some urban problems and they were formed by these problems and offered some specific design concepts. For example, during 1970s, cities faced some problems associated with rapid urban growth and expansion of cities into natural areas and land-consumptive development patterns. The urban containment emerged

as response to these problems. It aims to limit sprawl by promoting the usage of the space and the resources effectively. Therefore, its most important strategy is the compactness identified by high density development. Emergence of Neo-traditional development was in the early 1980s in the United States. In those years, there were main problems that people faced in life. One of the problems is the increase in the number of cars. This development is strongly influenced by the rise of the automobile in the mid-20th century. Therefore the development emphasizes increased walking and decreased driving through grid patterns and walkable streets. Furthermore, this flow offers mixed use development because of the fact that a wide range of activities is within walking distance and people tend to use automobile less often. In conclusion, compactness, sustainable transportation and mixed land use are prominent features of NTD. Compact city has emerged as an answer to faster demographic, spatial and economic growth. All urban forms try to achieve sustainability by using different tools. The major propositions suggested that the compact city form can contribute to achieving sustainability because it correlates more design concepts related to sustainable urban forms and also offers solutions to more problems than other sustainable urban forms. In other words, compact city form covers other city form. Compact city form is the most effective city form in terms of sustainable development (Breheny M. , 1995) (Rickaby, 1987) (Feitelson & Verhoef, 2001) (Jabareen Y. R., 2006). Compact city form promotes density, mixed land use compactness and sustainable transportation. Eco-city has emerged as an answer to global climate changes crisis, correspondingly environmental degradation. It aims to reduce cities' impact on environment and offers its residents better quality of life while using minimal natural resources to live and work. One of the primary goals of eco city is to protect the environment from negative effects of cities that stem from climate change. Therefore, the building's site, materials, water saving features etc. and infrastructure which have direct impacts on environment are important for eco-city. Because, according to UNEP (2009), the building sector contributes up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy. In addition, transportation can harm the environment and contribute global annual greenhouse gas emissions. The eco city model aims to increase the opportunity to access places by using public transport and non-

motorized vehicles such as bicycles and by walking within the eco-city through mixed land use development and sustainable transportation design concept. Urban greening significantly influences environment and public health. The relation between urban greening and public health is very strong. Public health is substantial for the eco-city model. Therefore, greening is also crucial for the city to provide their residents quality life. Briefly, an eco-city model is composed of sustainable transportation, mixed-use development, greening and passive solar design concepts.

We need to take a more holistic approach for ensuring urban sustainability. This holistic approach for sustainability promotes using sustainable urban forms in cities. Above mentioned design concepts derived from extensive literature are essential tools for achieving sustainable development. They are also key factors in determining whether an urban development progress is sustainable or not. However, while sustainable urban forms underline some of the design concepts, they disregard others. When analyzing urban form literature, prominent design concepts of sustainable urban forms is stated in Table 3.4.

Table 3-4 Prominent features of sustainable urban development.

Sustainable Urban Form	Prominent features
Neo-Traditional Development	Compactness, Sustainable transportation, Mixed land use
Urban Containment	Compactness, density
Compact City	Compactness, Density, Mixed land use, Sustainable transportation.
Eco-City	Sustainable transportation, Mixed land use, Greening, Passive solar design

3.2. Design Concepts Derived From Sustainable Urban Forms

Land use patterns, transportation system, infrastructure, density, characteristics of the built environment are considered as principal elements of urban form. They play a key role in the sustainable urban development. In addition, they are crucial to reduce effects of climate change at the urban level. In planning literature; there are different design concepts to determine whether city is sustainable when examining sustainable urban forms. While According to Newman & Kenworthy (1989), sustainable city provides a high density, mixed use centralized urban form, Barton (2000), argue that mixed land use is the most sustainable concept. Frey (1999), Newton (2000), Buxton (2000) advocates creating and preserving higher density, compactness, sense of place and increasing the potential for walking and public transportation to ensure sustainability. Masnavi (2000) offers mixed land used development. According to Him, segregated land uses require more frequent and longer trips. Alberti (2000) points out that parks and green spaces promote clean air, exercise and recreation, animal habitat, and urban cohesiveness. They help to moderate local climate, and encourage the preservation of natural areas. Frey (1999), and Cuff (2001) suggest moderate parcel sizes as a sustainable urban form because of less disruption to the physical environment. Battle et al (2001) specify that environmental technology like solar panels and specialized design can mitigate negative effects of climate change. Wheeler (2004) sketches a sustainable city's features: compact, mixed land uses and easy access to facilities.

All of the above-mentioned concepts are key issues of sustainable urban forms. The conclusions of the debate about sustainability of urban forms have focused on compactness, sustainable transport, and mixed land uses. These design concepts are derived from sustainable urban forms in planning literature.

All sustainable urban forms try to achieve sustainable urban development by using different tools and each sustainable urban form offers particular design concepts. However, all of these design concepts contribute to sustainable urban development. According to Jabereen (2006), the sustainable urban form including more design concepts than the others contributes more to sustainability than they do. Briefly, the design concepts are used to determine whether a city is sustainable or not. Jabareen

(2006) points out that there are seven design concepts in the article of Sustainable Urban Forms; Their Typologies, Models, and Concepts published in 2006. By analyzing urban literature, sustainable urban forms are centered on the design concepts of compactness supported by high density, mixed land use and sustainable transportation. In this section, the design concepts are analyzed in terms of their characteristics and indicators.

3.2.1. Compactness

Compactness is widely accepted as a key factor to reach sustainable urban development. It can minimize the need to transport energy, materials, products, and people (Elkin, Duncan , & Mayer, 1991). According to Wheeler (2004), sustainable urban development had been conceptualized as entailing compact and efficient land use with the provision of better access through less automobile use along with an efficient use of resources leading up to less pollution and waste. Compactness provides environmental benefits thanks to shortened distances and reduced automobile dependency correspondingly reduced CO₂ emission, and it has economic benefits due to reduced infrastructure and transport costs, and also has social benefits thanks to proximity to local services and jobs. Compactness is one of the best ways to prevent urban sprawl. Urban Sprawl is defined as;

“Sprawl is the spreading out of a city and its suburbs over more and more rural land at the periphery of an urban area. This involves the conversion of open space (rural land) into built-up, developed land over time” (SprawlCity.org)

“Urban sprawl is commonly used to describe physically expanding urban areas. The European Environment Agency (EEA) has described sprawl as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas. Sprawl is the leading edge of urban growth and implies little planning control of land subdivision. Development is patchy, scattered and strung out, with a tendency for discontinuity. It is leap-frogs over areas, leaving agricultural enclaves. Sprawling cities are the opposite of compact cities — full of

empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth” (EEA, 2006).

For Rogers, compactness of urban form is the indispensable feature of a sustainable city. If the cities are compact, polycentric, ecologically aware and based on walking, they can be economically strong, well governed and designed. Diverse activities are placed to connect people easily. Hence social inclusion can promote (Rogers, 1995).

In addition, according to Frey, compact urban form can be stated as follows:

- Reuse of infrastructure and of previously used urban land: upgrading of existing urban land and conservation of the countryside,
- Less energy consumption: lower fuel and heating costs as a result of intense urban form,
- Availability of affordable public transport: Increased overall accessibility and mobility, reduced traffic volumes, related pollution and risk of death and injury in traffic,
- Viability of mixed use as a result of increased densities: reduced travel distances, efficient way of accessing local facilities,
- The potential of social mix when supported by a range of dwelling and tenure types,
- An efficient milieu for businessmen and services by concentration of local activities in communities (Frey, 1999).

Compactness does not have a generally accepted definition. Gordon and Richardson (1997) defined compactness as high-density or mono centric development. Ewing (1997) defined concentration of employment and housing, as well as some mixture of land uses. Different from these definitions, Anderson et al (1996) stated both mono centric and polycentric forms as being compact.

Alternatively, there are compactness definitions which are more measurement-based. Bertaud and Malpezzi(1999) developed a compactness index. The index is the ratio between the average distance from home to central business district (CBD), and its

counterpart in a hypothesized cylindrical city with equal distribution of development. Similarly, Kasanko et al (2006) defined indicators for measuring compactness. First, compactness is the measured distance between residential areas and the city center and how it has evolved in time. The assumption is that in more sprawled cities the distance has grown more and faster than in more compact cities. Second, the indicator describes the saturation of land use. Urban areas have been divided in co-centric rings, the width of which is 1 km and the center point of which is in the city center. While the rings move further away from the city center, the dominance of open space and forests grows. Galster et al (2001) described that compactness development is clustered and it minimizes the amount of land developed in each square mile.

Apart from the definition of compact urban form at macro-form level, compact urban form is defined as internal structure of urban fabric. For Bannister et al., compactness could be defined in two-dimensional base and it directly influences characteristic of urban space. From this point of view, compactness is identified as maximum length to width ratio (Banister, Watson, & Wood, 1997). When defining the urban compactness, it cannot be considered separately from other sustainable design concept. For Burton, there are three basic criteria that can be designated as the indicators of urban compactness:

- High-density,
- Mixed land-use,
- High-level of intensification (Burton, 2002).

Unlike Burton's definition in urban context, Cervero and Kockelman define compactness by classifying it into three categories at neighborhood level:

- Density,
- Diversity,
- Design (Cervero & Kockelman, 1997).

There are various empirical researches to measure compactness.(for example Miller (1953); Richardson (1961); Cole (1964); Massam & Goodchild (1971); Frolov

(1975); Osserman (1978); Kim & Anderson (1984); Bribiesca (1997); Bachi (1999); Bottema (2000); Wentz (2000); Zhao & Stough (2005); Santiago & Bribiesca, (2009). Many empirical researches used only population densities to measure compactness (for example, Barrett (1996); Newman and Kenworthy (1989). However, Burton (2002) stated that the gross densities can be misleading.

But Burton (2002) point out that;

“The so-called compact city appears to have a variety of attributes, but empirical studies have tended to focus on limited aspects, such as gross and residential densities. To determine the potential of urban compactness, it is necessary not only to address the heterogeneity of the concept but also to differentiate between ‘static’ or baseline levels, and changes in these levels through the process of compaction.”

Compactness is a dynamic concept related to other concepts like density, mixed land use, sustainable transportation etc. Hence the concept should not be evaluated only in two dimensions. Evaluation of compactness should use information about development of urban macro form, urban mobility and energy consumption at metropolitan level.

Compactness is a critical factor to reach urban sustainability in sustainable urban development literature. It is considered as a solution to the rising population growth, high urban densities and very limited resources. Neo-traditional development, the urban containment and compact city form offer compactness. Newton (2000) states compactness can contribute to sustainable urban development. It helps to reduce CO2 emission from transportation through decreasing fuel consumption. Unlike Newton, Breheny (1992) points out that compactness may mean a reduction in environmental quality through the loss of open spaces. According to Knight (1996), compact urban structure may be drawback economically when the central structure becomes too big. Moreover, for household that demands more space, compactness

may be less desirable. However, when thinking in terms of energy saving, CO2 emission, compactness is the primary components for urban sustainability.

3.2.2. Sustainable Transportation

Automobile use is increasing dramatically. In urban areas, motor vehicles are the main contributors to GHG emission. Transportation, a significant contributor to climate change, is the most important problem related to land use patterns (Moore & Throsnes, 1994); (Kelly E. D., 1994). It affects energy consumption that has dramatically increased dependency on petroleum. According to report of International Energy Agency (IEA);

“Transport accounts for about 19% of global energy use and 23% of energy-related carbon dioxide (CO2) emissions and these shares will likely rise in the future. Given current trends, transport energy use and CO2 emissions are projected to increase by nearly 50% by 2030 and more than 80% by 2050” (IEA, 2009).

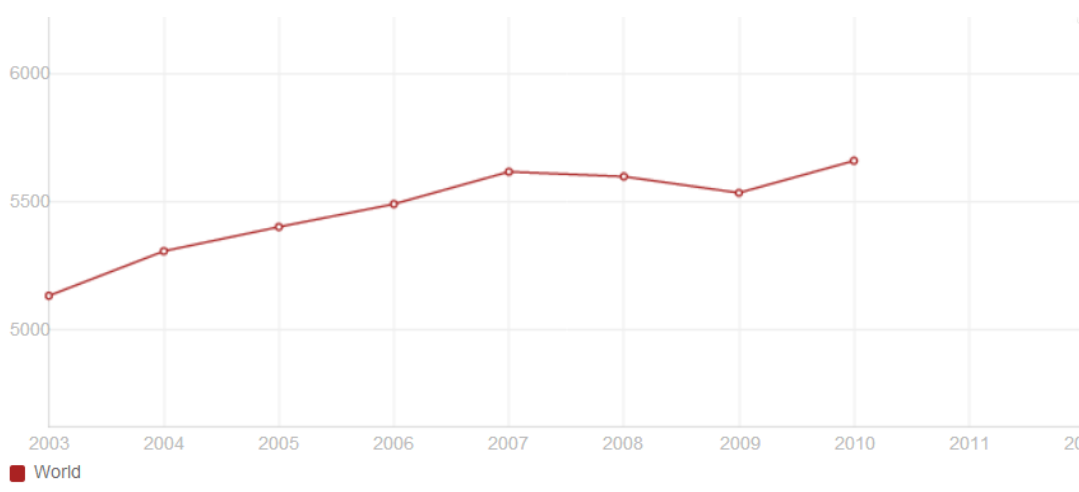


Figure 3-7 CO2 emissions from transport (million metric tons)

Source: IEA Statistics, 2011

Sustainable transportation implies balanced between environmental, social and economic qualities (Litman, 2003). There are no common accepted key definitions of sustainable transportation. It includes;

“The goal of sustainable transportation is to ensure that environment; social and economic considerations are factored into decisions affecting transportation activity” (Moving on Sustainable Transportation (MOST), 1999).

“... sustainability is not about threat analysis; sustainability is about systems analysis. Specifically, it is about how environmental, economic, and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation” (Transportation Research Board, 1997).

“Sustainability is ‘the capacity for continuance into the long term future’. Anything that can go on being done on an indefinite basis is sustainable. Anything that cannot go on being done indefinitely is unsustainable” (Center for Sustainability, 2004).

Transportation, noise and air pollution closely affect the quality of life and health of urban populations. To prevent all these, sustainable transport has been identified as one of the priority areas. Sustainable transportation can improve environmental, social and economic qualities.

Those are listed below.

Table 3-5 Transportation impacts on sustainability

Source: Litman, 2006

Economic	Social	Environmental
Traffic congestion	Inequity of impact	Air and water pollution
Mobility barriers	Mobility disadvantages	Habitat loss
Accident damages	Human health impacts	Hydrologic impacts
Facility cost	Community interaction	Depletion of non-renewable resources
Consumer cost	Community liveability	
Depletion of non-renewable resources	Aesthetics	

According to the University of Plymouth Centre for Sustainable Transport (2005),

“a sustainable transportation system allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; also limits emissions and waste within the planet’s ability to absorb them, minimizes consumption of non-renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.”

Ewing et al (2007) states CO2 reduction for transportation can be viewed as a three-legged stool. One leg of stool is the vehicle fuel efficiency, second is the carbon content of the fuel itself, and third is the amount of driving or vehicle miles traveled.

Vehicle fuel efficiency and the carbon content of the fuel are related to technological development. These two legs provide hybrid cars and lower – carbon fuels (such as biodiesel). Third leg may be the most important. Increasing urban population leads to expansion of the cities. Thus, people living in urban areas become more automobile dependent. This leg can be achieved by compact city form. Because sprawling urban area affects the amount of driving or vehicle miles traveled adversely.

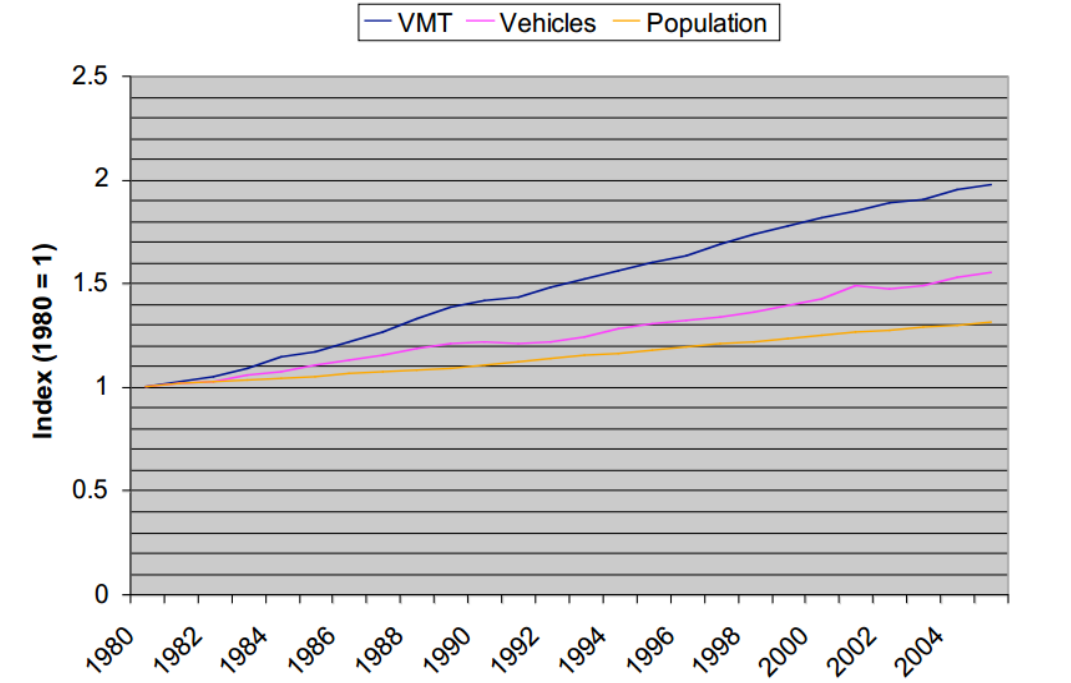


Figure 3-8 Growth of VMT, Vehicle Registrations, and Population in the United States relative to 1980 Values

Source: FHWA 2005

Litman (2006) categorized indicators of sustainable transportation as simple and comprehensive indicators. Simple indicators are using relatively easily available data. Below are examples:

- *transportation fossil fuel consumption and CO2 emissions: less is better*
- *vehicle pollution emissions: less is better*

- *per capita motor vehicle mileage: less is better*
- *mode split: higher transit ridership is better*
- *traffic crash injuries and deaths: less is better*
- *transport land consumption: less is better*
- *roadway aesthetic conditions (people tend to be more inclined to care for environments that they consider beautiful and meaningful).*

However, these indicators depend on some factors for example population size and demographic growth, travel distances, climate, power sources and level of economic activity. Hence, while evaluating countries in terms of negative impacts of transportation, these factors take into account.

Sustainable transportation is an urgent priority in sustainable urban development. It can be strongly influenced by urban form and growth. Transportation and land use issues are considered together. Otherwise certain problems emerge as:

- *More distance-intensive interactions in urban areas, increasing commuting distances and decreasing time savings,*
- *Transport-based unproductive land uses -excessive road and parking spaces- in urban lands of high economic potentials,*
- *Automobile dependent urban structure, with direct impacts of noise, pollution and functional visual segregation.*
- *Auto-based urban transportation pattern, making city vulnerable to future energy crises (Scheurer, 2001).*

Transportation is responsible for noise, congestion and polluting emissions such as carbon dioxide (CO₂) and greenhouse gas (GHG) that are primarily responsible for global warming. Sustainable transportation is a significant constraint to these problems. The neo-traditional development, the compact city and the eco-city model offers sustainable transportation.

3.2.3. Density

Density is the ratio of people inhabiting or dwelling units to a specific urbanized area. It is a critical typology to affect sustainability. Because, it determines the consumption of energy, materials, land for housing, transportation, and urban infrastructure. Eco Density policy state: *“a city cannot talk seriously about sustainability without talking about density.”*

Urban designer Jan Gehl (1996) points out that low density and dispersed cities are unsustainable. People living in these cities are automobile dependent due to vehicle miles traveled (VMT). Contrary to this, Randy O’Toole (1997), public policy analyst, states that cities with increasing densities face more expensive real estate, greater road congestion and more air pollution.

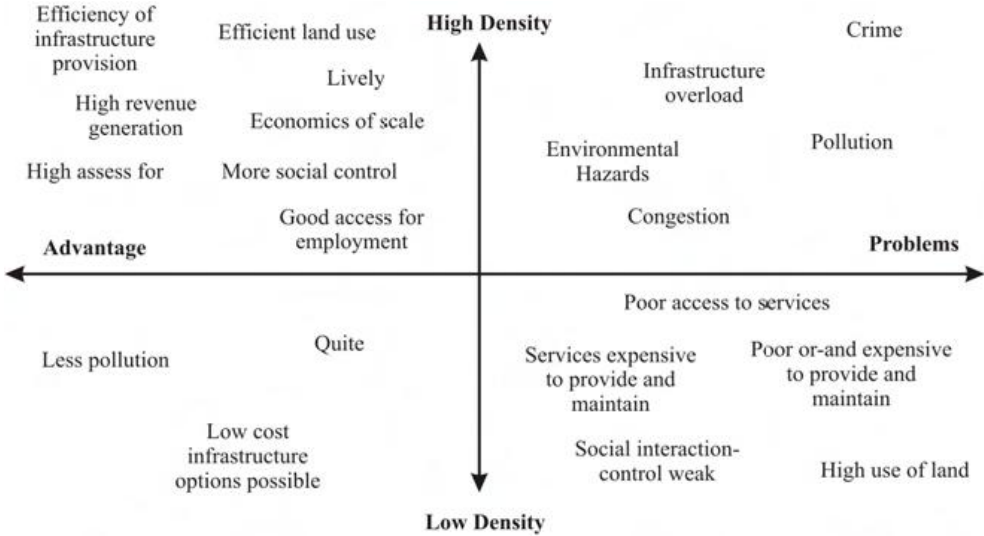


Figure 3-9 Advantages and disadvantages of high and low density

Source: Acioly & Davidson, 1996

Density is the key factor for urban sustainability. There is strong relationship between density and urban sustainability. It affects energy consumption of cities by

combating urban sprawl. It is related to other design concepts such as compactness and sustainable transportation.

Urban sprawl is inefficient land use. It is main obstacle to reach urban sustainability. Density is an effective design concept to prevent urban sprawl which has many detrimental effects on the environment. This process consumes large quantities of land, multiplies the required infrastructure, and increases the use of personal vehicles as the feasibility of alternate transportation declines. When there is an increased dependency on personal vehicles, consequentially, there is an increased demand for roads and highways, which in turn, produce segregated land uses, large parking lots, and urban sprawl. These implications result in the increased consumption of many non-renewable resources, the creation of impervious surfaces and damaged natural habitats, and the production of many harmful emissions. Segregated land use also lowers the quality of life as the average time spent traveling increases and the sense of community diminishes (Silk & Lopez, 2005).

Newman & Kenworthy (1999) indicate that there is a relationship between total energy consumption of a city and its urban density. They claim that cities with low density consume more energy than the ones with high density. Newman & Kenworthy (1999), at the book of cities and automobile dependence, show that according to comparison of 10 major cities in the US with 12 European cities, European cities are five times denser, but the US cities consume 3.6 times as much transport energy per capita.

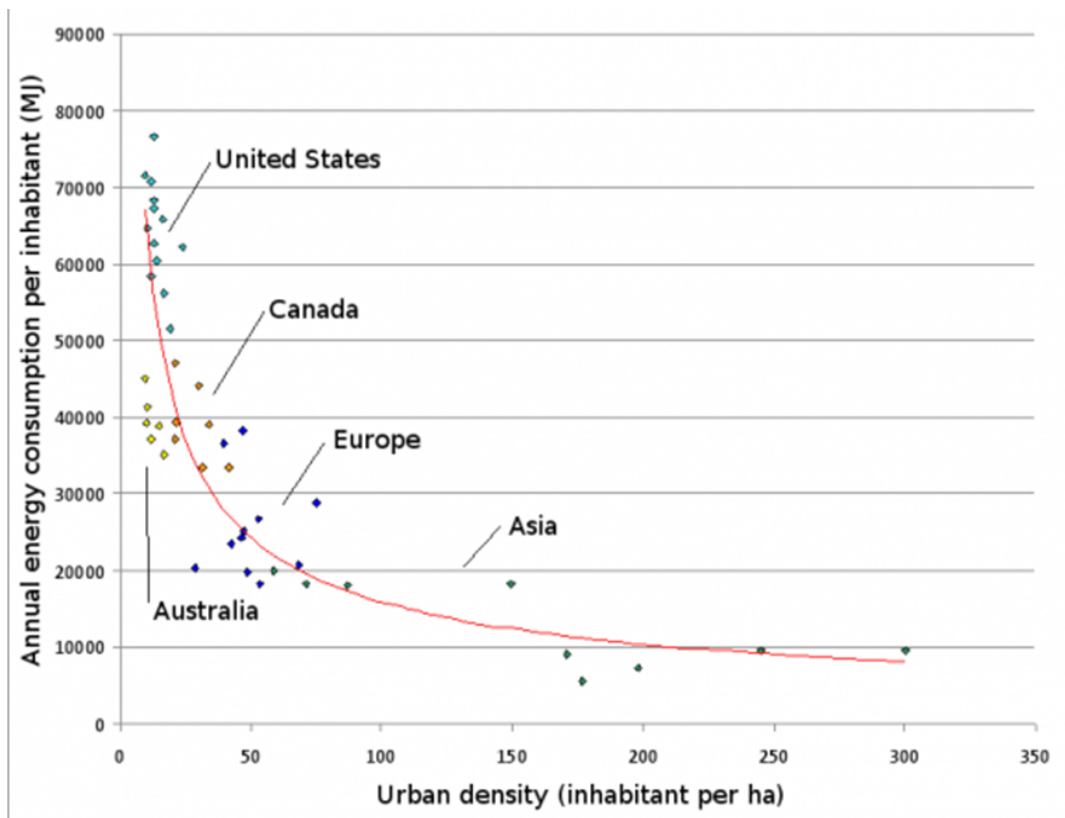


Figure 3-10 Density and energy consumption

Source: Newman & Kenworthy, 1999

Newman and Kenworthy (1999) point out that density data is related to the data of travel characteristics. European and Asian cities are denser than American cities. They state that car usage in European cities is less than half the car usage in U.S. cities. When compared to people in urban America, people in urban Europeans and Asians are nearly 2.5 to 6 times less mobile in terms of car usage.

Average travel distances in terms of their density:

- As low-density cities, North America –the U.S., Canada- and Australia average 14.7 and 12.6 kilometers.
- As the medium density cities, Europe’s average is 10.0 kilometers.
- As high-density cities, Asia averages 7.9 kilometers (Newman & Kenworthy, 1989).

Majority of urban planners support high-density development (Department of the Environment, Transport and the Regions (DETR), 1998); (Haughey, 2005); (Jenks & Dempsey, 2005); (Jenks, Burton, & Williams, 1996);(Owen, 2009); (Urban Task Force, 2005); (Williams, Burton, & Jenks, 2000). The urban containment and the compact city form offer high-density development as a design concept to reach urban sustainability.

To evaluate urban densities which differ city-to-city, Fulford (1996) citing Newman & Kenworthy (1989) and 'Friends of Earth' provides the following figures for optimal urban densities:

Table 3-6 Optimal urban densities

Source: Fulford, 1996

	GRD	NRD	Source
Public transport	30-4	90-120	Newman and Kenworthy(1989)
Walking	100	300	Newman and Kenworthy(1989)
Sustainable Urban		250-300	Friends of Earth
Central/Accessible Urban		Up to 370	Friends of Earth

GRD (Gross Residential Density): Population divided by geographical area

NRD (Net Residential Density): Excludes open spaces and non-residential land

In the thesis, discussion of the density concept is used for explaining sustainable transportation and compactness.

3.2.4. Mixed land uses

Mixed land uses are the integration of residential development with commercial, civic, and recreational uses. Population density is very high in urban area. People travel for a long distance to get from one facility to another. Therefore, increase in automobile dependency leads to increase in CO2 emission. Sustainable urban development encourages the mixed-use development including residential, commercial, institutional, recreational areas. Mixed land use may be described as the development with less traffic due to accessibility to many facilities (Breheny & Rookwood, 1993); (Owens, 1986); (Sherlock, 1991). This development decreases time travel and cost. So, it achieves sustainability by reducing CO2 emission from transportation. On the contrary, areas close to each other may lead to traffic congestion, correspondingly air pollution and noise. The Congress of New Urbanism' Charter argues that: “*Neighborhoods should be compact, pedestrian-friendly, and mixed-use*” (Congress for the New Urbanism, 2001).

Livingston et al (2003) stated that in the following table there is relationships between mixed and density built environment and automobile use.

Table 3-7 Influence of the density factor of built environment on modes of transportation in American Cities

Source: Livingston, Ridlington, & Baker, 2003

Average Daily Trips per Household				
Neighborhood Type	Households per Hectare	Automobile	Transit	Walking
Conventional Suburb	5-12	5.9	0.2	0.5
New Urban or Traditional Suburb	12-25	5.0	0.3	0.6
Mixed Density, Apartments, Townhouses	25-60	3.8	0.8	0.9
Town Center, Urban	50-125	2.9	1.3	1.4

There are three interpretations of mixed uses in sustainability arguments. First one is *varied and plentiful supply of facilities and services: a city well served by facilities, with a balance of residential and nonresidential land uses*. Secondly, horizontal *mix of uses* refers to the mix of uses within streets or neighborhoods. Lastly, *vertical mix of uses* refers to the mix of uses within individual buildings, with different uses often on separate floors (Burton, 2002).

Table 3-8 Types of mix of uses

Sources: Burton, 2002

Types of Mix of Uses	Description	Increase in the mix of uses
Varied and plentiful supply of facilities:	Balance of residential land uses.	Creation of new mixed-use settlements and neighborhoods Inclusion of facilities in new housing developments.
Horizontal mix of uses:	No zoning, mixed districts, mixed streets.	Strengthening of district centers. Sitting of commercial/retail development in residential areas.
Vertical mix of uses:	Mixed retail and housing development, mixed residential and commercial development.	New mixed-use developments. Increase in housing in city centers: living over the shop, conversion of empty office space.

According to Burton (2002), mix of use indicators are different for each interpretation of mixed uses. These are listed below.

Table 3-9 The set of mix-of-use indicators

Sources: Burton, 2002

MIX-OF-USES Variables	
Provision of facilities	<ul style="list-style-type: none"> • Number of key facilities for every 1000 residents • Ratio of residential to non residential urban land
Horizontal mix of uses	<ul style="list-style-type: none"> • Percentage of sectors containing four or more key facilities • Percentage of sectors containing all key facilities • Overall spread of key facilities
Vertical mix of uses	<ul style="list-style-type: none"> • Living over the shop: area of retail space that includes accommodation (as a percentage of total retail space) • Mixed residential and commercial uses: number of flats in commercial buildings (as a percentage of all built flats)

Grant (2002) expresses that there are three approaches to mixed-use development. These are intensity, diversity, integrability. Mixed use development can increase intensity of land uses, and can increase diversity of land uses and can integrate segregated land uses.

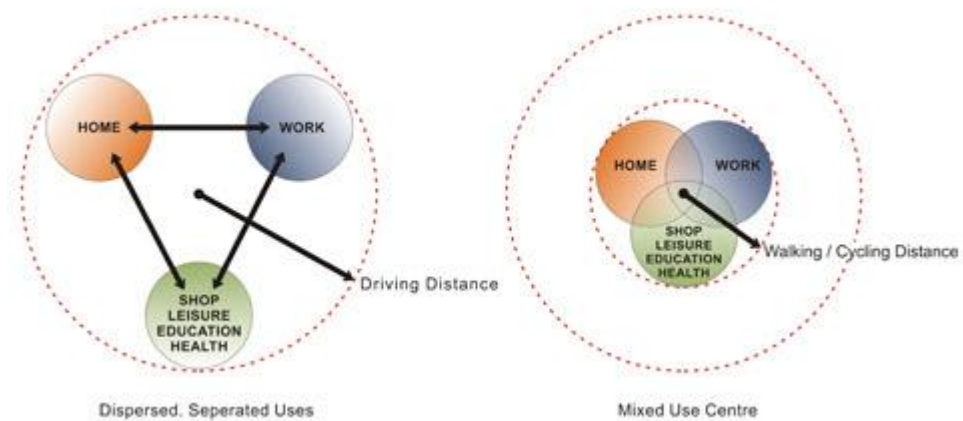


Figure 3-11 Dispersed-Separated uses and Mixed use centre

Source: Rogers, 1997

Mixed land use is linked to density and compactness. It is one of the core elements of sustainable urban development. All of the sustainable urban forms encourage mixed-use development. It is an influential factor in travel behavior. It is determined with mixed land use design concept. Mixed-use development provides a high quality of life as the average time spent in traveling decreases and the sense of community increases.

3.3. Assessment

Urban forms can have an impact on the urban sustainability. They have emerged as one of the main points of urban sustainability. Sustainable urban forms represent a major step in the sustainable urban development. They provide better environmental and living conditions.

Emergence of each sustainable urban form could deal with some urban problems. In other words, each sustainable urban form is as a solution to specific urban problems. Therefore they offer a solution to these problems by using particular design concepts. But all of the design concepts help to reach urban sustainability. The design concepts are used as a tool for evaluating the sustainability of urban. There are four

sustainable urban forms in the urban literature (Jabareen Y. R., 2006). All sustainable urban forms focus on specific design concepts. However, all of them suggest compactness, density, sustainable transportation and mix of uses. They are analyzed extensively in Chapter 3. The design concepts will be analyzed at different levels. Because, each design concept comes into play at different levels. For example, as compactness is effective at the metropolitan level, mix of uses come into play at neighborhood level. Hence, in this thesis Gaziantep will be evaluated through design concepts at the level that is effective. Sustainability indicators within a wider framework of analysis are necessary to determine whether Gaziantep has a design concept. Each design concept has specific indicators. When analyzing urban form literature, prominent indicators and related levels of design concepts are stated in Table 3.10.

Table 3-10 Sustainable design concept derived from sustainable urban forms

Design Concept	Indicator	Related Level
Compactness	<ul style="list-style-type: none"> • Urban form • Urban mobility 	Metropolitan Level
Mix of Uses	<ul style="list-style-type: none"> • Provision of facilities • Horizontal mix of uses • Vertical mix of uses 	Neighborhood Level
Sustainable Transportation	<ul style="list-style-type: none"> • Urban mobility • Energy use 	Metropolitan Level

Gaziantep is one of the cities promoting sustainable urban development in Turkey. The city is a pioneer of local climate plan in Turkey and was represented in the Rio+20 - United Nations Conference on Sustainable Development. The city of Gaziantep is a role model for other cities in Turkey. In the following chapter, Gaziantep will be evaluated in terms of urban sustainability through three core design concepts.

CHAPTER 4

A CASE STUDY: GAZIANTEP

4.1. Sustainable Development and Climate Change Mitigation in Turkey

Climate change is one of the serious issues of our time and it plays a key role in shaping our future. Generally, climate change legislation includes clean and effective energy. However, cities that are major drivers of climate change get a little attention; yet cities are more important than we think. It must be acknowledged that the urban structure of cities is the largest contributor to the climate change. Hence, historical development of urban spatial structure is important to evaluate cities in terms of urban sustainability. Following passage gives general information about the historical development of Turkish cities with regard to urban sustainability.

Traditional Turkish cities (ottoman cities) were influenced by several civilizations because of geographical location. According to Cerasi (1999), the cities demonstrate sensitivity to local topography and respect to nature. Turkish cities consist of neighborhoods (mahalle). The ‘neighborhoods’ were the settlement units of old Turkish cities. They include the same organization principles and they were the basis of the social organization of the Ottomans (Aru, 1996). In ottoman period, buildings reflecting locality were seen in neighborhoods, although there were monumental buildings due to central authority. The streets had a hierarchical order and were mostly pedestrian. Presence of house with a courtyard reveals close relationship with nature (Kuban, 1986). Turkish traditional city is a good example of integration between environment and architecture, In other words, “design with nature” (Oktay, 2004). Following the proclamation of the republic, The Province Bank was founded in 1933 and Turkey initiated planned urbanization; ‘Jansen Plan’ for the new capital Ankara between the years 1932 and 1956, the ‘Henry Prost Plan’ for Istanbul between 1937 and 1951. Furthermore, Housing Development Administration of

Turkey (TOKİ) and several municipalities were established. They produced development plans for Anatolian cities (Kubat, 2009). Process of urbanization in Turkey started in 1950s. After that time, problem of squatting was emerged. Squatters with minimal basic infrastructure offer poor life quality for those who live there. Although, sustainability has been common among European cities since 1960s, Turkey become familiar with the term of sustainability after United Nations Conference on Human Settlements (Habitat II) held in Istanbul in 1996. First attempts of eco- villages were based on mid-1990s in Turkey. There have been very few example of sustainability in urban scale. Concept of sustainability was used just in architecture. The majority of the projects were not based on the concept of "sustainability" as a starting point. They were structures that applied the principles of sustainable design unconsciously (Arsan, 2008).

According to UNEP, Climate Change Mitigation refers to efforts to reduce or prevent emission of greenhouse gases. Turkey should take urgent action for this. IPCC stated that;

“At the present time total annual emissions of GHGs are rising. Over the last three decades, GHG emissions have increased by an average of 1.6% per year1 with carbon dioxide (CO2) emissions from the use of fossil fuels growing at a rate of 1.9% per year. In the absence of additional policy actions, these emission trends are expected to continue” (IPCC, 2007).

“...Atmospheric CO2 concentrations have increased by almost 100 ppm in comparison to its preindustrial level, reaching 379 ppm in 2005, with mean annual growth rates in the 2000–2005 periods that were higher than those in the 1990s. The total CO2 equivalent (CO2-eq) concentration of all long-lived GHGs is currently estimated to be about 455 ppm CO2-eq, although the effect of aerosols, other air pollutants and land-use change reduces the net effect to levels ranging from 311 to 435 ppm CO2-eq” (IPCC, 2007).

United Nations Framework Convention on Climate Change (UNFCCC) points out present climate change effects as rising summer temperatures, reduced winter

precipitation in the western provinces, loss of surface waters, greater frequency of droughts, land degradation, coastal erosion, and flooding (UNFCCC,2007).

The effects of climate change mentioned above felt in Turkey. IPCC Fourth Assessment Report (2007) stated that, in the Mediterranean Basin, temperature increased by 1°C - 2°C. Aridity, heat waves and number of very hot days will increase. For Turkey, average temperature increased around 2.5°C - 4°C, reaching up to 5°C in inner regions and up to 4°C in the Aegean and Eastern Anatolia. On the other hand, The IPCC report demonstrates that in near future, Turkey will be unstable in terms of precipitation patterns (IPCC, 2007). Precipitation will decrease in the period 2071-2100 with respect to 1961-1990 in Turkey. Annual precipitation is estimated to decrease by about 5 percent in 2030. In 2050, annual precipitation will decrease by approximately 10% (Güven, 2007).

Turkey's energy consumption is constantly increasing as it has a developing economy. Turkey's carbon dioxide (CO₂) emissions have grown along with its energy consumption. Total greenhouse gas emissions as CO₂ equivalent increased 124% in 2011 compared to the 1990's emission. CO₂ emission per capita was 5, 71 tons in 2011, while it was 3, 42 tons for the year 1990.

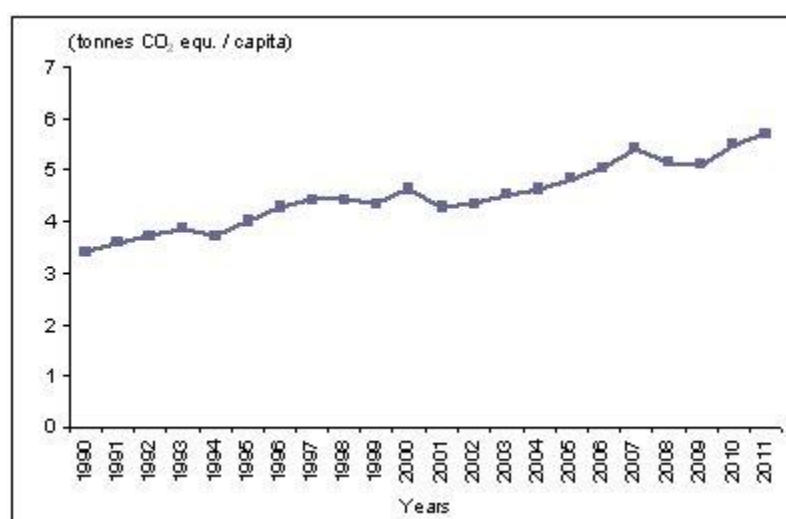


Figure 4-1 Greenhouse gas emission *per capita*, 1990-2011

Source: TUIK, 2013

The anthropogenic greenhouse gases are regulated under the The Kyoto Protocol in the United Nations Framework Convention on Climate Change (UNFCCC), the international treaty which came into force in 2009 in Turkey. According to The Protocol, developed countries will reduce their GHG emissions below the levels specified for each of them in the Treaty within a five-year time frame.

“Turkey achieved 171 per cent increase in GDP between 1990 and 2008. The growth rate of Turkey was 9 percent in 2010 and 8.5 in 2011. The population of Turkey is currently around 75 million. It has increased 27 per cent since 1990. Turkey’s per capita GHG emissions is 5.09 tons (2009), one third of the OECD and half of the EU average. The share of Turkey in global cumulative greenhouse gas (GHG) emissions since the year 1850 is 0,4 per cent. Turkey’s GHG emission has almost doubled between 1990 and 2009, increased from 187 million tons to 370 million tons. However, Turkey has reduced its GHG emissions 20 per cent from the business as usual scenario starting from the year 1990 by only domestic measures and resources” (MFA, 2011).

According to Turkish Statistical Institute, the overall greenhouse gas (GHG) emission as CO₂ equivalent for the year 2011 was 422.4 million tons. The energy sector had the largest portion with 71% of overall 2011 emissions. The energy sector was followed by industrial sectors with 13%, the waste with 9% and the agricultural activities with 7%.

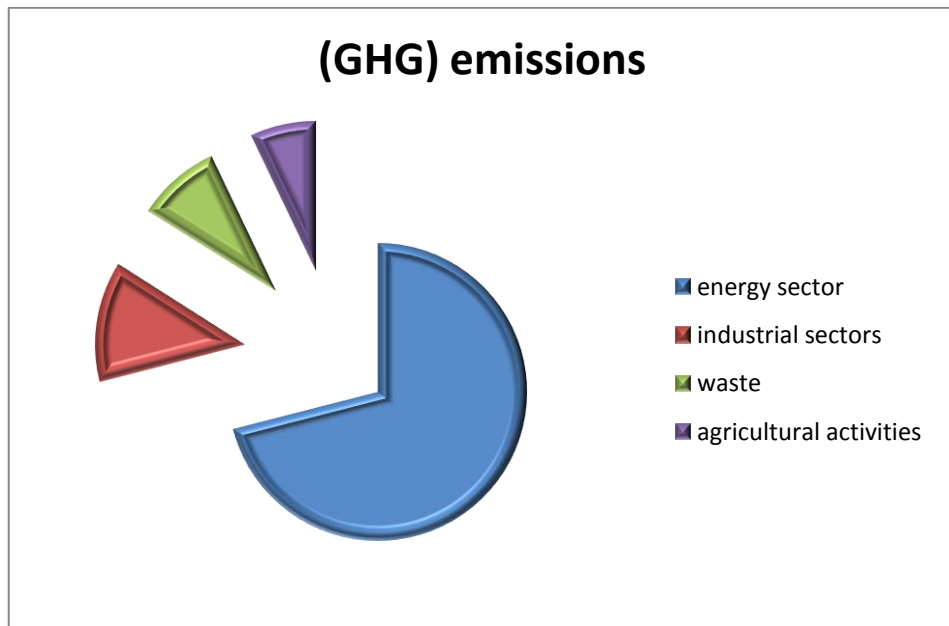


Figure 4-2 GHG emission of Turkey

Source: TUIK, 2013

Turkey's First National Communication on Climate Change was held in 2007. It indicates the impacts of climate change in Turkey as; increasing summer temperatures, decreasing winter precipitation in western provinces, loss of surface water, increased frequency of droughts, land degradation, coastal erosion and floods (MEU, 2011).

Turkey began to take measures against the impacts of the climate change. Turkey's Ninth Development Plan (2007- 2013) states that

'Within the scope of Turkey's circumstances, a National Action Plan setting greenhouse gas emissions decrease policies and measures with the participation of all related stakeholders will be prepared to fulfill her commitments under the UN Framework Convention on Climate Change' (SPO, 2006).

National Climate Change Strategy for Turkey, approved by the Higher Planning Council, entered into force in 2010. In this strategy, The National Vision is described as:

“Turkey’s national vision within the scope of “climate change” is to become a country fully integrating climate change-related objectives into its development policies, disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts for tackling climate change within its “special circumstances”, and providing its citizens with a high quality of life and welfare with low-carbon intensity” (MEF, 2010).

Cities and Climate Change, a global report on human settlements of UN-HABITAT published in 2011 indicated that; *“World’s cities are responsible for up to 70 per cent of harmful greenhouse gases while occupying just 2 per cent of its land”*. Hence, local authorities play a vital role in mitigating climate change. When assessing policies to combat climate change at the local level; Gaziantep is a pioneer because in Turkey, it has the first wide analysis of GHG emissions. Possible future mitigation and adaptation policies of Gaziantep are determined. Climate actions plan of Gaziantep states that CO₂ per capita will be reduced in 2023 and will reach a level of 3.00. At the same time, 15% reduction in energy consumption per capita in 2023 is expected.

Gaziantep’s GHG emission balance is equivalent to 4,560 ktCO₂e, and is about 3.52 tCO₂e per capita. Sum of the residential and transport sector had the largest portion with 45% of overall 2011 emissions. Gaziantep’s greenhouse gas emission by sector is shown below:

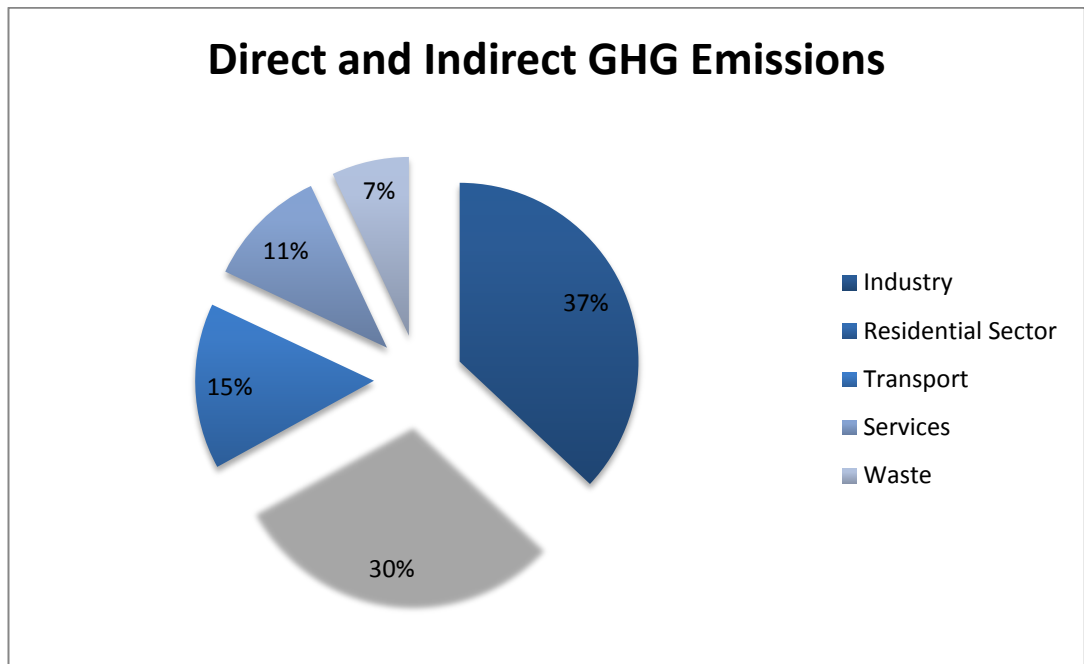


Figure 4-3 Direct and Indirect GHG emission

Source: AFD, 2011

Gaziantep is the fastest-growing province in Turkey; with a 4.25% yearly population growth rate between years 1990–2010. According to new city plan, population is expected to reach 3 million people in 2030. Most of this growth generated spontaneous urban growth. This rapid growth is creating serious problems. Contributing climate change depending on increasing energy demand is one of these problems (ECA, 2011). In 2011, Gaziantep was a pioneer of local climate plan in Turkey. The city is a role model for other cities.

Table 4-1 Population Dynamics in the Largest Turkish Cities

Source: *World Gazetteer* and authors' calculations

Rank	Name	1990 Population	2010 Population	Compounded Annual Growth
1	Istanbul	6,629,431	12,175,592	3.09%
2	Ankara	2,583,963	4,082,184	2.31%
3	Izmir	1,758,780	2,815,046	2.38%
4	Bursa	834,576	1,567,756	3.20%
5	Adana	916,150	1,491,066	2.47%
6	Gaziantep	603,434	1,388,004	4.25%
7	Konya	513,346	950,645	3.13%
8	Antalya	378,208	809,437	3.88%
9	Kayseri	425,776	796,291	3.18%
10	Mersin	422,357	629,224	2.01%
	TURKEY	56,086,184	75,960,383	1.53%

According to Climate Actions Plan of Gaziantep (2011), management of urban renewal, planning for urban sprawl, the indirect intervention is important issues to reduce GHG emission and provide more sustainable urban life.

Generally, cities that have unplanned incremental urban development are part of the climate change problem. Design concepts related to sustainable urban forms offers the best solution for this problem. They help us to design cities not only at existing neighborhoods but also at new development areas in terms of urban sustainability.

Gaziantep is an ever-expanding city due to immigration. Thus, it must be designed according to design concept related to sustainable urban forms to reduce energy demand correspondingly reducing negative effects of climate change. Design

concepts related to sustainable urban forms are required to achieve sustainability. These core concepts as stated above are compactness, sustainable transport and mixed land uses. In this section, Gaziantep will be assessed in terms of urban sustainability through the design concepts.

4.2. General Information about Gaziantep

Gaziantep, one of the first settlements in Anatolia and the sixth biggest city in Turkey, is the biggest city in southeastern Turkey. In 2013, The Population of Gaziantep was 1.840.103 (TUIK, 2012).

According to (Kurian, 2001), Gaziantep is one of the oldest inhabited cities in the world. First known settlement in the Gaziantep was Doliche city at BC 1700. Doliche was located in the northern part of Gaziantep. The ruins of many ancient settlements like Hellenistic, Roman and Byzantine periods have reached today. Gaziantep passed into the hands of Turks at the beginning of the 19th century. During the national struggle, the city was received the title of “Gazi” due to success (Governorship of Gaziantep, 2010).

Gaziantep is located at a special location. The city is located between the Mediterranean Sea and the Mesopotamian region and was placed at the center of historic crossroads, connecting east to south and north to west, and along the Silk Road. Hence, Gaziantep has hosted many cultures throughout history and it contains structures and artifacts from following periods and civilizations: Paleolithic, Neolithic, Chalcolithic Copper Age, Bronze Age, Hittite, Median, Assyrian, Persian, Hellenistic (Alexander the Great), Roman, Byzantine, Abbasid, Seljuk and Ottoman. Thanks to this strategic location, Gaziantep becomes a traditional market center. During the Ottoman Empire period, Lazkiye and Halep were trade centers. Antep had close ties with Halep and was being used as a transit centre in order to reach Halep (Alpargu, 1999). In the fifteenth century, the city was a developed city, called the “Small Buhara”, because of being a city centre of culture and commerce in the region. In the nineteenth century, the city was become the centre of weaving industry (Göyünç, 1999). Today, Gaziantep plays an important role in the Turkish economy

with its industrial and commercial infrastructure. Gaziantep's export figure was 5.9 billion dollars in 2012. Exports increased by 19% compared to the year 2011. Gaziantep is currently doing trade with 172 countries in the world and is the 6th ranked in the highest amount of exports among Turkish cities.

Table 4-2 Export Rank Data

Source: Gaziantep Chamber of Commerce, 2013

Rank	Province	Exports in 2012
1	İstanbul	60.999.030
2	Kocaeli	13.080.861
3	Bursa	11.916.551
4	İzmir	8.484.258
5	Ankara	6.550.267
6	Gaziantep	5.879.414

According to the socio-economic index determined by Ministry of Development (previous name was State Planning Organization) Gaziantep was 33th within 81 provinces in terms of development level in 2010 ranking. Gaziantep contributed to Turkey's economy with 1, 4% of the country's total GDP. Gaziantep's GDP was 2,093 million\$ in 2001 (MOD, 2003). Furthermore, Gaziantep, the basis of development of GAP with its industry and trade volume and also an entrance gate of GAP in terms its geography, influences 18 cities around it economically (TUIK, 2012).

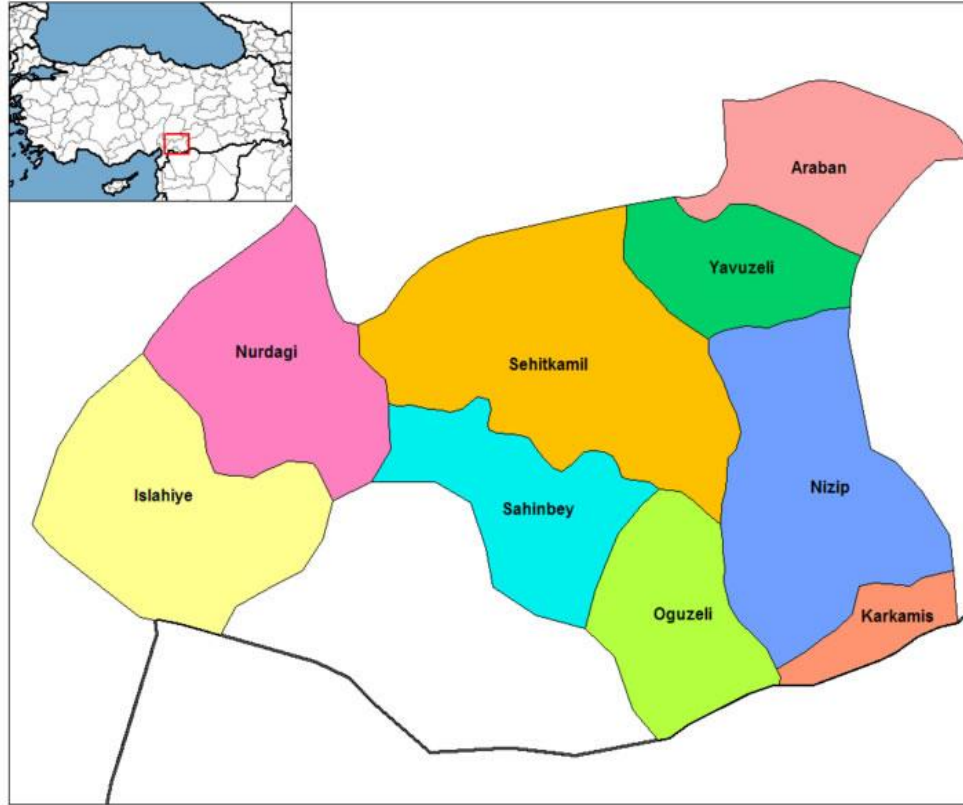


Figure 4-4 Map of Gaziantep

Source: <http://www.uyduharita.org/wp-content/uploads/gaziantep-haritasi-1.png>

Gaziantep is the sixth largest city of Turkey and the largest one in the Southeastern in terms of population. With its 6845 km² territorial area, the province covers around 1% of the total area of Turkey (TUIK, 2012). The population of the province of Gaziantep was 1,700,763 in 2010 according to Address Based Population Registration System. 1,501,566 of Gaziantep's population live in urban areas and 199,197 people live in towns and villages. While the percentage of Gaziantep's population that lives in urban areas is 88%, the percentage that lives in town and villages is 12%. As the central population of the city is 1,341,054, the province's population density is 249 (people per km²). The largest counties are respectively, Gaziantep, Şehitkamil, Nizip and Islahiye in terms of population. The largest county in terms of land area is Şehitkamil and Karkamış is the smallest county in terms of population and area. Gaziantep has 9 county, 22 municipalities

and 438 villages. Urbanization rate in Gaziantep in terms of annual population growth rate is above the average growth rate of Turkey (TUIK, 2012).

Table 4-3 Information about Gaziantep and Turkey

Source: TUIK, 2012

	Gaziantep	Turkey
Total Population	1,501,566	75.627.384
Provincial and District Capitals	1,341,054	58,459,968
Urban Population Rate	88%	77,3%
Rural Population Rate	12%	22,7%
Population Density	249 people per km ²	98 people per km ²

Gaziantep is in the second place (after Istanbul) in Turkey according to population growth rate between 2000 and 2010. According to TUIK (Turkish Statistical Institute) data, by the year 2023, the population of Gaziantep is predicted to be 2.257.278 because of the high fertility and emigration rate (TUIK, 2012).

Gaziantep is one of the fastest growing cities in Turkey. Generally unsustainable urban activities of fastest growing cities are blamed for high levels of greenhouse gas emissions and best places to begin to combat negative effects of climate change. It also implies environmental degradation, lack of urban services and infrastructure. Hence, cities have to be more environmentally sustainable. Gaziantep is one of the

pioneer cities of sustainable urban development in Turkey. The city continues to make solid progress toward becoming more sustainable.

This paper examines the underlying interactions and relationships between sustainable urban form and design concept that derived from sustainable urban forms. It focuses on core design concepts particularly within the context of mitigation of adverse climate change effect. This thesis also presents sustainable development as a solution to reduce the intensifying impact of climate change on cities. Whether urban progressing of Gaziantep is sustainable or not is the primary focus of this paper. Forthcoming section highlights progressing of urban sustainability in Turkey in terms of climate change mitigation by conducting in-depth interviews and literature review.

4.3. Evaluating sustainability through urban core design concept

4.3.1. Compactness

Compactness contributes to urban sustainability. It is considered as a solution to the unsustainable nature of cities and one of the best ways to fight urban sprawl described as uncontrolled growth of city. Gaziantep is one of the oldest settlements in Anatolia. Its population growth began with the migration from rural to urban in 1950s. According to data of Turkish Statistical Institute, while Gaziantep had a population of nearly 120.000 in 1970s, the population grew to over 1.75 million in 2012. Gaziantep's population growth continued in 2013 due to Syrian refugees. Population growth is the most significant factor effecting urban sprawl.

Table 4-4 Gaziantep's Population through years

Source: TUIK, 2012

(1980-2012)									
Year	1980	1985	1990	1997	2000	2007	2008	2010	2012
Population	808.697	966.490	1.140.594	1.127.686	1.385.249	1.560.023	1.612.223	1.700.763	1.799.558

When historical development of Gaziantep is analyzed, four major master plans draw attention. First master plan of Gaziantep was made by Herman Jansen in 1938.

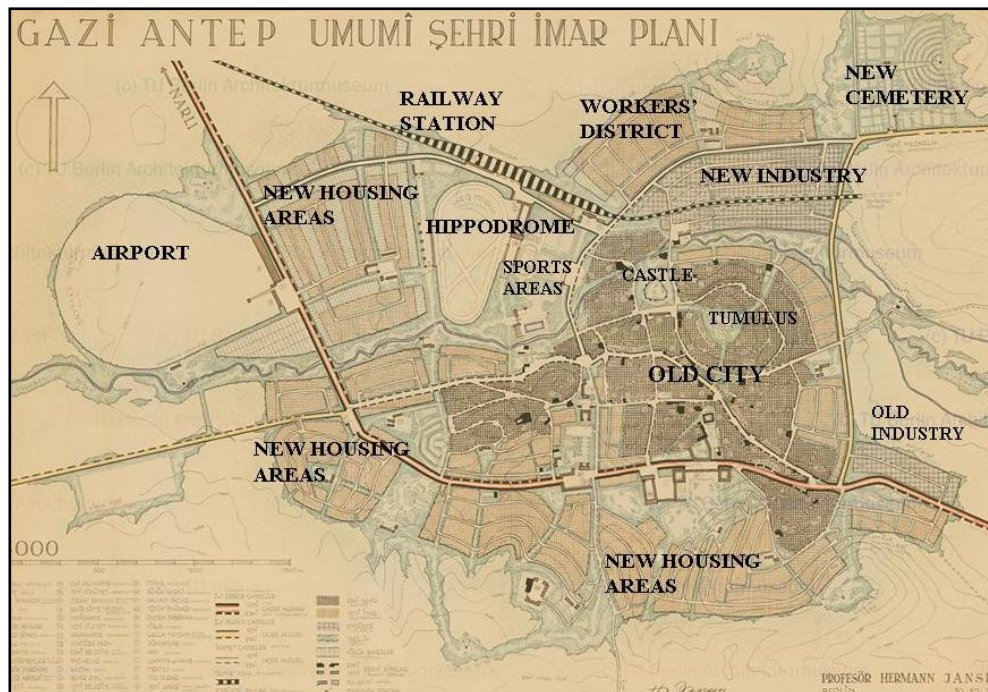


Figure 4-5 Gaziantep urban plan, zoning and spatial arrangement

Source: <http://www.europeana.eu>

Gaziantep Plan had more specification when compared to other Herman Jansen's plans like Adana and Mersin plans. It had spatial arrangement and abundance of spaces of socialization and recreation. The plan includes two important purposes. The first one is the railway connection to the city in the northern part of old city. Secondly, widening highway to Aleppo in south of the old city along east-west direction. According to Herman Jansen's plan, Gaziantep was divided into three zones. Generally, the boundary of zones was determined by railway route, Aleppo highway, sports district (including hippodrome) and Alleben stream which is passing along the north of old city. Industrial development and Workers' District in the northern part was disconnect from the old city by Alleben stream and railroad. The plan offers that the southern and western part of old city was used for new housing development. Housing units were identified as three-storey garden houses and administrative center was located in the old city between Aleppo highway and Alleben stream which is an intersection between greenbelt and the old city(Karakaya, 2012).



Figure 4-6 Gaziantep's new governorship building and the official parade area

Source: Architecture Museum TU Berlin, Inv. Nr. 23410 and 23412

The plan emphasized Castle and tumulus (Türk Tepe) by greenery. Alleben stream, as the natural asset of city, was designed as a recreational corridor both separating and integrating old city and new city. Topographic elements were handled as a design tool especially for arrangement of new housing areas in the southern part (Karakaya, 2012).

According to Akcan (2009), high rise blocks were not offered by Herman Jansen; he proposed a height limit of three storeys for bigger towns such as Gaziantep. Furthermore, while housing blocks for six families were proposed for workers' neighborhood, single family houses with a garden was proposed for the rest. Jansen developed a separate residential area for workers in all his plans for Turkish cities.

Gaziantep's population was approximately 50.000 in 1938 when the plan was applied. Then, Jansen estimated that city population would be 150.000-200.000 in 1950. However, city population was just 70.000 in 1950 (CRP 401-402 Planning Studio Analyses, 2012). One of the basic concerns of Jansen plan can respond to the growing population within the borders of urban development area. Jansen states that a city should not exceed beyond the limits of walking distances and urban expansion is very dangerous regarding security conditions (Jansen, 1937). Jansen designed Gaziantep as a compact city but his estimation of population and macro form growth was not succeeded.

After his arrangement for Gaziantep, Kemal Ahmet Aru ve Kemali Söylemezoğlu have generated a new urban plan for the city in 1950. They emphasized traditional urban values of the city and road system (IKA, 2013).

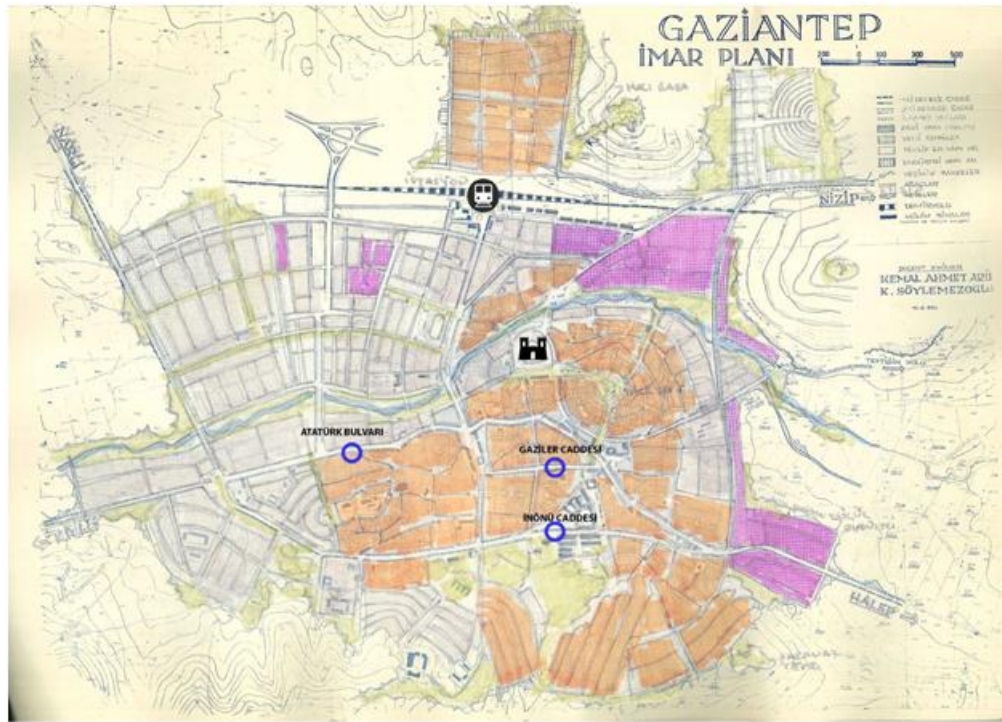


Figure 4-7 Gaziantep urban plan, zoning and spatial arrangement

Source: MMG

While working areas were placed in the northeast of Nizip road and in the southeast Halep road, the Alleben were surrounded by recreation and green areas. City center started to gain a modern quality. Gaziler Street was renewed. Roads in the old part of the city were suitable for motor vehicle traffic. City development towards areas in the west and the southeast of the city has been envisaged. Parallel to this, growing of the city shifted to the Atatürk Boulevard, İnönü Street and Akkoyunlu Street (Ay, 2001).

In 1950s, Gaziantep had an estimated population of 104,000 (UN, 2012). Gaziantep met relatively high-rise apartments and slums, for the first time in history, because of increase in population and accelerated urbanization with migration movements between 1950 and 1960. Population of Gaziantep increased unexpectedly. This sudden population increase led to increase in housing and working place demand. In the second development plan of Gaziantep, though new residential areas are

separated from old city, low-rise multi-storey buildings within the old city texture collapsed and city was refreshed with new structures (IKA, 2013). These developments led the plan to be insufficient.

Between 1960 and 1975, 40 new neighborhoods were developed in Gaziantep. Most of them were out of planned areas (Ay, 2001). These new neighborhoods led to increase in unqualified construction of residential and business areas. It caused uncontrolled expansion into rural areas.

Third development plan of Gaziantep was prepared by Zühtü Can to meet new needs of the city. The city's development until the 1990s tried to be led by the decisions of this plan. The foreseen year was 1995. The plan's population estimation was 1 million. According to Zühtü Can Plan, new development areas were expanded. Plan was prepared as 8010 hectares (Ay, 2001). However population projection for 1995 failed. The city population remained quite behind the estimations. Then, the urban population increased very quickly and city development into unplanned areas continued. These unplanned parts of the city were applied thorough additional plans which are done disconnectedly from the whole city. Hence, the proliferation of the unhealthy and unplanned city parts speed up. Between 1974 and 1989, Gaziantep, which had 8100 hectares of planned areas, had 31.394 hectares of adjacent area (Ay, 2001).

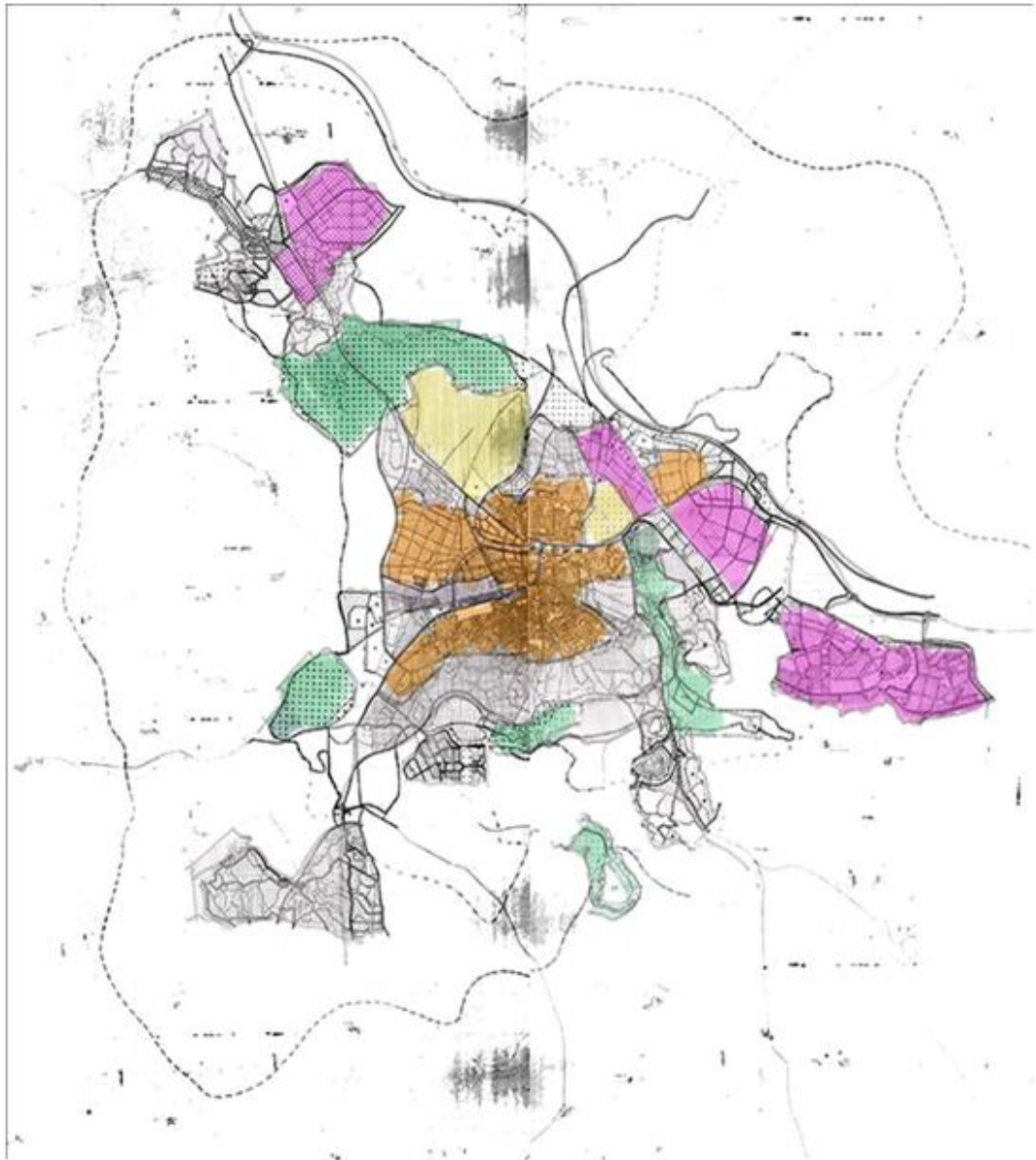


Figure 4-8 Gaziantep's third city master plan

Source: MMG

Due to problems of squatter housing, local master plans, squatter constructions spreading, increase in neighboring areas, and considering city's needs, fourth city master plan was prepared by Oğuz Aldan in 1990. In Oğuz Aldan's plan, the target year was 2005; and the population of the city was assumed to reach 1.800.000. This

plan offered that city's planned areas increased from 8.000ha to 21.000ha (Ay, 2001).

According to this plan, İbrahimli and Kızılhisar, areas on the North and South of the city, were planned as residential areas to meet housing needs of the inhabitants.

While urban population was approximately 71.000, the population has increased 15 times in 46 years. After 1990, thanks to the plans, planned housing area was increased from 4.500ha to 7.400ha. Industrial areas, the dominant sector in the development of the city, increased from 1800 hectares to 2250 hectares in the city plan of 1990. Traditional center -Gaziler Street, Mütercim Asım Street, Şihcan Street, Hal Region- changed into its original qualities. A new commercial center called GATEM (Gaziantep Trade and Industry Center) was created as nearly 40 hectares in the east part of the city (Ay, 2001). Population estimates are exaggerated. In 1994, Population of Gaziantep did not reach 1.000.000 and also it was not 1.800.000 in 2005. Due to incorrect population estimates, many areas were zoned for construction in the city. This caused uncontrolled expansion of the city.

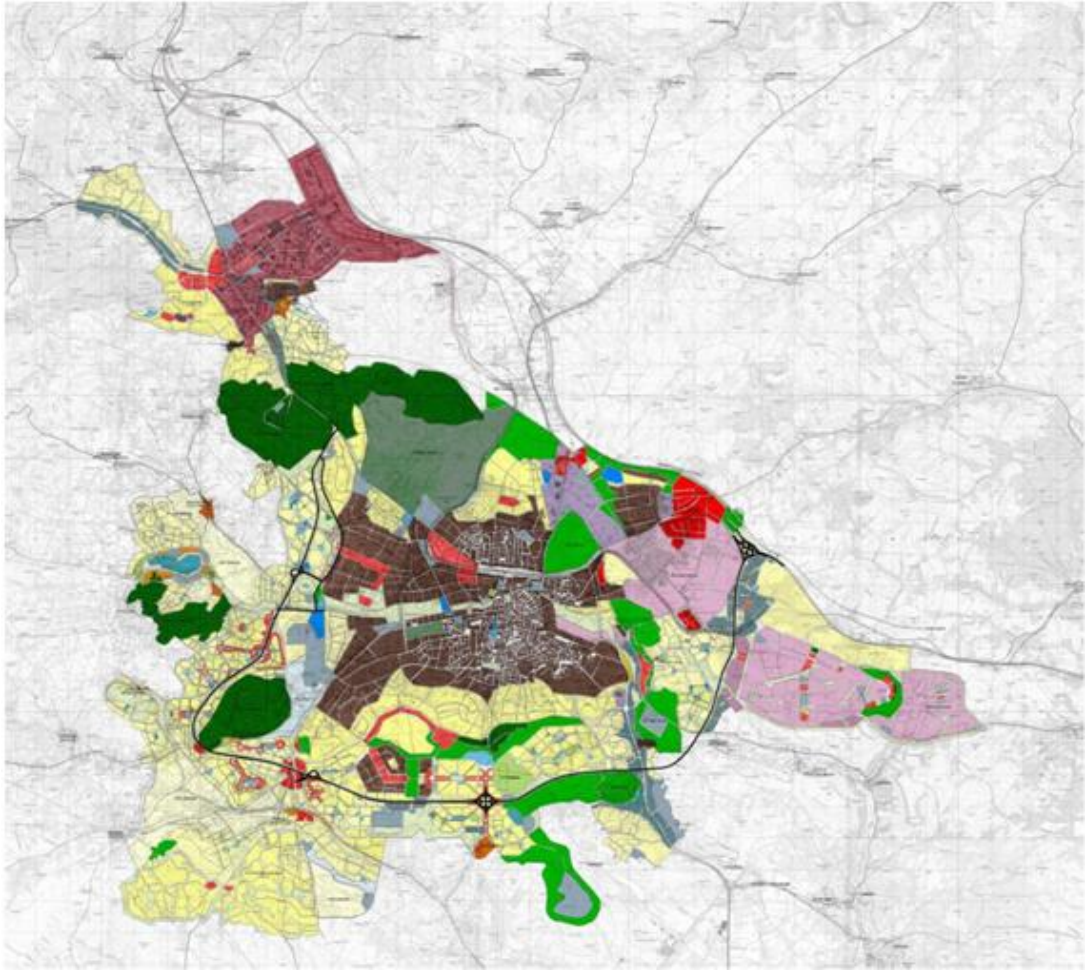


Figure 4-9 Gaziantep's fourth city master plan

Source: MMG

Gaziantep has a lot of additional master plans apart from four city master plans because of increasing urban population. In additional plan in 1980, Göllüce Mass Housing Area was planned for Afghan immigrants who run away from the war. However, local people settled in that area instead of Afghan immigrants. Bağlarbaşı Mass Housing Area (1990 Additional Master Plan) was planned for the immigrants that came from the southeastern Anatolia and the eastern Anatolia because of the terrorism in 1990s. Serice Mass Housing Area (1993 Additional Master Plan) is in the south and southwest side of the city. Although some of the areas that were opened with 1990 Additional plan were completely empty, 1993 Additional Master

Plan was prepared by municipality. 1998 Additional Master Plan was prepared to gentrify the existing squatter housing areas. This plan includes Taşlica Mass Housins Area and Safa şehir Mass Housing Area which is near the industry. 2002 Additional Master Plan includes the west side of the city that is well connected to the industry areas and to the city center with wide and regular road patterns. This area was planned for people with the high income who want to escape from the negative effects of the city. 2003 ring road additional and revised master plan offers 10.000 square meters of area nationalized due to the difference between two road route decisions. After The Law of Metropolitan Municipality, administrative structure of the municipality changed. Municipal borders of the city increased from 65.000 ha to 158.400 ha. 2004 Additional master plan includes areas close to the highway and terminal and also well connected to the industry and the city center. Areas close to the city center and the industrial areas were planned with 2005 Additional Master plan. This plan aims to contribute to the city's prestige. Bozdağ village was zoned for the urban rent. The area has not well connected to the industry areas and to the city center and is not appropriate for urban rent. Government policies resulted in changing the shaping of the urban macro form. It also caused urban sprawl with unplanned additional master plans.

Especially after 1980's, with the influence of the neoliberal policies, rapid changes have come out in urban areas. One of these changes is urban sprawl in metropolitan areas in Turkey. This growth pattern includes low-density, leap frog, scattered and sprawling development that experienced especially around rural settlements. As a result of the neoliberal policies and the additional development plans which have opened extensive amount areas to development, sparse urban areas have increased in Gaziantep (Kaçar, 2008).

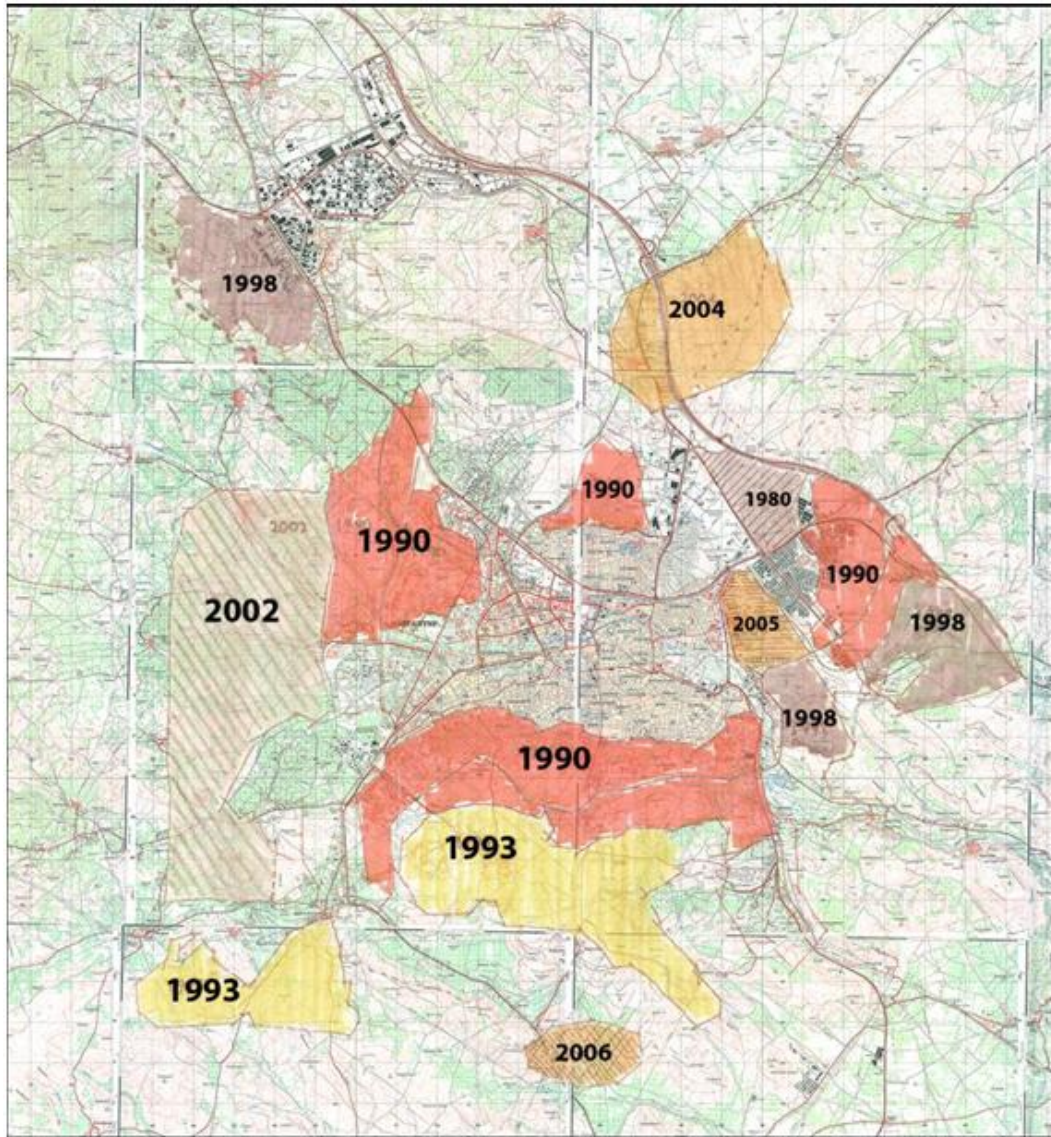


Figure 4-10 Additional Master Plans of Gaziantep

Source: MMG

Compactness can be evaluated with the distance between residential areas and the city center. It can be interpreted by observing how this distance has evolved in time. Therefore, sprawl cities grew more than compact city in terms of distance. When additional plans are examined, this distance increased between 1980 and 2006. The new development areas are far from the city center. It causes increase in car dependency. According to Turkish Statistical Institute, while there were 210.773 cars

in 2005, in 2011 there were 349.139 cars in Gaziantep. These data may be shown as evidence of urban sprawl.

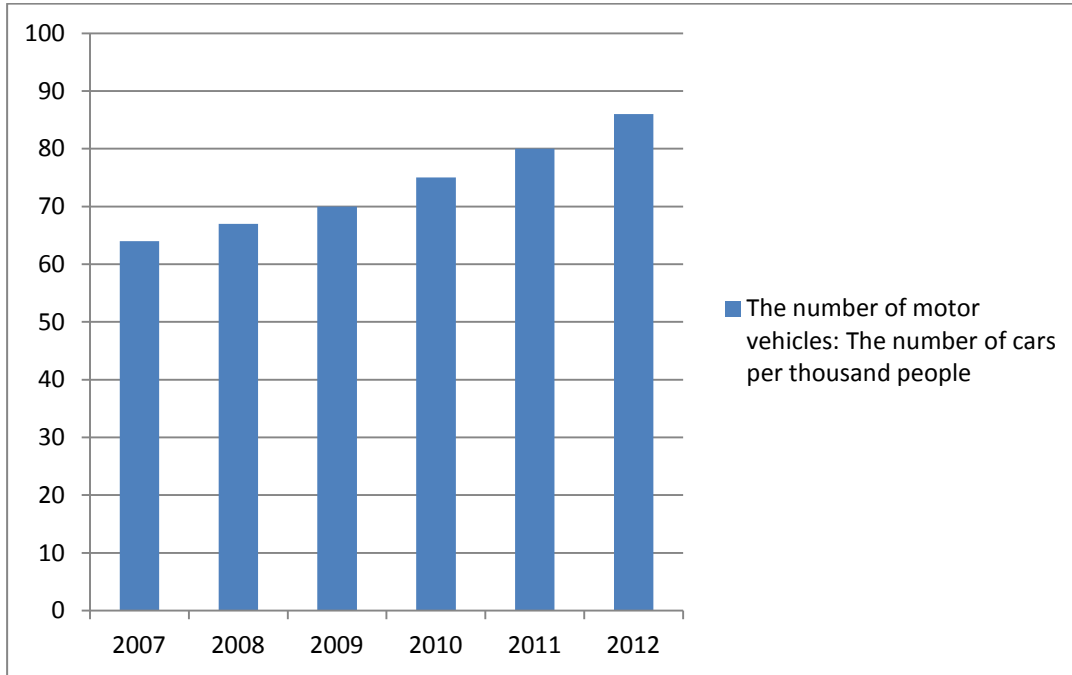


Figure 4-11 The number of motor vehicles: The number of motor vehicles per thousand people in Gaziantep

Source: TUIK, 2012

As seen from the above figure, there was a significant increase in the number of motor vehicle per thousand people. This means that the average growth rate of urban population is lower than the rate of increasing number of motor vehicles. This increase may help to interpret urban sprawl. According to 2013 data, in Turkey, the number of motor vehicles has increased 108.1 % in the past 14 years to reach 17 734 673 by the end of September. This growth rate of vehicle numbers in Turkey affected the growth rate of vehicle numbers of Gaziantep. According to TUIK (2013)⁴, Gaziantep that has number of motor vehicles 399 167, came in ninth position among Turkish cities in 2013. Besides, while there is nearly one car for

⁴ This results calculated as the total number of motor vehicles divided by the total population

every nine people in Turkey; approximately one of every twelve people has a car in Gaziantep in 2012. However; while this rate is one car for every six people for Muğla, there is nearly one car for every five people for Ankara. Gaziantep, with ever-increasing number of vehicles on the road, still has relatively small number of motor vehicles compared to Turkey's average, Ankara and Muğla.

Population density should be used as a compactness indicator. When evaluating in terms of population density, as seen in Table 9.2, Gaziantep's population was 427.017 and the population density was 53.31 per/ha in 1974. After nearly twenty years, the city reached a population of 821.127 dispersed on about 21000 Ha, with an average density of 39.10 p/ha. In 1990, density degree decreased significantly due to the influence of the neoliberal policies, rapid changes come out in urban area. In Gaziantep, decentralization became influential till the 1990s. In 1990, density decreased. However; in 2006 urban density reached to 43.30 p/ha because of rapid population growth and the rate approached to the European standard.

Table 4-5 Land Use Area and Population Density

Source: MMG

Year	Land use Area	Population Urban	of Population Density
1974	8010 Ha	427.017	53.31
1990	21000 Ha	821.127	39.10
2006	37.000 Ha	1.342.518	43.30

By comparing the density measure of Gaziantep with world cities, we can position the compactness degree of the city. The density is significantly high than some world cities.

Table 4-6 Intensity of land-use in global cities

Source: Newman & Kenworthy, 1999

City	Population
San Francisco	16.0
Los Angeles	23.9
Detroit	12.8
Boston	12.0
New York	19.2
AMERICAN AVG.	14.2
Canberra	9.5
Melbourne	14.9
Sydney	16.8
AUSTRALIAN AVG.	12.2
Vancouver	20.8
Toronto	41.5
CANADIAN AVG.	28.5
Brussels	74.9
Stockholm	53.1
Copenhagen	28.6
Paris	46.1
Munich	53.6
Amsterdam	48.8
London	42.3
EUROPEAN AVG.	49.9

Table 4-6 (continued)

Kuala Lumpur	58.7
Singapore	86.8
Tokyo	71.0
Bangkok	149.3
Hong Kong	300.5
ASIAN AVG.	161.9

It is important that density indicators should not direct us to such an interpretation that Turkish cities have the same compact character with European cities. While European cities have expanded within limited diameter, Turkish cities have followed leap-frogged development pattern within an ever-expanding diameter (Çalışkan, 2004). In this sense, Gaziantep has also experienced this pattern of urban development.

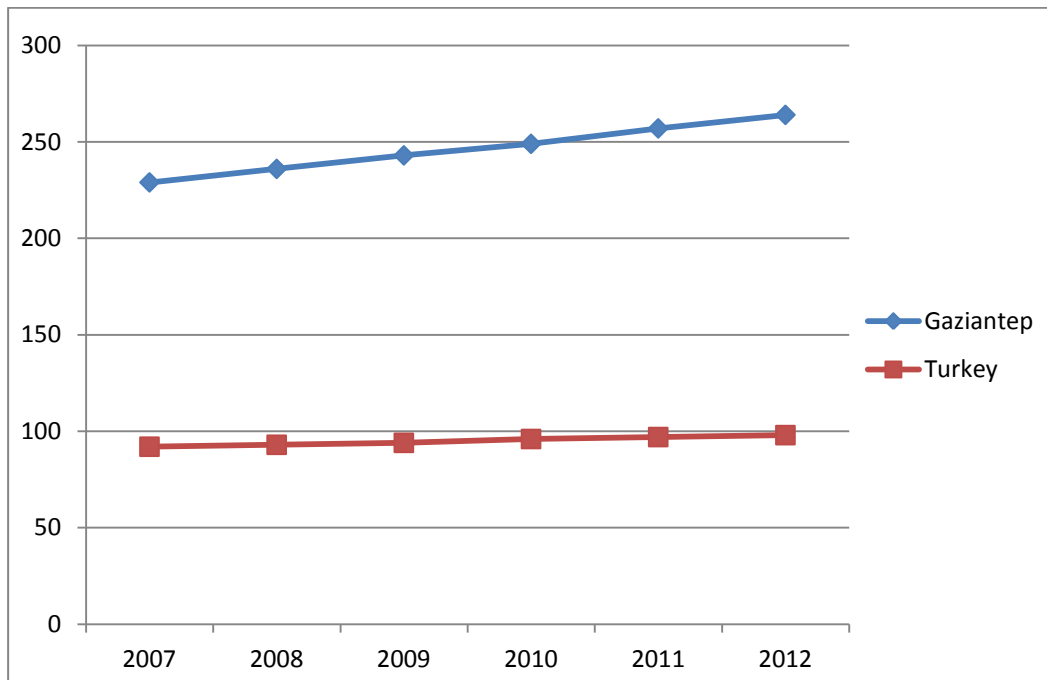


Figure 4-12 Population density by years “Address Based Population Registration System (2007-2012)” /km² (550/sq. mi)

Source: TUIK, 2012

The increase in the density of Gaziantep is relatively high in comparison to Turkey’s average. If the population index in 1960 is considered as 100, the index raised to 497 for the whole country in 2000. In the same period, population index was 620 for Gaziantep. Compared to Istanbul whose population index was 602, Gaziantep has a relatively high rate of population growth (Ersoy, M., Keskinok, Ç., Günay, B., 2007). When the spatial structure of Gaziantep is examined, irregular settlements were seen in the east, south and southeast of the city. Only old town of Gaziantep developed regularly to west direction. While Gaziantep was compact previously, it is sprawl now due to the decision taken that is not considering the integrity of the city (IKA, 2013). To support such a statement above, development of the city macro form can be beneficial. The city of Gaziantep was originally built around the castle and the area surrounding it is called Türktepe. Within time, city developed along the main transport axis. It spread on both sides of the main road.

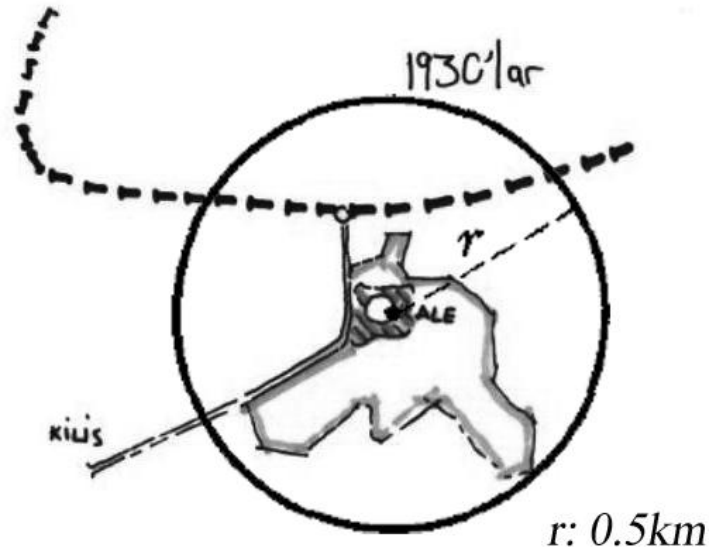


Figure 4-13 Development of macro form in 1930s

In 1930s, first master plan of the city was prepared by Herman Jansen. A subsequent plan that was prepared for the city was affected by the first master plan. The Herman Jansen's plan offered important transportation axes. Gaziantep was one of the important centers of Turkish textile sector at that time. Jansen aimed to develop economy of the city around textile industry. Hence, northern and southern parts of the city were reserved for workers. The decision affected direction of city development. Another plan decision was surrounding Alleben River by greenbelt by preserving agricultural lands. The city center began to expand out of the city and its suburbs. Gaziantep population was approximately 50.000 in 1938 when the plan was applied. The radius of settlement area was approximately 0.5 km.

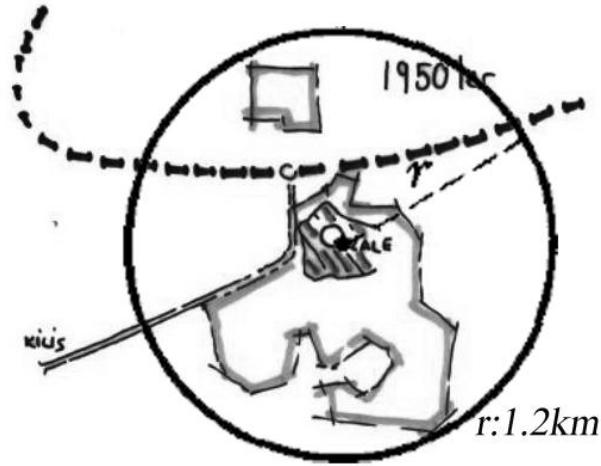


Figure 4-14 Development of macro form in 1950s

In 1950, second master plan of the city was prepared by Kemal Söylemezoğlu and Ahmet Aru. The plan responded to the increase in population and number of motor vehicles by allowing suitable roads on the traditional center for the motor based vehicles. People with low-income that migrate to Gaziantep settled in Karşıyaka and Düztepe. However, the city had developed to the axis determined by Jansen's plan. In 1950s, Gaziantep had an estimated population of 104, 000 (UN, 2012). The radius of settlement area was approximately 1.2 km.

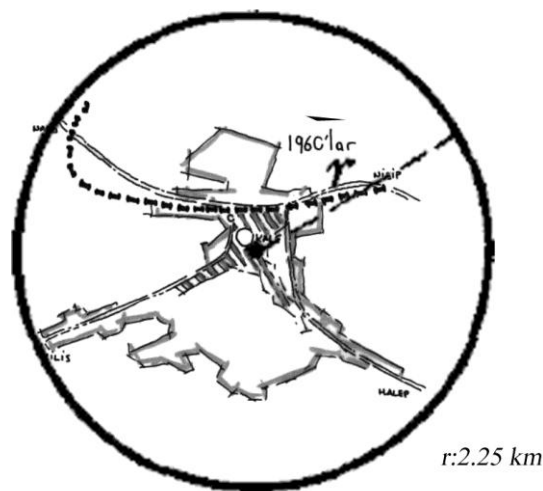


Figure 4-15 Development of macro form in 1960s

In 1960s, high income group settled in Kavaklık area. This caused expansion of the city to the southwest direction. The development patterns of city show a linear form on the southeast and southwest direction. Population increased and urbanization accelerated. This led to increase in housing and working place demand. So Gaziantep met slums. New residential areas were built far from the city center. In 1960s, Gaziantep had an estimated population of 511.026 (TUIK, 2012). The radius of settlement area was approximately 2.25 km.

In 1970s, third master plan of the city was prepared by Zühtü Can. Between 1960 and 1975, 40 new neighborhoods were developed in Gaziantep. Most of them were out of the planned areas (Ay, 2001). Small industrial site started to develop on Nizip Street, Araban and İpek road. These sites led to uncontrolled expansion into rural areas.

In 1970s, Gaziantep had an estimated population of 606.540 (TUIK, 2012).

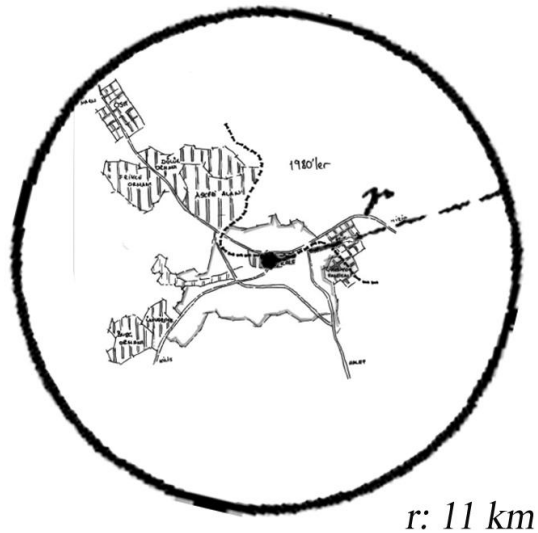


Figure 4-16 Development of the city macro form in 1980s

Third master plan assumed that the population of the city was foreseen as one million. In consequence of this assumption, new areas are opened to development.

Organized industrial region in the south and southeast of the city was placed. Number of slums in the city increased. In 1950s, Gaziantep had an estimated population of 808.697 (TUIK, 2012). The radius of settlement area was approximately 11 km.

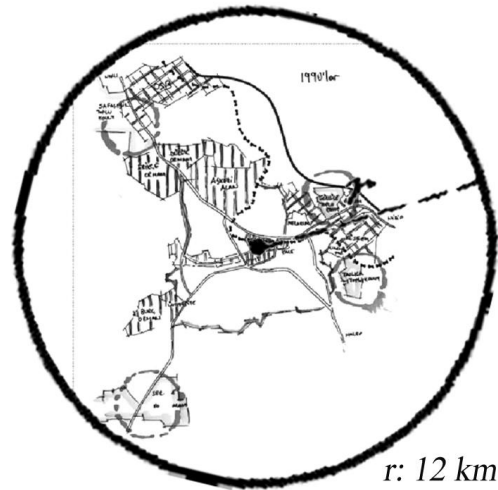


Figure 4-17 Development of the city macro form in 1990s

In 1990s, fourth master plan of the city was prepared by Oğuz Aldan. The master plan assumed that the population of the city would reach to 1.800.000. This plan offers that city's planned areas would increase from 8.000ha to 21.000ha (Ay, 2001). Rapid growth of the peripheral areas of the city led to formation of a new commercial area. Wholesale trade market of the city gathered in a place called "GATEM", which is the Gaziantep's biggest commercial center with 4500 workplaces in the northeast part of the Gaziantep.

Development of the city macro form can be interpreted by the way of the changes of the radius of coverage area for measuring compactness. Within twenty years after 1930, radius was increased by approximately 2 times. It reflects rapid growth of the peripheral areas of the city. In 1980s, Gaziantep was zoned as institutional,

residential and industrial areas. Oğuz Aldan's plan supported these zoning areas. It offers new residential areas far from the industrial and other working places. This fragmentation and segregation processes continued in 1990s.

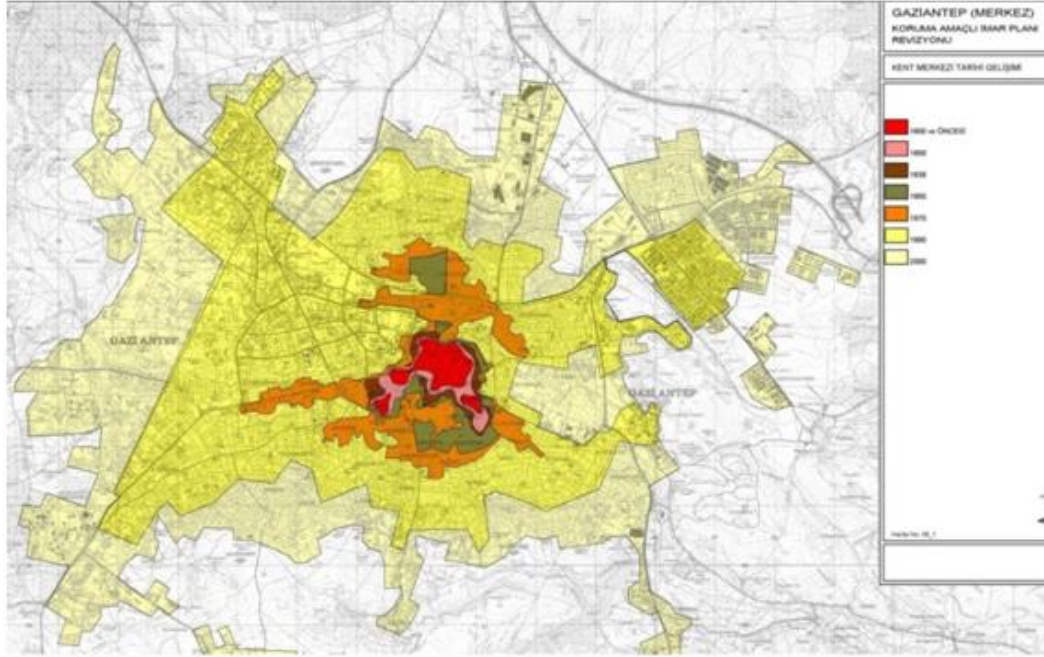


Figure 4-18 Development of the city macro form in 1990s

Source: MMG

Gaziantep was designed to be compact city. Then, people are forced to move to the edge of the city owing to increasing density with immigrants. People who moved to the edge of the city formed sub-centers. Gaziantep has more than one city center. While majority of population live near the city center, a minority of population live in some peripheral areas. The city expands towards peripheral areas owing to rapid growth of population instead of increase in densities of existing parts.

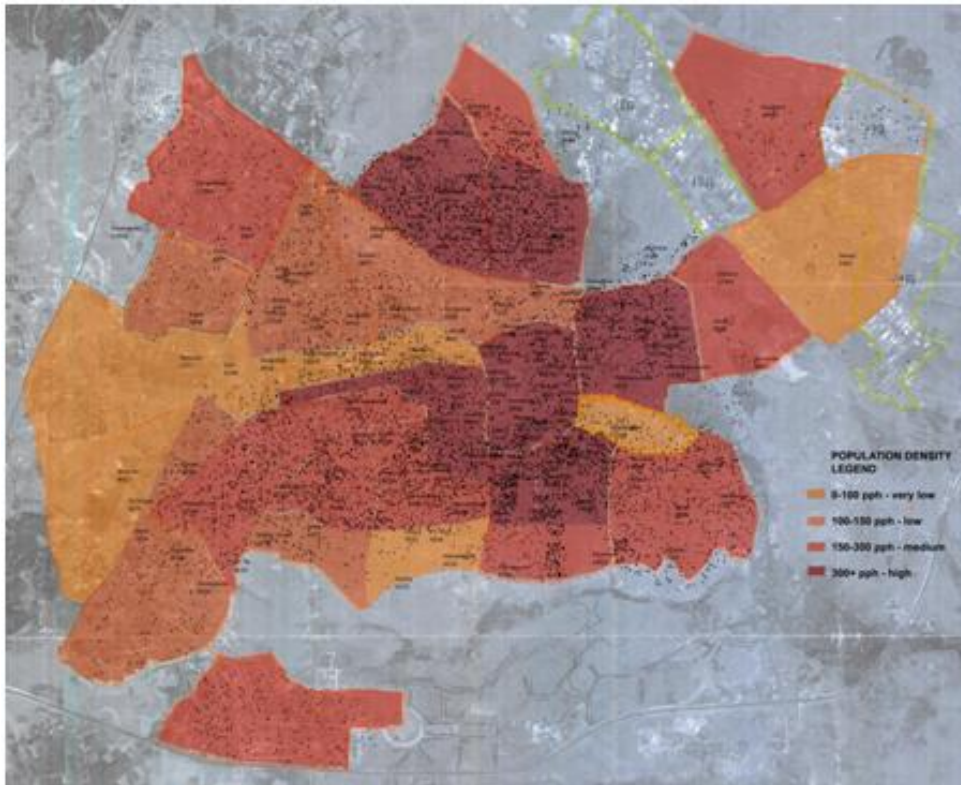


Figure 4-19 Population Density (categorized four types of densities; as 0-100 pph very low, 100-150 pph low, 150-300 pph medium and 300+ pph high density.)

Source: CRP 401-402 Planning Studio Analyses, 2012

Population density map allows us to understand whether the city would reach a saturation level. There are significant differences in the density of city part. The differences are prevalent particularly between city center and western part of the city. When the map is analyzed, in the inner core of the city, population density is higher; whereas towards the outskirts population density decreases. However some areas in the city center have relatively low population density. New areas were opened to development without city center reaches saturation level.

When considered from another angle, there are a close relationship between urban compactness and transportation(Richardson, 1961). Compactness is generally defined as the opposite of urban sprawl. While urban compactness promotes physical activity, it encourages car dependency. In compact cities, generally trips can be made

without a car. There are fewer private cars on the road when compared to sprawl cities. Şenbil and Yetişkul stated that there is almost a perfect match between the ratio of urban population in and the ratio of private car population in Turkey, and in terms of relative urban population change in the provinces, relative motorization also shows strong variation in the essay called “Motorization in Turkey: The Case of Passenger Cars”. Gaziantep was the fastest growing city between 1990 and 2010, with 4.25%. Gaziantep had a population around 800.000. In 2013, the population is 1.7 million. At the same time, ratio of the private car number seems to rise suddenly. The increase in the number of cars results in the increase in the number of traffic accidents. In order to examine the relationship between urban sprawl and road accidents, researchers took a look at 450 counties that is about two-thirds of the total population in the United States. Researchers found that the dense and compact cities as New York, Philadelphia, Boston and San Francisco had fewer deaths from traffic accidents than the least dense cities as Cleveland, Atlanta and Minneapolis (OCFP, 2005).

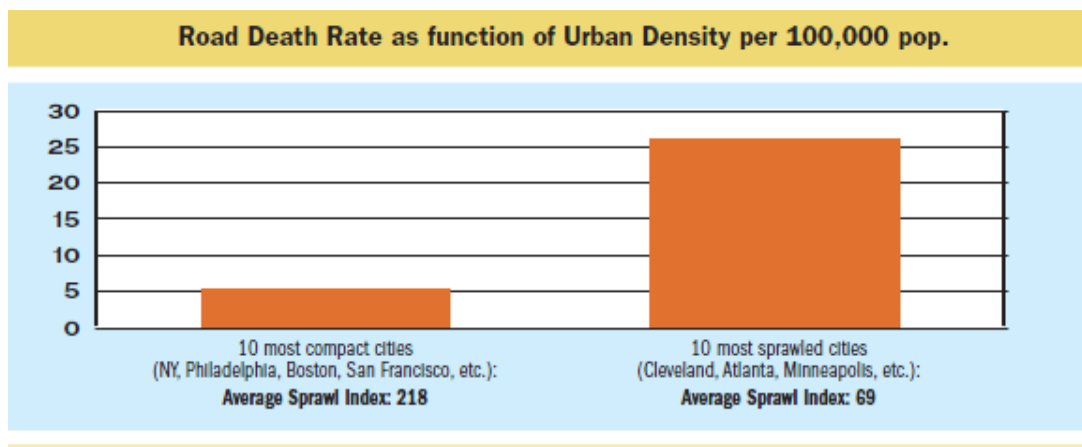


Figure 4-20 Road Death Rate

Source: OCFP, 2005

Dumbaugh and Ray (2009) analyzed GIS data on crash incidence and urban form for the City of San Antonio, Texas. They found that compact cities have lower crash rates. In Gaziantep, while the number of traffic accidents was 1010 in 2001; in 2008, this number reached 2045. Information showed below about Gaziantep help us to evaluate the city in terms of compactness.

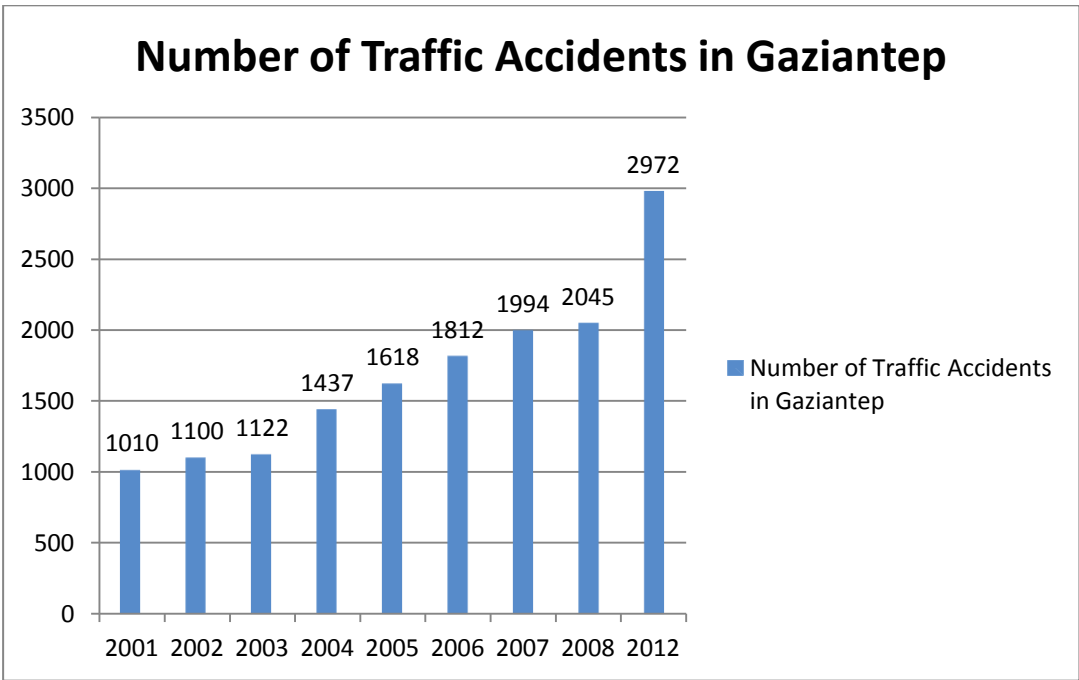


Figure 4-21 Number of Traffic Accidents in Gaziantep

Source: (TUIK, 2013)

Urban form affects traffic frequency. Ewing, Schieber and Zegeer (2003) point out that urban sprawl is directly related to traffic fatalities and suspected to be a major contributing cause of traffic fatalities. According to the figure above, number of traffic accidents increased roughly by 200% in Gaziantep. In the light of this information, Gaziantep may be evaluated as a sprawl city.

4.3.2. Assessment of Compactness

Compactness is a critical factor to reach urban sustainability in sustainable urban development literature. It offers solution to the unsustainable rising population growth, high urban densities and very limited resources. When Gaziantep is assessed in terms of compactness; Herman Jansen, who prepared the first master plan of Gaziantep, designed the city as a compact city. However his estimation of population and macro form growth did not succeed. Then Kemal Ahmet Aru and Kemali Söylemezoğlu generated the second master plan of the city. They highlighted traditional urban values of the city and road system. In 1950s, the city met relatively high-rise apartments and slums for the first time in its history in spite of accelerating urbanization with migration movements between 1950 and 1960. Between 1960 and 1975, 40 new neighborhoods -most of them were out of planned areas- were developed in Gaziantep. Third development plan of Gaziantep was prepared to meet new needs of city by Zühtü Can. Then fourth city master plan was prepared by Oğuz Aldan in 1990. In the following years, Gaziantep has a lot of additional master plans apart from four city master plans because of increasing urban population. Government policies and unplanned additional master plans caused urban sprawl. Development of the city macro form can be interpreted via the changes of the radius of coverage area that is used for measuring compactness. Within twenty years after 1930, radius increased by 2 times. It reflects rapid growth of the peripheral areas of the city. Population growth and urban sprawl leads to automobile dependency. While in 2005, number of motor vehicles in Gaziantep was approximately 200000; in 2012 this number reached nearly 400000. Population growth and sprawl urban are also responsible for many traffic accident fatalities. In Gaziantep, while the number of traffic accidents was 1010 in 2001; in 2008, this number reached to 2045.

Government policies, unplanned additional master plans, increasing population, accelerating urbanization, rise in car ownership and traffic accident made Gaziantep a relatively sprawl city. Special precautions should be taken in order to make Gaziantep a compact city.

4.3.3. Sustainable Transportation

Throughout the history, the city of Gaziantep has been located on important trade routes near the Silk Road and it connects Anatolia with the fertile lands of Mesopotamia. Therefore, its transportation system that connects Gaziantep to surrounding cities and particularly to Syria, plays an important role in the development of the city. In this region, there are three important highway connections. First one is O-54 Motorway which connects Niğde, Mersin and Şanlıurfa. Secondly, D-400 is known as the Silk Road. Thirdly, D-850, in the North South direction, connects Syria to Turkey.



Figure 4-22 Map of Roads of Gaziantep

Source: CRP 401-402 Planning Studio Analyses, 2012

According to the records of Gaziantep Police Department (2013), there are 167 045 automobile, 12 194 minibuses, 3 787 buses and 216 141 other vehicles (trucks, van, motorcycles, special purpose vehicles and tractors) in Gaziantep. These figures indicate a high density of road use.

Table 4-7 Number of motor vehicles

Source: TUIK, 2013

Years	Automobile	Minibus	Bus	Others	Total
2001	61.463	4.515	1.286	86187	153451
2002	64.422	4.591	1.348	88269	158630
2003	68.193	4.819	1.473	92911	167396
2004	77.050	7.841	1.598	102074	188563
2005	84.135	8.613	1.673	116352	210773
2006	91.673	9.547	1.835	135166	238221
2007	99.502	10.594	2.100	147625	259821
2008	107.756	11.018	2.464	159804	281042
2009	116.564	11.105	2.611	168278	298558
2011	139 972	11 280	3 922	192 587	347 140
2012	155 052	11 543	3 768	207 781	378 144
2013	167045	12194	3787	216141	399 167

Gaziantep has an insufficient public transport system and road transport system, so the number of private vehicles increased in the city. The insufficient transportation system leads to traffic problems due to the lack of infrastructure. The problem the city faced caused environmental pollution (IKA, 2013).

In the city, there is international airport: Gaziantep airport. The airport was opened in 1976 as a small airport. In 2006, it served as an international airport. In 2009, 15.765 flights, 915,262 passenger transportation and 10,651,537 tons of freight shipment were made (DHMI, 2010).

According to DHMI data related to air transport and logistics in the region, airport transportation is not using its full capacity (IKA, 2010).

The central station of Gaziantep was opened in 1954. In 2009, the existing rail length was 254 km in Gaziantep (TCDD, 2009). Gaziantep railway network has both domestic connections and international connections.

Adana, Ankara, Birecik, Aleppo, Elazığ, İstanbul, Kahramanmaraş, Karkamış, Malatya, Nizip, Nusaybin and Osmaniye are the places that can be travelled to from Gaziantep via railways (TCDD, 2010). Although Gaziantep railway network is enough at now, at future periods the network will not be sufficient for the region due to expected increase in transportation, logistics and trading activities (IKA, 2010). There are projects to improve the city railway connection to circumjacent cities. The projects are Gaziantep – Aleppo High Speed Train Project, Adana – Gaziantep Direct Conventional Line Project and Konya – Adana High Speed Train Project (MMG).

The Municipality invested 21 km light railway line that connects a middle income neighborhood to the city center. There are plans to extend it by another 30 km. Currently, there are 4 trams and each has a carrying capacity of 220 people. These trams run at a 20- minute interval in both directions (ECA, 2011)

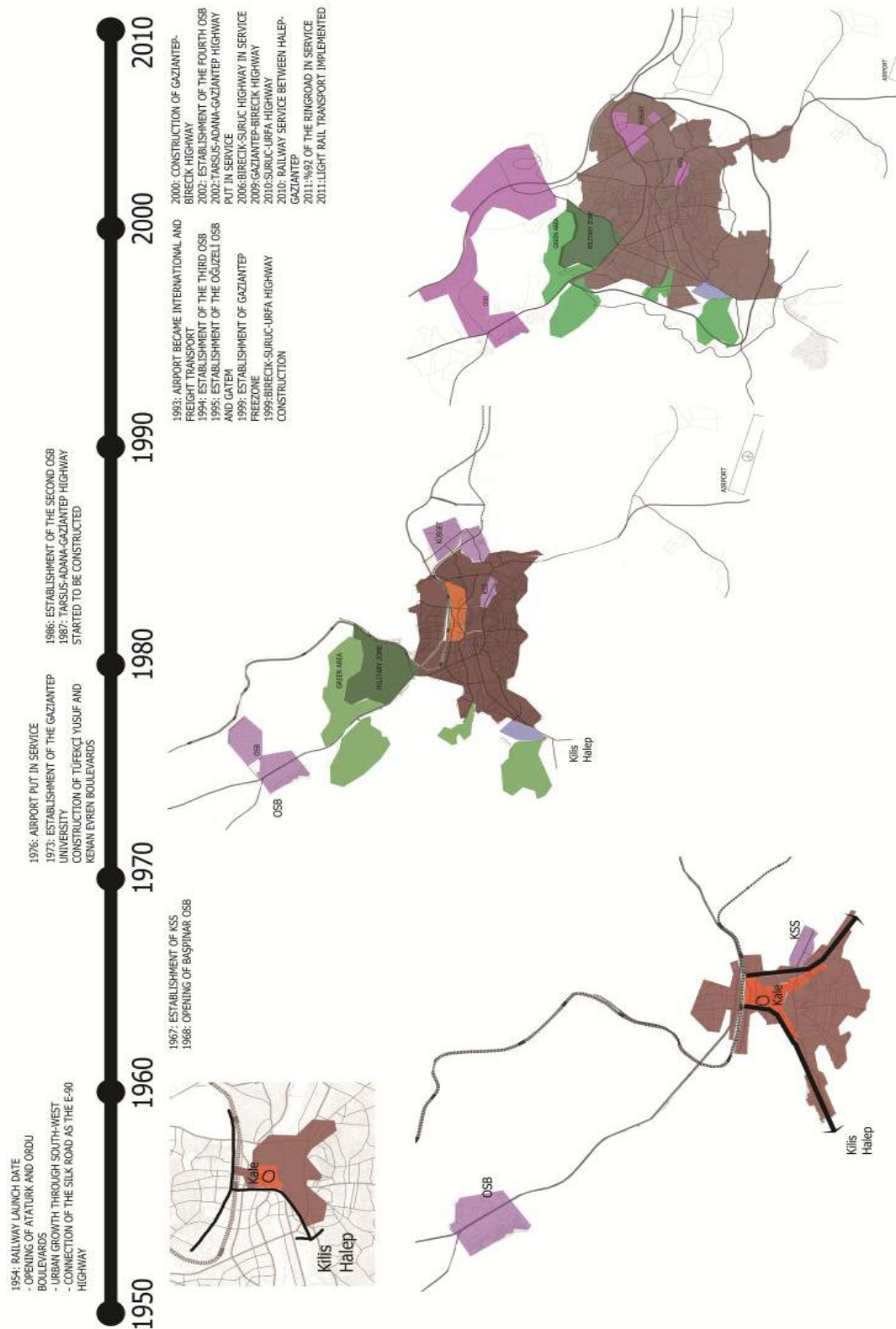


Figure 4-23 Urban Macro form Developments Concerning Transportation

Source: CRP 401-402 Planning Studio Analyses, 2012

Transportation plays an important role in sustainable development. Transportation sector has high potential for city’s growth in a sustainable manner. Rapidly growing population and rising automobile dependency can have an impact on greenhouse gas (GHG) emissions from transportation. In the past 10 years; population of Gaziantep has grown by 62% while the number of motor vehicles increased more than doubled (ECA, 2011).

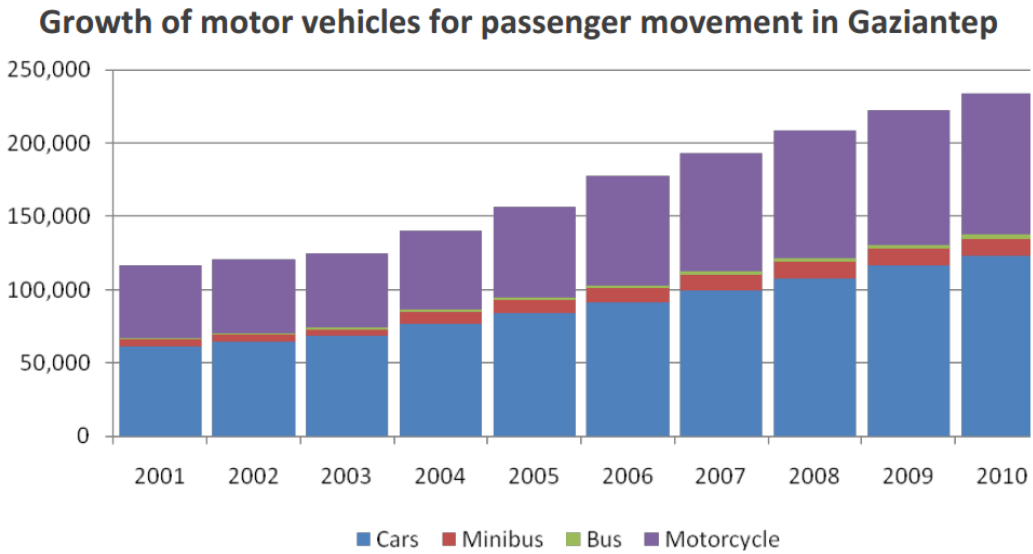


Figure 4-24 Growth of motor vehicles for passenger movement in Gaziantep

Source: ECA, 2011

By 2010, Gaziantep had 304,344 motor vehicles for passenger, 225 for every 1,000 inhabitants, a rate far higher than most cities with similar incomes and population size. Most of these vehicles are cars and motor cycles (ECA, 2011). However, average car ownership (per 1000 people) in Gaziantep is fewer than Turkish average. Car ownership for 1000 people in Gaziantep is 86, while in Turkey this number is 114. The cities of Konya, Antalya and Mersin share same prosperities to Gaziantep mainly according to their public transportation networks, their population and their economic situation. All these cities include a light rail transit system but not a metro system in respect to their population.

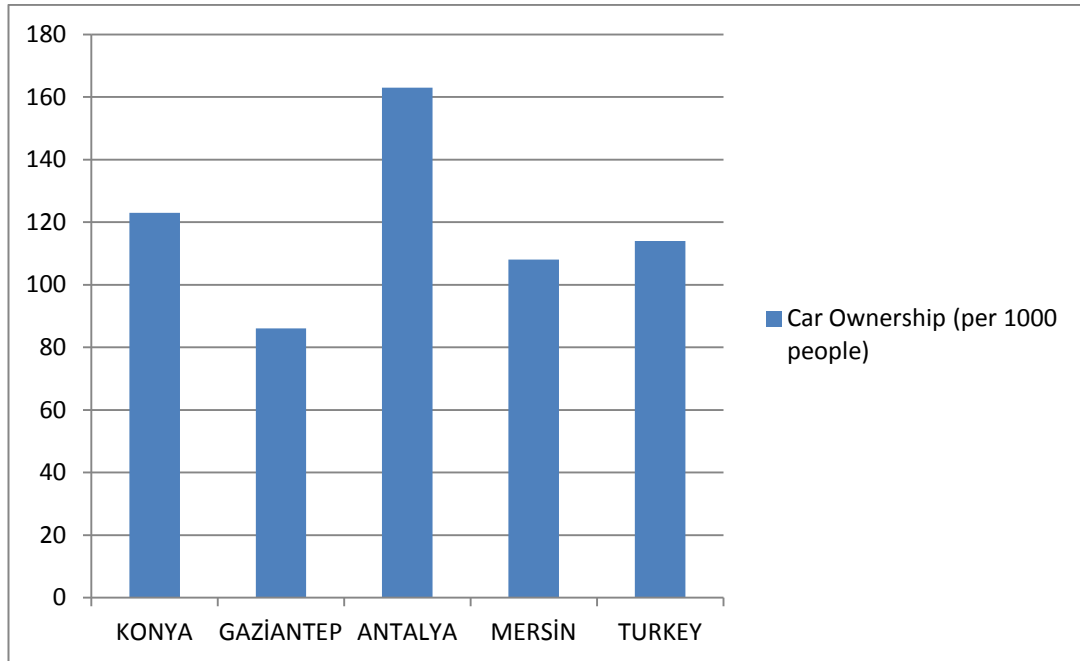


Figure 4-25 Comparison of car ownership

Source: TUIK, 2012

Compared to cities that have similar GDP in Turkey, car ownership of Gaziantep is relatively low. The transport sector is responsible for the majority of city-wide energy use. Public transportation is more energy efficient than private vehicles. While amount of public transportation energy used was approximately 960.000.000 MJ, private vehicle was nearly 2.700.000.000 MJ (ECA, 2011). To understand the magnitude of this energy, an example can be used. For example; if a 100 watt light bulb for one hour a day for one month runs, the energy used is 108 MJ. In other words, 25.000.000 light bulbs can run for one month with this energy used for private vehicles. Another example, a family's (4 people) monthly energy consumption was determined to be 230 kWh (828 MJ) by the chamber of electrical engineer. The energy used for private vehicles is equal to a family's energy needs for approximately 271740 years.

Table 4-8 Annual Energy Use and Energy Spent on Mobility in Gaziantep

Source: ECA, 2011

Annual Energy Use and Energy Spent on Mobility in Gaziantep, 2010			
Mode	Energy Use (MJ)	Energy Spent	Energy Intensify (MJ/PKM)
Public Transportation	964,257,023	53,775,872	0,32
Private Vehicle	2,770,038,147	1,999,442,747	1,30

However, amount of private vehicle energy used is still low compared to other cities. According to TRACE database (Tool for Rapid Assessment of City Energy), Gaziantep has one of the lowest rates of all cities in TRACE database.

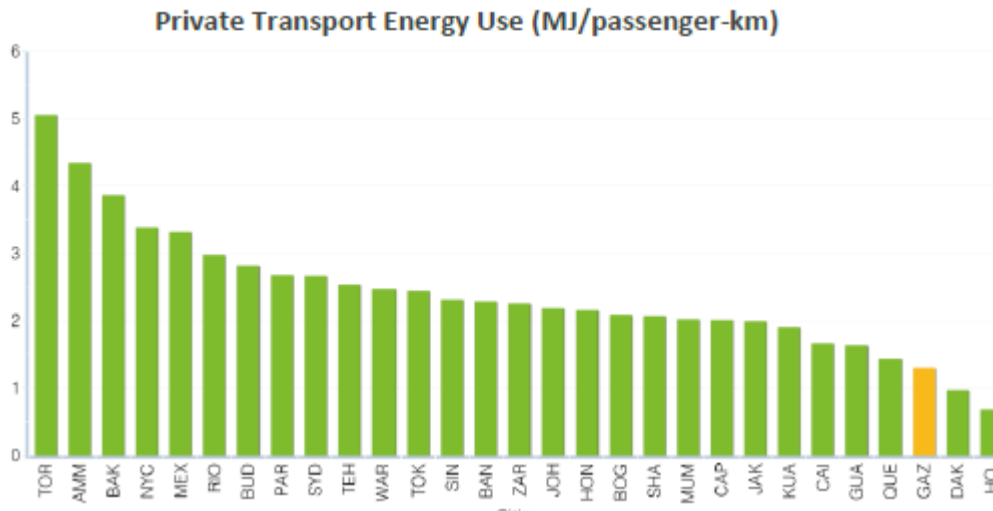


Figure 4-26 Private Transport Energy Use

Source: ECA, 2011

Furthermore, climate actions plan of Gaziantep states that;

“The population (15 to 75 years old) is making an average of 1.2 trips per day (corresponding to a daily mobility of about 950 000 trips per day). This mobility is three times less than in Lyon, French city with the same size as Gaziantep. The distance of these trips is short, allowing a high share of walking for 58% of trips, and the remaining 42% is made via vehicles. This strong role of walking has to be highlighted: for comparison, walking represents only 33% in Lyon. This is the result of a cultural habit, and important mix of places for business and for living. Regarding the trips using vehicles, travel practices in Gaziantep show a high rate of collective modes, with 75% of trips made with public transport. The fact that private car only covers 20% of travelling is absolutely remarkable compared to Lyon where private car is used in 2/3 of travels using vehicles and public transport is used only with a 21% share” (AFD, 2011).

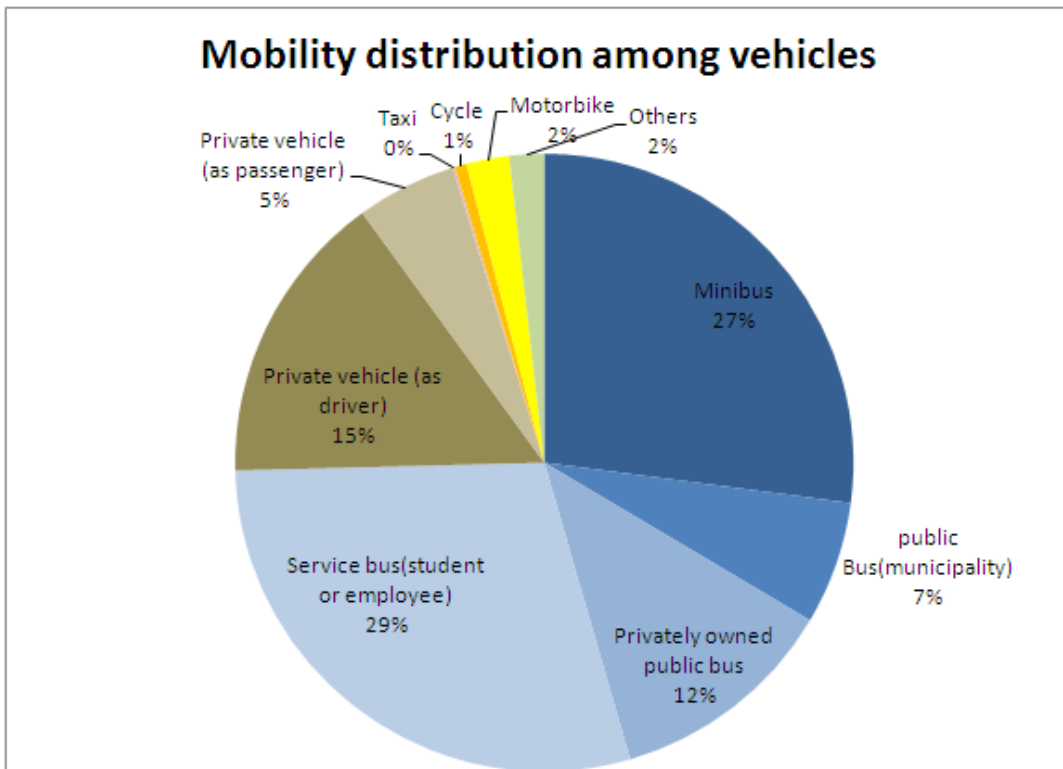


Figure 4-27 Mobility Distribution among Vehicles

Source: ECA, 2011

When characteristics of travel of Gaziantep are analyzed, most of the travels are made between the center and the primary working areas, industrial zones. According to Municipality Transportation Master Plan, 65,000 employees are transferred to OIZ from the center of Gaziantep. Also, 40,000 employees are transferred to K sget area. GHG emissions from the transport sector are 690 kt CO₂e. 470 kt CO₂e of this emission is from road transportation of people. It is 0.36 ktCO₂e/capita (AFD, 2011).



Figure 4-28 Traffic Volume in the Urban Area of Gaziantep

The routes that have the highest traffic volume in the urban area of Gaziantep are shown in the table above. According to the scheme, most of the travels are made for going to industrial zones. Increasing traffic volume should be responded with developed public transport systems.

In the medium and large size cities of the Mobility in Cities Database sample⁵ (50 cities), which are located mostly in developed economies, the average amount of CO₂ emissions from passenger transport per capita is about 1240 kg per year. For the European cities in the sample, this average is about 907 kg (UITP). Despite the fact that car ownership has been increasing, Gaziantep still produces relatively lower level of GHGs from transportation compared to developed countries. However, pre-emptive measures should be taken against increasing private vehicle ownership.

Light rail transportation system is considered as key drivers for sustainable urban development service in Gaziantep. The system provides fast and efficient transportation by using less energy and emitting less greenhouse gases. It also reduces traffic congestion and air pollution. According to Asım Güzelbey, the Mayor of Gaziantep Municipality, 21 km railway exists in the city. There is 15 km of railway from the Gar Square till the Burç crossroad and 6 km of railway between University and Akkent.

⁵ The UITP Mobility in Cities Database (MCD) contains 120 indicators on public transport and urban mobility in 50 medium and large size cities for the year 2001.



Figure 4-29 Map of Light rail transportation system (Planned LRT and the Suburban Rail way Routes)

Source: MMG

In addition, in Gaziantep, light rail system is planned to be extended by 30km. The light rail system generates better environmental outcomes. However, in terms of the relative length of high capacity transit lines, Gaziantep ranks relatively low when compared to other cities. According to local authorities, expanding high-capacity

transit is one of the key ways of making Gaziantep more sustainable (ECA, 2011). The reason of low ranking is that the line connects a high income neighborhood to the city center. Generally, low income neighborhood uses private transportation. Briefly, light rail transportation system can't respond to the local needs efficiently at the moment. However, MMG planned to lease land along the main railway line that connects the industrial areas to the railway station in the city (ECA, 2011).

Pedestrian transportation has a crucial role in sustainable transportation. It has a major importance in the modal split of Gaziantep urban area in Gaziantep transportation master plan. The plan offered pedestrian streets and cycling area which is partly closed to vehicular traffic in the city's central. Cycling is also important for sustainable transportation. However, cycling is not yet very common in Gaziantep. It represents only 1% of the trips. There is no bicycle road in Gaziantep at the moment. However, a bicycle road of 19 km will be constructed (AFD, 2011).

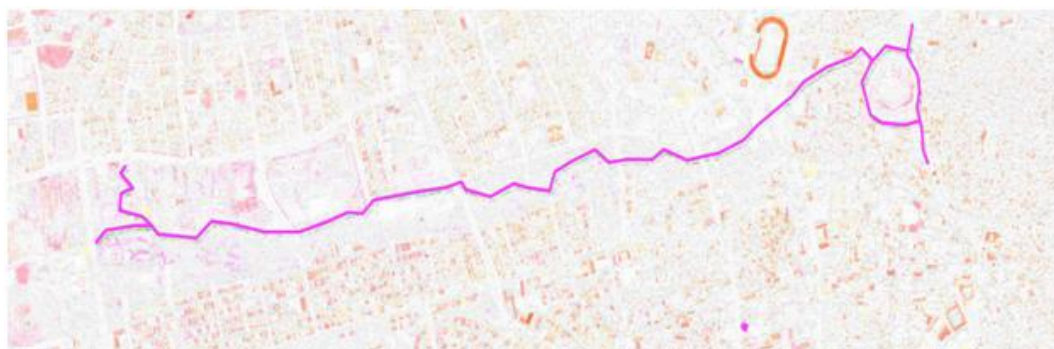


Figure 4-30 Planned bicycle road

Source: MMG

4.3.4. Assessment of Sustainable Transportation

Transportation, a significant contributor to climate change is the most important problem related to land use patterns. Sustainable transportation reduces the vulnerability to climatic changes. It also provides balance between environmental,

social and economic qualities. Sustainable transportation has an urgent priority to achieve urban sustainability. It can be influenced strongly by urban form and growth. Gaziantep is located on the important trade routes that connect the city to surrounding cities and particularly to Syria. Transportation plays an important role in the city development. The city has an international airport and 254 km railway. However, the city does not have a sufficient public transport system at inner-city. This problem caused not only an increase in the number of private vehicles but also in environmental pollution. There are 18 km of light railway lines in the city, but this line does not reach maximum carrying capacity because it connects a middle income neighborhood to the city center. However, Metropolitan Municipality of Gaziantep plans to extend the light railway line towards low income neighborhood. Rapidly growing population and rising automobile dependency in the city led to increase in the rate of GHGs emissions and energy use naturally. While amount of public transportation energy used was approximately 960.000.000 MJ, private vehicle one was nearly three times the amount of public transportation energy used. This amount is still low compared to other cities. Besides, despite rising automobile dependency, Gaziantep still produces relatively lower level of GHGs from transportation compared to developed countries. Pedestrian streets and cycling area have a crucial role in sustainable transportation. Cycling is not very common in Gaziantep yet and there is no bicycle road in the city. However MMG plans to construct new areas for using cycling and pedestrian transportation. In the light of this information, Gaziantep's transportation system is unsustainable due to increasing automobile dependency and above mentioned issues, but the system grows in a sustainable manner due to taken precautions.

4.3.5. Mixed-Land Uses

Gaziantep is one of the fastest growing cities in Turkey. It has the tendency of occupying the surrounding rural spaces at the outskirts. Increasing distances between home and work leads to automobile dependency. Correspondingly, traffic congestion has emerged as a problem in the transportation. Mixed use developments help to

combat this problem by reducing motorized travel and trips throughout the day. Mixed land uses is a critical component of achieving better places to live.

The city's total land area is 622.200 hectares. The land is mostly sloped and rugged. The southern and northern borders of the city are formed by Nur (Amanos) mountains and Euphrates respectively. The mountain belt lays parallel to the Nur Mountains. There are the valleys and rivers covering the city (Gaziantep Governorship, 2010). Mountains cover extensive areas. Mountainous areas are followed by plains, plateau and upland.

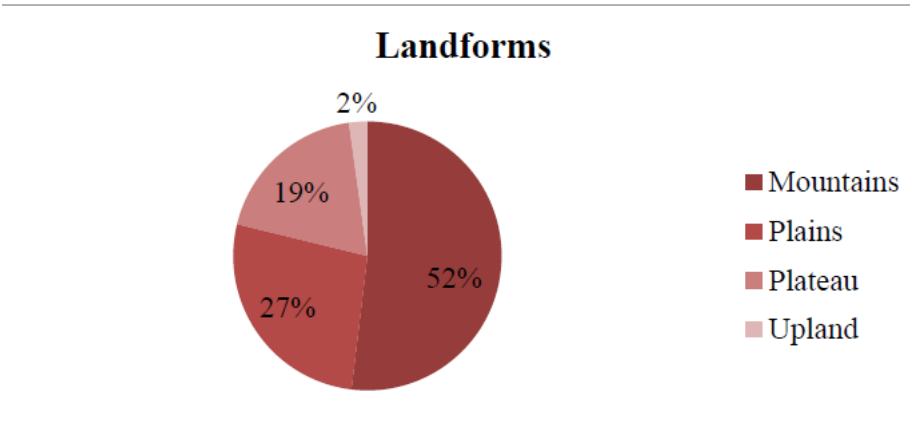


Figure 4-31 Landforms of Gaziantep

Source: GCI, 2013

Settlement areas were limited by mountains. The city is dominantly settled in the middle of the land that is the most suitable zone for development. The city includes densely populated urban settlements. Urban settlement consists of areas serving different functions such as residential areas, industry, military zone, cemetery, tourism areas, transportation nodes, Techno Park, solid waste and collection areas.

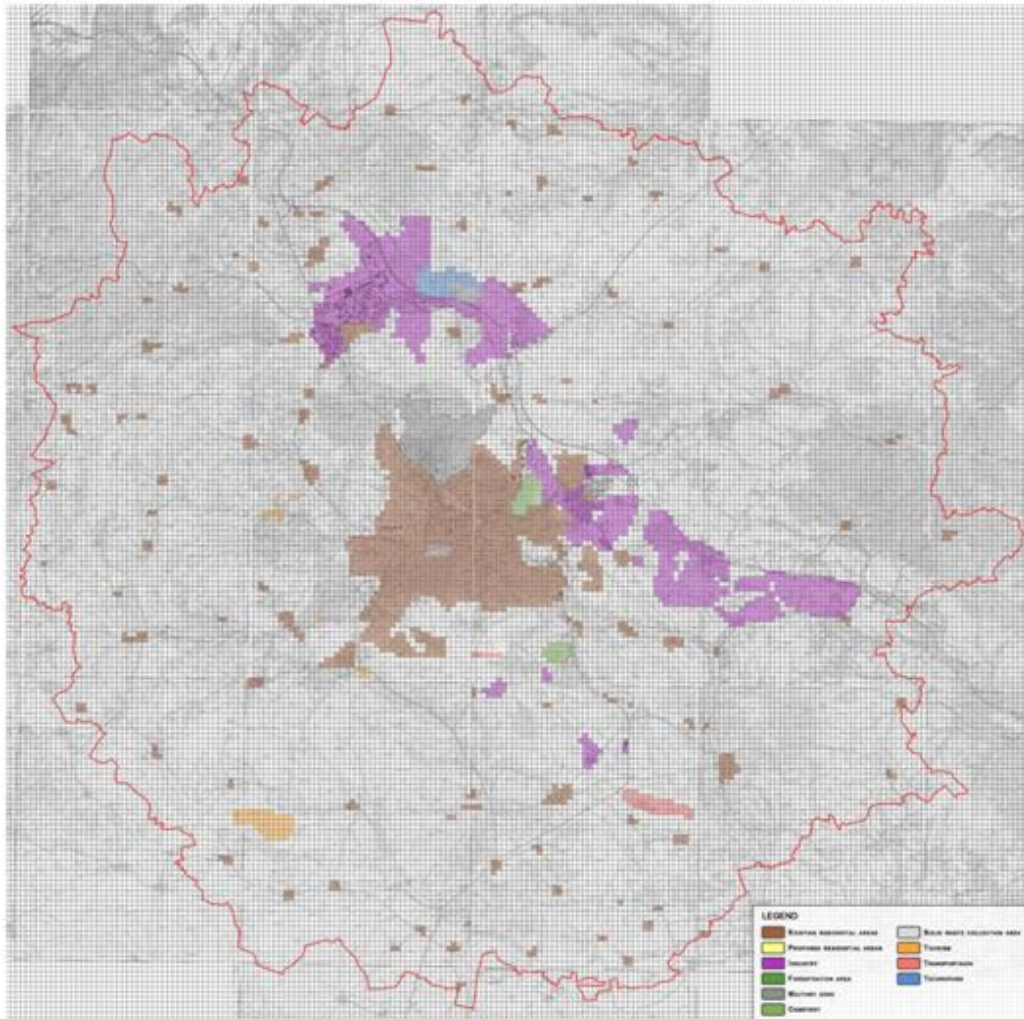


Figure 4-32 Land-use Plan

Source: CRP 401-402 Planning Studio Analyses, 2012

When evaluated at the urban scale; while northern and eastern parts of the city contain the organized industrial areas, residential areas are constructed at the southern and western parts. This cause long distance trips between housing and workplaces. Hence, vehicle miles traveled (VMT) and auto traffic increases. However, the light industrial areas were established nearby residential areas at the east of the city. The orientation of the growth of city was toward to the east due to reduce the distance trips for going to work and coming back from work.

A sustainable land-use plan encourages mixed-use development including residential and commercial areas. Accordingly, the city has relatively mixed land use development at the neighborhood scale. However, when analyzed at the urban scale, locating the organized industrial area at the north of the city caused high Vehicle Miles Traveled (VMT).

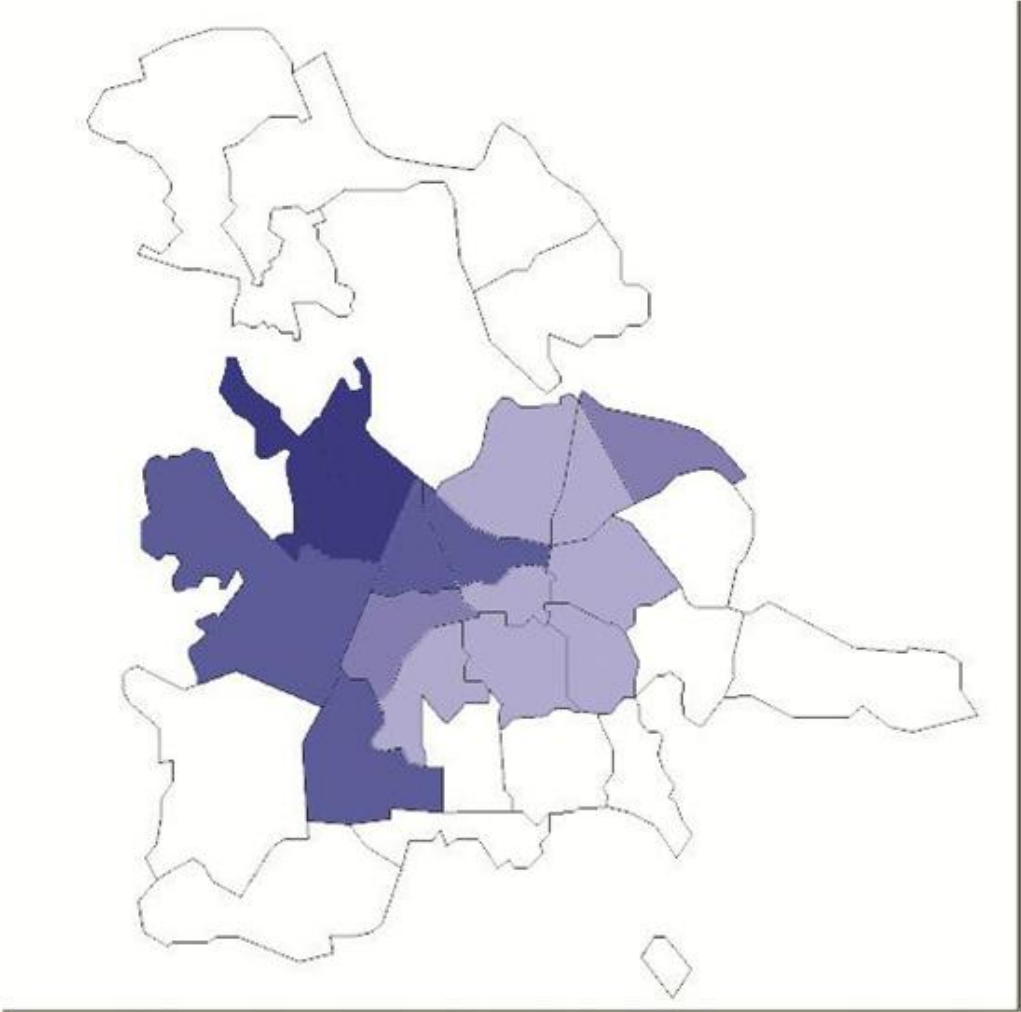


Figure 4-33 The car ownership rates in the regions of the city

Car ownership is an important indicator of mixed land uses development. Because mixed land uses is the integration of residential development with commercial, civic, and recreational uses. When mainly working and educational trips are in the walking

distance, it affects car usage in a diminishing way. It helps to decrease automobile dependency, correspondingly car ownership. When Figure 4-33 is evaluated, neighborhoods in city center have low ratio of car ownership. OIZ, to where most of the travels are made from the city center, was located in the neighborhood that is shown in dark blue. 65,000 employees are transferred from the center of Gaziantep to the Organized Industrial Zone.

The major travel corridors of Gaziantep are formed in between there. Trips made in the center are mostly on foot.

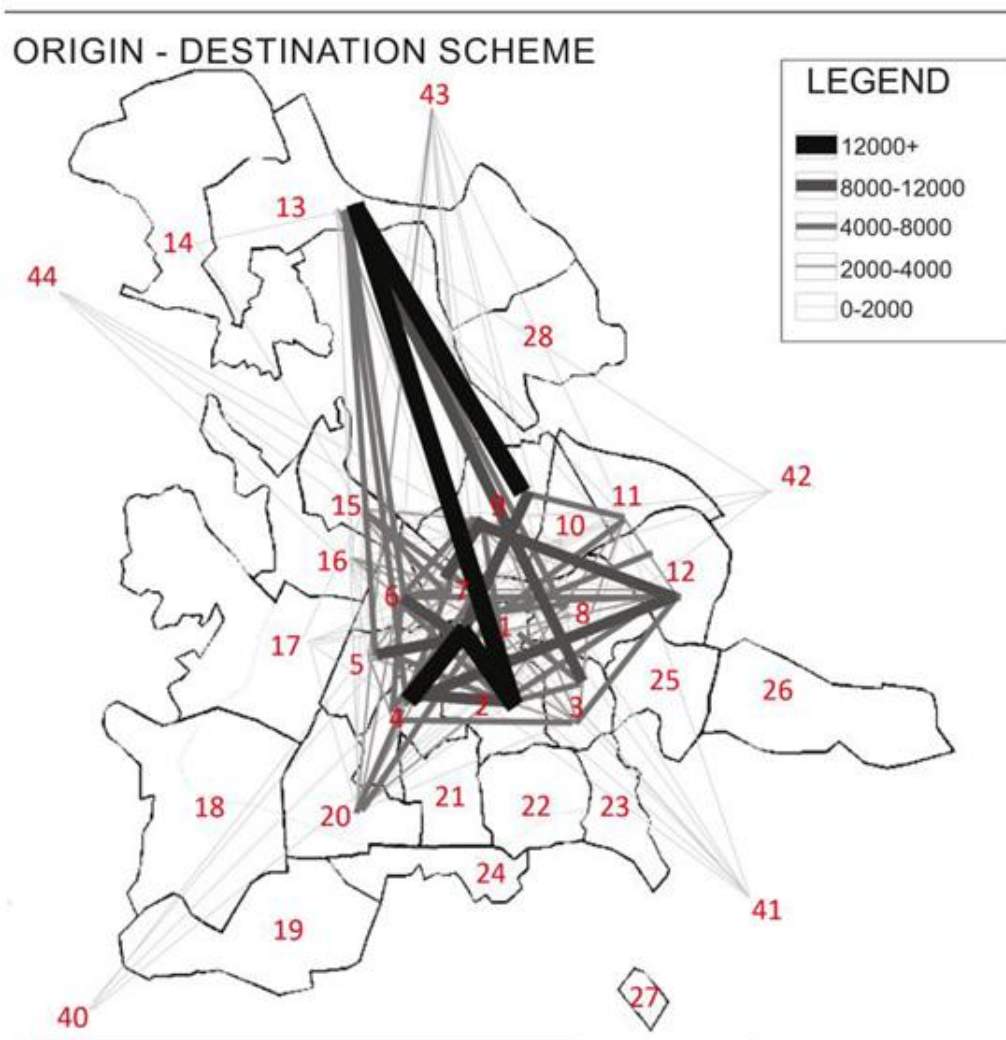


Figure 4-34 Origin – Destination Scheme

Source: CRP 401-402 Planning Studio Analyses, 2012

While single used development urban areas have high levels of car ownership and usage, mixed used development urban areas have high levels of alternative transport use such as, walking and cycling owing to the difficult to access activities and because origin-destination points are close together. The scheme shows that most of the travels are made between the center and the working places. It can easily be understood that the main travel reason is work.

When evaluated at the neighborhood scale; While Hanifoğlu Street, Bey Street and Çamurcu Street, whose average height of buildings is 1-2 storey, have a strong relationship between outside and inside, there is a weak relationship between outside and inside at Karagöz Street, Atatürk Boulevard, Inonu Street, İstasyon Street and Prof. Muammer Aksoy Boulevard whose average height of buildings is 4-5 storey. They include varied areas as housing, governmental buildings, Turkish bath, café, restaurants and mosques that serve citizens and tourists. However, mixed land uses development does not work in there because of deficiency of pedestrian roads, lack of parking areas and traffic congestion.



Figure 4-35 General view from streets of Gaziantep

Above pictures were taken from streets of Gaziantep. The pictures show that streets have vertical mix of uses. That means mixed residential, retail and commercial development in a building. Generally, while the lower levels of the mixed use building in the streets are used for commercial use, upper floors of the building are used for residential use and offices.

Mixed land use is a critical component for achieving sustainability. Residential, commercial and recreational areas are in the close proximity. As literature review

states, mixed land use is influenced by various factors. The research indicates that there is a strong relationship between travel behavior and mixed use development. People walk and ride bicycles more often in mixed-use development areas which have higher densities and incorporate places to work, shop, or play within residential areas (Frank, et al, 2005); (Brownson RC, 2006); (Saelens & Handy, 2008). Pedestrian trips and cycling tend to increase in the presence of mixed uses of land. Therefore, mixed land uses decrease average daily vehicular trip rate. Proportion of trips can be used as a tool for evaluating mixed use development.

Transportation Mode	Daily Total Trips (%)		Daily Vehicular Trips (%)	
Pedestrian	54,08	54,08	-	-
Para-transit transport	12,57	34,31	27,36	74,71
Bus	8,23		17,92	
Personnel and Student Service	13,51		29,42	
Private car (Driver)	7,06	9,49	15,38	20,66
Private car (Driver)	2,36		5,14	
Taxi	0,07		0,14	
Bicycle	0,28	1,34	0,62	2,91
Motorcycle	1,05		2,30	
Others	0,79	0,79	1,72	1,72
TOTAL	100	100	100	100

Figure 4-36 Modal Split

Source: Transportation master plan, 2004

According to the transportation master plan of Gaziantep, 54.08% of the total urban trips are made by pedestrians. This rate is very high compared to other cities.

Table 4-9 Modal split of journeys (Cities with over 1,000,000 inhabitants)

Source:

<http://ltaacademy.gov.sg/doc/J11Novp60PassengerTransportModeSHares.pdf>

City	Walking	Cycling	Public transport	Private motor vehicle	Year
Barcelona	40%	2%	33%	25%	2012
Beijing	21%	32%	26%	21%	2005/2011
Berlin	30%	13%	26%	31%	2008
Chicago	6%	1%	27%	61%	2009
Delhi	21%	12%	48%	19%	2008/2011
Guangzhou	0%	0%	49%	51%	2010
Hong Kong	0%	0%	80%	19%	2009
London	30%	2%	27%	41%	2011
Madrid	36%	0%	34%	30%	2006
Melbourne	13%	2%	7%	77%	2007
New York	39%	0%	22%	33%	2009
Paris	4%	1%	62%	33%	2008
Prague	23%	1%	43%	33%	2009
Rome	21%	0%	20%	59%	2006
Shanghai	27%	10%	33%	20%	2009-2011
Singapore	22%	1%	44%	33%	2011
Sydney	18%	0%	11%	69%	2009
Tokyo	23%	14%	51%	12%	2008/2009
Vienna	28%	5%	36%	31%	2010

Modal split refers to the percentage of passenger trips. In the table above, modal splits of different cities are compared to each other by separating as walking, cycling, public transport and private motor vehicle. All cities mentioned in the table above have low ratio of pedestrian trip compared to Gaziantep. Modal split of Gaziantep is based on the number of journeys mainly made by walking. Pedestrian transportation of the city constitutes approximately 55% of all trips.

4.3.6. Assessment of Mixed Land Uses

Sustainable urban development encourages the mixed-use. It provides development with less traffic due to accessibility to many facilities including residential, commercial, institutional, recreational, etc. It influences travel behavior as the average time spent in traveling decreases. In Gaziantep, most of the daily vehicular trips are made for going to work due to the fact that the organized industrial areas, which have an approximate of 40.000 workers, are constructed at the eastern parts of the city. On the other hand, the residential areas are constructed at the southern and western parts, but the orientation of the growth of city is toward these industrial areas. However; when evaluated in the neighborhood scale, neighborhoods of the city include varied areas. In other words, all facilities like civic, institutional and commercial facilities are within walking distance to each other. The average daily vehicular trip rate per person is 0.49 in Gaziantep. The rate is very low compared to other cities. According to Livingston et al. (2003) this rate is 3.8 (See Table 3.7). Furthermore, the transportation master plan of Gaziantep stated that 54.08% of the total urban trips are made by pedestrians. This is the result of the mix of places for business and for living. When above mentioned indicators are evaluated, Gaziantep should be evaluated as a mixed-use zoning.

CHAPTER 5

ASSESSMENT AND CONCLUSION

‘Sustainability’ is a widely used term in a globalizing world and this term is used in different fields. The term means a better quality of life for everyone living now and for generations to come and more sustainable world environment within the concept of development. The most accepted definition of the term is: “*the development that meets the needs of present without compromising the ability of future generations to meet their own needs*”. The term also was repeated several times in international summits, conferences and declarations.

Climate is defined as the composite or generally prevailing weather conditions of a region throughout the year. Some of these weather conditions are temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds. In other words, the meteorological conditions characteristically prevail in a particular region. The major cause of climate change is human induced causes related to any human activity that releases “greenhouse gases” into the atmosphere.

Climate change mitigation is closely linked to sustainable development. Climate change can undermine the components of sustainable urban development. Cities are responsible for the majority of greenhouse gas emission causing climate change. Struggling with climate change effects all scales; cities combine to make sustainable energy, land use, transportation, usage of natural resources that are critically important. All of these can be succeeded with sustainable development.

The city of Gaziantep has experienced a rapid growth of urban population due to its main characteristic of being an industrial city. As the case of any industrial city, the growth processes of Gaziantep’s industry have had significant effects on the environment owing to GHG emission to the atmosphere.

The aim of this study is to assess whether the urban development process of Gaziantep has followed a sustainable path. To this end, an analysis of core design concepts derived from sustainable urban forms is carried out following a conceptual classification. These concepts are derived from an extensive literature survey on sustainable urban forms. The core concepts are compactness, sustainable transportation and mixed land uses. From the viewpoint of core design concepts related to sustainable urban forms;

The first concept is compactness. Compactness is a critical factor to reach urban sustainability in sustainable urban development literature. It offers solution to unsustainable population growth, high urban densities and very limited resources. When we study urban compactness of Gaziantep, we should pay more attention to four major master plans analysis in historical development of Gaziantep. Herman Jansen, who prepared the first master plan of Gaziantep, designed the city as a compact city; however, his estimation of population and macro form growth was not succeeded. Then Kemal Ahmet Aru ve Kemali Söylemezoğlu generated the second master plan of the city. They highlighted traditional urban values of the city and road system. According to master plans of Gaziantep, population of Gaziantep increased and urbanization accelerated with migration movements in 1950s. The sudden increase led to housing and working place demand. The city faced slums for the first time in history. Between 1960 and 1975, 40 new neighborhoods -most of them were out of planned areas- were developed in Gaziantep. Third development plan of Gaziantep was prepared to meet new needs of the city by Zühtü Can. Then fourth city master plan was prepared by Oğuz Aldan in 1990. In 1990s, the urban population increased very quickly and city development into unplanned areas continued. In the following years, Gaziantep had a lot of additional master plans apart from four city master plans because of increasing urban population. Hence, it caused uncontrolled expansion into rural areas. Government policies and unplanned additional master plans caused urban sprawl. When urban compactness is interpreted through the changes of the radius of coverage area; radius was increased by 2 times within twenty years after 1930. It reflects rapid growth of the peripheral areas of the city. Compact city promotes physical activity unlike sprawl cities. In other words,

urban compactness promotes fewer private cars on the road compared to sprawl cities. The new development areas are far from the city center. It causes increase in car dependency. According to Turkish Statistical Institute, while there were 210.773 cars in 2005, in 2011 there were 349.139 cars in Gaziantep. The increase in the numbers of cars results in the increase in the number of traffic accidents. While number of traffic accidents was 1010 in 2001, in 2012 this number reached to 2972. These data can be shown as an evidence of urban sprawl. When analyzing Gaziantep in terms of compactness; Gaziantep is a sprawl city owing to increasing size of the city in unplanned manner.

The second concept is sustainable transportation. Transportation, a significant contributor to climate change, is the most important problem related to land use patterns. Sustainable transportation reduces the vulnerability to climatic changes. It also provides balance between environmental, social and economic qualities. Sustainable transportation has an urgent priority to achieve urban sustainability. It can be influenced strongly by urban form and growth.

It drew attention to sustainable development of the world's cities in the 21st century. When transportation of Gaziantep is examined in terms of sustainability, there are effective access and mobility in the city. Gaziantep is located on important trade routes that connect the city to surrounding cities and particularly to Syria. There is an international airport in Gaziantep and 254 km of railway exist in the city at the interurban scale. However, Gaziantep has insufficient public transport system at the intracity scale. This problem led to increase in the number of private vehicles, traffic problems and environmental pollution in the city. Population of Gaziantep has grown by 62% while motor vehicle number increased more than doubled. By 2010, Gaziantep had 304,344 motor vehicles, 225 for every 1,000 inhabitants, a rate far higher than most cities with similar incomes and population size. Rapidly growing population and rising automobile dependency in the city led to increase in the rate of GHGs emissions and energy use, naturally. Despite rising automobile dependency, amount of GHGs emission from transportation and amount of private vehicle energy used are still low compared to other cities. While amount of public transportation

energy used was approximately 960.000.000 MJ, private vehicle energy used was nearly three times the amount of public transportation energy used. This amount is still low compared to other cities. Light rail transportation system is considered as a key driver to reduce traffic congestion, air pollution and emit greenhouse gases. Gaziantep has 21 km light rail system. However, it has low transit capacity because of the line that connects high income neighborhood to city center. Low income neighborhood uses private transportation. In other words; low income neighborhood does not have any option other than using their private cars. Briefly, light rail transportation system can't respond to local needs efficiently at the moment. However, MMG plans to extend it by 30km. Pedestrian transportation and cycling have a major importance in the modal split of Gaziantep urban area in Gaziantep transportation master plan. At now, pedestrian streets are partly closed to vehicular traffic in the city's central and there is no bicycle road. However; 19 km bicycle road is planned to be constructed. According to information obtained by literature study, secondary survey and interview, Gaziantep's transportation system is unsustainable due to increasing automobile dependency. But the system grows in a sustainable manner due to taken precautions and high level of awareness can be seen in the knowledge on sustainable development. Municipality points out that necessary measure will be taken related to this issue.

The final concept is mixed-land uses. The mixed-land use has a key role in solving sustainability issues by achieving sustainable urban form. The city of Gaziantep is one of the most developed provinces of the region. The city's total land area is 622.200 hectares. The land is generally sloped and rugged. Urban areas are very limited and dominantly settled in the middle of the land. Mixed land use development means relative proximity of different land uses within a specified area. It influences travel behavior as the average time spent in traveling decreases. In Gaziantep, most of the daily vehicular trips are made for going to work due to the fact that the organized industrial areas, which have an approximate of 40. 000 workers, are constructed at the eastern parts of the city. On the other hand, residential areas are constructed at the southern and western parts. This led to increase in vehicle miles traveled (VMT) and auto traffic. However; the orientation of the growth of the

city was toward to OIZ to reduce daily trips for work. When evaluated in the neighborhood scale, the neighborhoods of Gaziantep include varied areas like recreational, commercial and residential. Mixed land uses decrease average daily vehicular trip rate. According to comparative and comprehensive study about urban trips, 54.08% of the total urban trips are made by pedestrians. This rate is very high compared to other world cities. For example this rate is 39% in New York City which is generally considered to have mixed-used development. Furthermore, the average daily vehicle trip rate per person is 0.49 in Gaziantep. The rate is very low compared to other cities. According to the results of the comparative analysis of the mixed land used development, Gaziantep has developed in mixed-use patterns.

An evaluation of the three design concepts indicates that Gaziantep is not a sustainable city when evaluated in terms of core design concepts in the context of sustainable urban forms. However, city continues to make solid progress toward becoming more sustainable. Gaziantep is being planned with a clear future vision that aims achieving sustainability in so many areas.

REFERENCES

1. Gaziantep Chamber of Commerce. (2013). *Figures for Gaziantep 2013*. Gaziantep: Olay Press.
2. Acioly, J. C., & Davidson, F. (1996). Density in Urban Development. *Building Issues 3*, (LundUniversity, Lund Center for Habitat Studies) .
3. AFD. (2011). *Climate Actions Plan of Gaziantep:Energy and Greenhouse Gas Emissions Profile Preliminary Actions Plan and Implementation Strategy Final Report rev 2* . Retrieved from <http://www.afd.fr/webdav/shared/PORTAILS/PAYS/TURQUIE/PAGE%20D'ACCUEIL/Gaziantep-CCAP-ENG-final-20111102.pdf>
4. Akbari, H. (2005). *Energy Saving Potentials and Air Quality Benefits of Urban Heat Island Mitigation*. Retrieved from Lawrence Berkeley National Laboratory: <http://www.osti.gov/bridge/servlets/purl/860475-UIHWIq/860475.pdf>
5. Alberti, M. (2000). Urban Form and Ecosystem Dynamics. In e. (. Williams, *Achieving Sustainable Urban Form* (pp. 84-96). London: E&F Spon.
6. Aldous, T. (1992). *Urban villages-A concept for creating mixed-use urban developments on a sustainable scale*. London: Urban Villages Group.
7. Alpargu, M. (1999). XV. yüzyılda Antep'in tarihine umumi bir bakış. In Y. Küçükdağ, *Cumhuriyetin 75. Yılına Armağan : Gaziantep*. Gaziantep.
8. Anderson, W. P., Kanaroglou, P. S., & Miller, E. J. (1996). Urban form, energy and the environmental: a review of issues, evidence and policy. *Urban Studies* , 7-35.
9. Anderson, W. P., Kanaroğlu, P. S., & Miller, E. J. (1996). Urban Form, Energy and Environment:A review of Issues, Evidence and Policy. *Urban Studies* 33 , 7-35.

10. Angel, S., Parent, J., Civco, D. L., Blei, A., & Potere, D. (2011). The Dimensions of Global Urban Expansion: The Dimensions of Global Urban Expansion 2000-2050. *Progress in Planning* , 53-107.
11. Arsan, Z. D. (2008). Türkiye’de Sürdürülebilir Mimari. *Mimarlık* .
12. Aru, K. A. (1996). Concepts on the general characteristics of Ottoman-Turkish cities. In Y. Sey, *Tarihten Günümüze Anadolu’da Konut ve Yerleşme (Housing and settlement in Anatolia: a historical perspective) Second United Nations Human Settlements Conference (Habitat II) (Economic and Social History* (pp. 329-35).
13. Ay, Y. S. (2001). Gaziantep'te Planlamaya Genel Bakış. *Türkiye Mühendislik Haberleri* (415), 44-46.
14. Bachi, R. (1999). *New methods of geostatistical analysis and graphical presentation: distributions of populations over territories*. New York: Springer.
15. Banister, D., Watson, S., & Wood, C. (1997). Sustainable cities: transport, energy and urban form. *Environment and Planning b: Planning and Design* 24 , 125-143 .
16. Barrett, G. (1996). The Transport Dimension. In M. Jenks, & K. William, *The Compact City: A Sustainable Urban Form?* Chapman and Hall, London: Spon Press.
17. Barton, H. (2000). Urban form and locality. In H. Barton, *Sustainable Communities: The potential for eco-neighbourhoods*. Earthscan Publications Ltd.
18. Battle, G., & Christopher McCarthy. (2001). *Sustainable Ecosystems and the Built Environment*. London: Wiley-Academic.
19. Bertaud, A., & Malpezzi, S. (1999). *The Spatial Distribution of Population in 35 World Cities: The Role of Markets, Planning and Topography*. Center for Urban Land Economics Research.

20. Bottema, M. J. (2000). Circularity of objects in images. *International Conference on Acoustic, Speech and Signal Processing*, (pp. 2247–2250). Istanbul.
21. Breheny, M. (1995). *Compact Cities and Transport Energy Consumption* (Vol. 1). Transactions of the Institute of British Geographers.
22. Breheny, M. (1992). *European Research in Regional Science: Sustainable Development and Urban Form*. London: Pion Ltd.
23. Breheny, M. J., & Rookwood, R. (1993). Planning the sustainable city region. In A. Blowers, *Planning for a Sustainable Environment* (pp. 150-189). London: Earthscan.
24. Breheny, M. (1992). Sustainable Development and Urban Form: An Introduction. In M. Breheny, *Sustainable Development and Urban Form* (pp. 138-159). London: Pion Limited.
25. Breheny, M. (1991). *Sustainable Development and Urban Form: The Contradictions of the Compact City*. England: Oxford.
26. Breheny, M. (1992). The Contradictions of the Compact City: A Review. In M. Breheny, *Sustainable Development and Urban Form* (pp. 138-159). London: Pion Limited.
27. Bribiesca, E. (1997). Measuring 2-D shape compactness using the contact perimeter. *Computers & Mathematics with Applications*, 33 , 1-9.
28. Burton, E. (2002). Measuring Urban Compactness in UK Towns and Cities. *Environment and Planning B: Planning and Design* 29 , 219-250.
29. Buxton, M. (2000). Energy, Transport and Urban Form in Australia. In e. (. Williams, *Achieving Sustainable Urban Form* (pp. 54-63). London: E&F Spon.
30. Çalışkan, O. (2004). *Urban Compactness: A study of Ankara Urban Form*. Ankara: Master Thesis.

31. Calthorpe, P. (1993). *The Next American metropolis: Ecology, community, and the American Dream*. Princeton: Architectural Press.
32. CARA. (n.d.). *Our Energy Use and Climate Change*. Retrieved 07 10, 2013, from Consortium for Atlantic Regional Assessment: <http://www.cara.psu.edu/tools/energy/index.html>
33. CEC. (1990). *Green Paper on The Urban Environment*. Brussels: Office for Official Publications of the European Communities.
34. Center for Sustainability. (2004). *Transportation Research Laboratory*. Retrieved from www.trl.co.uk.
35. Cerasi, M. M. (1999). *Osmanlı Kenti:Osmanlı İmparatorluğunda 18 ve 19. Yüzyıllarda Kent Uygarlığı ve Mimarisi*. İstanbul: Yapı Kredi Yayınları.
36. Cervero, R. (1998). *The transit metropolis: A global inquiry*. Washington, DC: Island Press.
37. Cervero, R., & Kockelman, K. (1997). Travel Demand and the 3Ds: Density, Diversity and Design. *Transportation Research-D 2* , 199-219.
38. Cole, J. P. (1964). Study of major and minor civil divisions in political geography. *The 20th International Geographical Congress*. London.
39. Congress for the New Urbanism. (2001). *New Urbanism Basics*. Retrieved from <http://www.cnu.org/about/index.cfm>
40. CRP 401-402 Planning Studio Analyses. (2012). (*METU: Department of City and Regional Planning*) . Ankara: Unpublished Report.
41. Cuff, D. (2001). *The Provisional City*. Cambridge: MA: MIT Press.
42. Dantzig, G. B., & Saaty, T. L. (1973). *Compact City: Plan for a Liveable Urban Environment*. San Francisco: W. H. Freeman.

43. Department of the Environment, Transport and the Regions (DETR). (1998). *Planning research programme: The use of density in urban planning*. London: TSO.
44. DHMI. (2010). Retrieved from <http://www.gaziantep.dhmi.gov.tr/havaalanlari/default.aspx?hv=12>
45. DoE. (1994). *Sustainable Development: The UK Strategy Department of the Environment*. London: The Stationery Office.
46. Duany, A., & Plater-Zyberk, E. (1991). *Towns and Town-Making Principles*. New York: Rizzol.
47. Dumbaugh, E., & Rae, R. (2009). Safe Urban Form: Revisiting the Relationship Between Community Design and Traffic. *Journal of the American Planning Association* , 309-329.
48. ECA. (2011). *ECA Sustainable Cities: Improving Energy Efficiency in Gaziantep (Turkey)*. Retrieved from http://www.esmap.org/sites/esmap.org/files/EECI_Gaziantep_TRACE_Pilot_Report_and_Annexes.pdf
49. *Ecological Cities*. (2007, 08 18). Retrieved 07 28, 2013, from Urban Ecology Australia: <http://www.urbanecology.org.au/topics/ecologicalcities.html>
50. EEA. (2006). *Urban sprawl in Europe. The ignored challenge*. European Commission/Joint Research Centre.
51. Ehrlich, P. R. (1968). *The Population Bomb*. Newyork: Buccaneer Books Inc.
52. Elkin, T., Duncan , M., & Mayer, H. (1991). *Reviving the City: Towards Sustainable Urban Development*. London: Friends of the Earth.
53. Ewing, R. (1997). Is Los Angeles-Style Sprawl Desirable? *American Planning Association Journal* 63 , 107-126.
54. Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., & Chen, D. (2007). *Smart Growth America*. Retrieved 11 10, 2013, from Growing

Cooler: Evidence on Urban Development and Climate Change:
<http://www.smartgrowthamerica.org/documents/exec2.pdf>

55. Ewing, R., Schieber, R. A., & Zegeer, C. V. (2003). Urban Sprawl as a Risk Factor in Motor Vehicle Occupant and Pedestrian Fatalities. *Am J Public Health* , 1541–1545.
56. Feitelson, E., & Verhoef, E. (2001). *Transport and Environment: In Search of Sustainable Solutions*. London: Edward Elgar Publishing Ltd.
57. Frey, H. (1999). *Designing the City: Towards a more Sustainable Urban Form*. London: E&F Spon.
58. Frolov, Y. S. (1975). Measuring shape of geographical phenomena - history of issues. *Soviet Geography Review and Translation*, 16 , 676–687.
59. Fulford, C. (1996). The compact city and the market: The case of residential development. In M. Jenks, E. Burton, & K. Williams, *The compact city: A sustainable urban form?* (pp. 122-133). London: E & FN Spon.
60. G-20 Toronto Summit. (2010, June 26-27). The G-20 Toronto Summit Declaration. Toronto, Canada.
61. Gaffron, P., Huismans, G., & Skala, F. (2005). *Ecocity; Book 1; A better place to live*. Hamburg, Utrecht, Vienna: Facultas Verlags- und Buchhandels AG, Vienna.
62. Galster, G., Hanson, R., Ratcliffe, M. R., Wolman, H., Coleman, S., & Freihage, J. (2000). *Wrestling Sprawl to the Ground: Defining and Measuring an Elusive Concept*. Fannie Mae Foundation.
63. Galster, G., Royce, H., Hal, W., Stephen, C., & Jason, F. (2001). Wrestling Sprawl to the Ground: Defining and Measuring an Elusive Concept. *Housing Policy Debate* 12 , 681-717.
64. Gehl, J. (1996). *Public Spaces, Public Life*. Copenhagen: Arkitektens Forlag.

65. Gillham, O. (2002). *The limitless city: A primer on the urban sprawl debate*. Washington, DC: Island Press.
66. Gillham, O. (2002). *The Limitless City: A Primer on the Urban Sprawl Debate*. Washington: Island Press.
67. Gordon, P., & Richardson, H. W. (1997). Are Compact Cities A Desirable Planning Goal? *American Planning Association Journal* 63 , 95-106.
68. Governorship of Gaziantep. (2010). *Gaziantep Valiliđi*. Retrieved 10 09, 2013, from İlimiz Hakkında: <http://www.gaziantep.gov.tr/#>
69. Gyn, N. (1999). Trkiye Cumhuriyeti'nin 75. Yılında Gaziantep. In Y. Kkdađ, *Cumhuriyetin 75. Yılına Armađan:Gaziantep*. Gaziantep.
70. Grant, J. (2002). Mixed Use in Theory and Practice. *APA Journal* 68 , 71-84.
71. Grierson, D. (2003). Arcology and Arcosanti: Towards a Sustainable Built Environment. *Electronic Green Journal* , Academic Search Premier.
72. Hardin, G. (1968). The Tragedy of the Commons. *Nature*,162 , 1243-1248.
73. Haughey, R. M. (2005). *High-density development: Myth and fact*. Washington, DC: Urban Land Institute.
74. Haughton, G. (1997). Developing Sustainable Urban Development Models. *Cities* , 189-195.
75. Howard, E. (1960). *Garden Cities Of To-Morrow*. London: Faber and Faber.
76. IEA. (2009). *Transport Energy and CO2*. Paris.
77. İKA. (2013). *İpekyolu Kalkınma Ajansı*. Retrieved 10 11, 2013, from Ulaşım ve Altyapı: <http://www.ika.org.tr/Ulasim-ve-Altyapi-icerik-68.html>
78. *International Ecocity Standards*. (2010). Retrieved 2013, from Ecocity Builders : <http://ecocitybuilders.org/IESproject.html>
79. IPCC. (2001). *Climate Change 2001: Impact, Adaptation and Vulnerability*. Cambridge, UK: Cambridge University Press.

80. IPCC. (2007). *IPCC Fourth Assessment Report: Climate Change 2007*. Cambridge: Cambridge University Press.
81. IPCC. (2007). *IPCC Fourth Assessment Report: Climate Change 2007*.
82. IUCN, UNEP and WWF. (2013). *Caring for the Earth-A strategy for sustainable living*. London: Earthscan Publishing.
83. Jabareen, Y. (2004). A knowledge map for describing variegated and conflict domains of sustainable development. *Journal of Environmental Planning and Management* (47), 32-42.
84. Jabareen, Y. R. (2006). Sustainable Urban Forms : Their Typologies, Models, and Concepts. *Journal of Planning Education and Research* , 26-38.
85. Jabareen, Y. R. (2006). Sustainable Urban Forms Their Typologies, Models, and Concepts. *Journal of Planning Education and Research* , 38-52.
86. Jansen, H. (1937). *Ankara İmar Planı-Ankara Development Plan*. İstanbul: Alaeddin Kırıl Basımevi.
87. Jenks, M., & Burgess, R. (2000). *Compact Cities. Sustainable Urban Forms for Developing Countries*. London: Spon Press.
88. Jenks, M., & Dempsey, N. (2005). Defining the neighbourhood.Challenges for empirical research. *Town Planning Review* 78 , 153–177.
89. Jenks, M., & Dempsey, N. (2005). *Future Forms and Design for Sustainable Cities*. Amsterdam: Architectural Press.
90. Jenks, M., Burton, E., & Williams, K. (1996). *The Compact City. A Sustainable Urban Form?* Chapman and Hall, London: Spon Pres.
91. Jones, K. (2006). *Sustainable Development Policy*. Cardiff and Vale NHS Trust.
92. Kaçar, Y. (2008). *Neo-Liberal Yapılanmanın Kentsel Mekâna Yansımaları: Gaziantep Örneği*. Mersin: Master Thesis.

93. Karakaya, E. (2012). Establishment Of National Economic Space: Jansen's Urban Planning In South Anatolia. *AESOP 2012*. Ankara: METU Press.
94. Kasanko, M., Barredo, J. I., Lavalle, C., McCormick, N., Demicheli, L., Sagris, V., et al. (2006). Are European Cities Becoming Dispersed? A Comparative Analysis of Fifteen European Urban Areas. *Landscape and Urban Planning* , 111-130.
95. Kelly, C. (no date). *Origins of Sustainability*. Retrieved 12 31, 2013, from University of Leeds: <http://www.its.leeds.ac.uk/projects/sustainability/resources/Origins%20of%20Sustainability.doc>
96. Kelly, E. D. (1994). 'The transportation land-use link. *Journal of Planning Literature* 9 , 128–145.
97. Kim, C. E., & Anderson, T. A. (1984). Digital disks and a digital compactness measured. In C. E. Kim, & T. A. Anderson, *Proceedings of the sixteenth annual ACM symposium on theory of computing* (pp. 117–124). New York: ACM Press.
98. Knight. (1996). "Economic and Social Issues", chapter in M Jenks, E Burton and KWilliams (eds) *The Compact City: A Sustainable Urban Form*. London: E&F N Spon.
99. Kostof, S. (1991). *The City Shaped: Urban Patterns and Meanings Through History*. London: Thames and Houston Ltd.
100. Krier, L. (1984). The City Within the City. *Architectural Design* , 16-22.
101. Kuban, D. (1986). *Turkish culture and arts*. Istanbul: BBA.
102. Kubat, A. S. (2009). The study of urban form in Turkey. *Urban Morphology* (pp. 31-48). Istanbul: International Seminar on Urban Form.

103. Kurian, G. T. (2001). *The Illustrated Book of World Ranking*. Michigan: Sharpe Reference.
104. Litman, T. (2006). Issues in sustainable transportation. *Int. J. Global Environmental Issues* , 331-347.
105. Litman, T. (2003). *Sustainable Transportation Indicators*. Retrieved 09 08, 2013, from http://www.vtpi.org/sus_iss.pdf
106. Livingston, A., Ridlington, E., & Baker, M. (2003). *The Cost of Sprawl: Fiscal, Environmental, and Quality of Life Impacts of Low Density Development in the Denver Region*. Colorado: Environment Colorado Research and Policy Center.
107. Masnavi, M. R. (2000). The New Millennium and the New Urban Paradigm: The Compact City in Practice. In K. Williams, E. Burton, & M. Jenks, *Achieving Sustainable Urban Form* (pp. 64-73). London: E & FN Spon.
108. Massam, B. H., & Goodchild, M. F. (1971). Temporal trends in the spatial organization of a service agency. *Canadian Geographer*, 15 , 193–206.
109. Matsumoto, T. (2011, 11 02). *Compact City Policies: A Comparative Assessment – Final Report*. Retrieved 07 27, 2013, from The Energy Smart Communities Initiative (ESCI): <http://esci-ksp.org/wp/wp-content/uploads/2012/03/Compact-Cities-Report-DRAFT.pdf>
110. McMillan, D. W., & Chavis, D. M. (1986). Sense of community: A definition and theory. *Journal of Community Psychology* , 6-23.
111. McNally, M. G., & Ryan, S. (1992). *Accessibility of Neotraditional Neighborhoods: A Review of Design Concepts, Policies, and Recent Literature*. Berkeley, California: The University of California Transportation Center.

112. MEF. (2010). *Republic of Turkey, National Climate Change Strategy (2010-2020)*. Retrieved from <http://iklim.cob.gov.tr/iklim/Files/Stratejiler/National%20Strategy.pdf>
113. Melia, S., Parkhurst, G., & Barton, H. (2011). *The paradox of intensification*.
114. MEU. (2011). *Turkey's National Climate Change Adaptation Strategy and Action Plan*. Ankara: BMS Press.
115. MFA. (2011). *Republic of Turkey Ministry of Foreign Affairs*. Retrieved 06 15, 2013, from United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol: http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa
116. Miller, V. C. (1953). *A quantitative geomorphic study of the drainage basin characteristics in the Clinch Mountain area, Virginia and Tennessee*. New York: Columbia University Department of Geology Technical Report, No. 3.
117. Moore, T., & Throsnes, P. (1994). *The Transportation/Land use Connection*. Chicago: American Planning .
118. Moving on Sustainable Transportation (MOST). (1999). *Transport Canada*. Retrieved from www.tc.gc.ca/envaffairs/most
119. Mulligan, J. (2011). Understanding Sustainability: Quality-Of-Life And Opportunities For Design. In E.-R. Committee (Ed.), *A Declaration and a Framework on Architectural Research*, (pp. 1-4).
120. Mumford, L. (1960). The Garden City Idea and Modern Planning. In E. Howard, *Garden Cities of Tomorrow* (pp. 29-40). London: Faber and Faber.

121. Nelson , A. C. (2004). Urban Containment American Style. In C.-H. C. Harry Ward Richardson, *Urban Sprawl in Western Europe and the USA* (pp. 237-254). England: Ashgate Publishing Ltd.
122. Nelson, A. C., & Duncan , J. B. (1995). *Growth Management Principles and Practices*. Chicago: APA.
123. Neuman, M. (2005). The Compact City Fallacy. *Journal of Planning Education and Research* , 11-26.
124. Newman, P., & Kenworthy, J. (1989). *Cities and Automobile Dependence: An International Sourcebook*. Aldershot, UK: Gower Publishing Company.
125. Newman, P., & Kenworthy, J. (1999). *Cities and automobile dependence*. Aldershot: Gower Technical.
126. Newman, P., & Kenworthy, J. R. (1999). *Sustainability and Cities: Overcoming Automobile Dependence*. Island Press.
127. Newton, P. (2000). Urban Form and Environmental Performance. In K. Williams, E. Burton, & M. Jenks, *Achieving Sustainable Urban Form* (pp. 46-53). London: E & FN Spon.
128. Newton, P. W. (2000). Urban form and environmental performance. In K. Williams, *Achieving Sustainable Urban Form* (pp. 46-53). London: E &FN Spon.
129. OCFP. (2005). *The Health Impacts Of Urban Sprawl Information Series Volume Two:Road Injuries and Fatalities*. Ontario.
130. OECD. (2010). *Cities and Climate Change*. OECD Publishing.
131. OECD. (2012). *Compact City Policies : A Comparative Assessment*. OECD Publishing.

132. Oktay, D. (2004). Urban Design for Sustainability:A Study on the Turkish City. *International Journal of Sustainable Development and World Ecology* , 24-35.
133. Osserman, R. (1978). Isoperimetric inequality. *Bulletin of the American Mathematical Society*, 84 , 1182–1238.
134. O'Toole, R. (1997, 09 30). *Will Congress Make It Harder for You to Travel?* Retrieved 09 23, 2013, from CATO Institute: <http://www.cato.org/publications/commentary/will-congress-make-it-harder-you-travel>
135. Owen, D. (2009). *Green metropolis: Why living smaller, living closer, and driving less are the keys to sustainability*. New York: Riverhead Books.
136. Owens, S. E. (1986). *Energy, Planning and Urban Form*. London: Pion.
137. Pearson, C. (1990). The New New Town. *Builder* , 294-301.
138. Pendall, R., Jonathan, M., & William, F. (2002). *Holding the Line: Urban Containment In The United States*. The Brookings Institution.
139. PlaNYC. (2011, 04). *Publications*. Retrieved 11 12, 2013, from NYC: <http://www.nyc.gov/html/planyc2030/html/publications/publications.shtml>
140. Ravetz, J. (2000). Urban Form and the Sustainability of Urban systems. In K. Williams, E. Burton, & M. Jenks , *Achieving Sustainable Urban Form* (pp. 2215-228). London: E & FN Spon.
141. Richardson, L. F. (1961). A note: measuring compactness as a requirement of legislative apportionment. *Mid-west Journal of Political Science*, 5 , 70–74.
142. Rickaby, P. (1987). *Six Settlement Patterns Compared* (Vol. 14). Environment and Planning B.

143. Rogers, R. (1995). *Megacities / Lectures*. Retrieved from http://www.megacities.nl/lecture_rogers.htm
144. S, S. d. (2006). Sustainable Urban Form: Environment and Climate Responsive Design. In R. Zetter, & W. G. Butina, *Designing Sustainable Cities in the Developing World* (pp. 163-178). Aldershot: Ashgate.
145. Santiago, R. S., & Bribiesca, E. (2009). State of the art of compactness and circularity measures. *International Mathematical Forum*, 4 , 1305–1335.
146. Scheurer, J. (2001). *Urban Ecology, Innovations in Housing Policy and the Future of Cities: Towards Sustainability in Neighborhood Communities (unpublished thesis)*. Retrieved from <http://www.istp.murdoch.edu.au/publications/projects/jan>
147. Schubert, U. (2001). *Urban Development towards Appropriate Structures For Sustainable Transport*. Wien: Energy, Environment and Sustainable Development.
148. Sherlock, H. (1991). *Cities are Good for Us*. London: Paladin.
149. Silk, L., & Lopez, R. (2005). *State of the Great Lakes 2005*. Retrieved 08 31, 2013, from Bionational: http://binational.net/solec/English/SOLEC%202004/Tagged%20PDFs/SOGL%202005%20Report/English%20Version/Individual%20Indicators/7000_Urban_Density.pdf
150. Soleri, P. (1996). Arcology: The City in the Image of Man and The Characteristics of Arcology. In R. T. LeGates, & F. Stout, *The City Reader* (pp. 453-457). London and New York: Routledge.
151. SPO. (2006). *Ninth Development Plan*. Ankara.
152. TCDD. (2009). Retrieved from <http://www.tcddadanatrafik.com/>

153. Transportation Research Board. (1997). *Toward a Sustainable Future*. Washington DC: Special Report 251.
154. TUIK. (2012). *Turkish Statistical Institute*. Retrieved 11 10, 2013, from Temel İstatistikler: <http://www.tuik.gov.tr/UstMenu.do?metod=temelist>
155. TUIK. (2012). *Turkish Statistical Institute*. Retrieved 11 10, 2013, from Temel İstatistikler: <http://www.tuik.gov.tr/UstMenu.do?metod=temelist>
156. TUIK. (2013, 04 12). *Turkish Statistical Institute*. Retrieved 09 12, 2013, from Greenhouse Gas Emissions Inventory, 1990-2011: <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=13482>
157. TUIK. (2013). *What the Figures Say*. Ankara: Turkish Statistical Institute, Printing Division.
158. UICN/UNEP/WWF. (1991). *Caring for the Earth: A Strategy for Sustainable Living*. Gland, Switzerland.
159. UITP. (n.d.). Retrieved from http://www.uitp.org/news/pics/pdf/MB_CO21.pdf
160. UN. (1992). ENVIRONMENT AND DEVELOPMENT. *REPORT OF THE UNITED NATIONS CONFERENCE ON* . Rio de Janeiro: United Nations Department of Economic and Social Affairs.
161. UN. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. UN.
162. UN. (1972). The UN Conference on the Human Environment. *Declaration of the United Nations Conference on the Human Environment* (p. 4). Stockholm: United Nations Publication.
163. UN. (1996). *What is a City?* Retrieved 08 09, 2013, from United Nations: <http://www.un.org/cyberschoolbus/habitat/units/un01txt.asp>
164. UNCHS . (2001). *Cities in a Globalizing World: Global Report on Human Settlements*. London: Earthscan.

165. UNCSO. (2012). *Rio+20 Corporate Sustainability Forum: Innovation and Collaboration for the Future We Want*. Retrieved 10 12, 2013, from Rio+20 United Nations Conference on Sustainable Development: <http://www.uncsd2012.org/index.php?page=view&nr=534&type=13&menu=23>
166. UNEP. (n.d.). Retrieved 11 12, 2013, from About UNEP: The Organization: <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=43>
167. UNEP. (2009). *Buildings and Climate Change; Summary for Decision-Makers*. Paris: United Nations Environment Programme.
168. UNEP. (2009). *Report of the Governing Council*. New York: United Nations.
169. UNEP/GRID-Arendal. (2008). *Climate change global processes and effects*. Malta: Progress Press.
170. UN-Habitat. (2011). *Global report on human settlements 2011; Cities and Climate Change*. London; Washington DC: Earthscan.
171. UN-Habitat. (2012). *Sustainable Urbanization In Asia*. Nairobi: United Nations Human Settlements Programme.
172. Urban Task Force. (2005). *Towards a strong urban renaissance*. London: HMSO.
173. Vehkamäki, S. (2013, 12 12). The concept of sustainability in modern times. Finland: University of Helsinki.
174. Ward, S. V. (2002). Ebenezer Howard: His Life and Times. In K. C. Parsons, & D. Schuyler, *From Garden City to Green City: The Legacy of Ebenezer Howard* (pp. 14-37). Baltimore: The John Hopkins University Press.

175. Wasserman, R. W. (2008). Causes of Urban Sprawl in the United States, Auto Reliance as Compared to Natural Evolution, Flight from Blight, and Local Revenue Relianc. *Journal of Policy Analysis and Management* , 536-555.
176. Wentz, E. A. (2000). A shape definition for geographic applications based on edge, elongation, and perforation. *Geographical Analysis*, 32 , 95–112.
177. Wheeler, S. (2004). *Planning Sustainable and Livable Cities*. New York: Routledge.
178. Williams, K., Burton, E., & Jenks, M. (2000). *Achieving Sustainable Urban Form*. London: Spon Press.
179. Williams, K., Burton, E., & Jenks, M. (2000). Achieving Sustainable Urban Form: Conclusions. In K. Williams, E. Burton, & M. Jenks, *Achieving Sustainable Urban Form* (pp. 347-355). London: E & FN Spon.
180. Williams, K., Burton, E., & Jenks, M. (2000). Urban form and environmental performance. In K. Williams, E. Burton, & M. Jenks, *Achieving sustainable urban form* (pp. 46-53). London: E & FN Spon.
181. Wirth, L. (1938). Urbanism as a Way of Life. *The American Journal of Sociology* , 1-24.
182. Zhao, Z. Q., & Stough, R. R. (2005). Measuring similarity among various shapes based on geometric matching. *Geographical Analysis*, 37 , 410–422.