ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

CLIMATE CHANGE AND URBAN RESILIENCE: VULNERABILITY AND RISK ASSESSMENT FOR ISTANBUL

M.Sc. THESIS

Aysun AYGÜN

Department of Urban and Regional Planning

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JANUARY 2015

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Thesis Advisor: Prof. Dr. Tüzin BAYCAN

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

İKLİM DEĞİŞİKLİĞİ VE KENTSEL DAYANIKLILIK: İSTANBUL İÇİN KIRILGANLIK VE RİSK DEĞERLENDİRMESİ

YÜKSEK LİSANS TEZİ

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OCAK 2015

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Date of Submission : 15 December 2014
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To my family,

FOREWORD

I would like express deepest gratitude to my advisor Prof. Dr. Tüzin BAYCAN for her help during the past few years. Her support, constructive critics, encouragement and motivation she gave contributed a lot to me personally and this thesis study. My thanks also go to my friends and colleagues for their support and valuable suggestions. I would like to acknowledge all those who gave their time during interviews and answer my questions patiently. Finally, I am grateful to my parents and family for supporting me in every aspect of life. Despite the distance, they were always with me.

December 2014

Aysun AYGÜN
(Urban Planner)

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ABBREVIATIONS

AKOM : Disaster Coordination Center
AMM : Antalya Metropolitan Municipality
APP : Appendices
DPT : State Planning Organization
DSI : State Hydraulic Works
EEA : European Environment Agency
GDP : Gross Domestic Product
GHG : Green House Gas
ICLEI : Local Governments for Sustainability
IDPFAL : İstanbul Directorate of Provincial Food Agriculture and Livestock
IER : İstanbul Environmental Report
IETT : İstanbul Electricity Tramway and Tunnel
IMM : İstanbul Metropolitan Municipality
IMP : İstanbul Master Plan
IPCC : Intergovernmental Panel on Climate Change
ISDR : International Strategy for Disaster Reduction
ISFALT : İstanbul Asphalt Factories
ISKI : İstanbul Water and Sewerage Administration
ISTAC : İstanbul Environmental Management in Industry and Trade
ITO : İstanbul Chamber of Commerce
LRT : Light Rail Transit
NGO : Non-Governmental Organization
OECD : Organization for Economic Co-operation and Development
R&D : Research and Development
TARBIL : Agricultural Monitoring and Information System
TOKI : Housing Development Administration
TPAO : Turkish Petroleum Corporation
TURKSTAT : Turkish Statistical Institute
UNCED : United Nations Conference on Environment and Development
UNESCO : United Nations Educational, Scientific and Cultural Organization
UNFCCC : United Nations Framework Convention on Climate Change
UNISDR : United Nations International Strategy for Disaster Reduction
URBES : Urban Biodiversity and Ecosystem Services
WWF : World Wide Fund for Nature

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CLIMATE CHANGE AND URBAN RESILIENCE: VULNERABILITY AND RISK ASSESSMENT FOR İSTANBUL

SUMMARY

Climate is changing and human activities are accelerating the natural changes in the climate. It has been already observed and projected that these changes will have significant impacts on ecosystems, physical systems and linked human activities. The urban areas especially metropolitan cities will experience several adverse impacts from climate change over the coming decades such as temperature increases, drought, and flood events. Since the number of people living in cities has passed 50 per cent, cities have become the most crucial part of the challenge of adapting to climate change in developing world. Metropolitan cities as engines of the urbanization and economic development are under risk due to adverse impacts of climate change. Determining the adapting strategies, risk level, vulnerability level and vulnerable areas in a city are the critical parts that should be concerned. The idea of managing vulnerabilities and risks forms after the determination of vulnerabilities and risks, which generates the first step of a long-term study. Unless cities have a clear understanding of the vulnerability and risk to climate change, the measures may be meaningless and ineffective. Therefore, assessing vulnerability and risk of cities to climate change becomes an important issue for developing resilience and adaptation strategies.

This study aims to investigate climate change related vulnerabilities and risks on vital sectors in Istanbul urban system as the largest metropolitan city of Turkey. The vital sectors have been defined as the resource, ecological system, species, management area, activity, or other area of interest that may be affected by climate change and critical to health of citizens and the economic viability of the city. Based on Istanbul's regional development strategies in Istanbul Development Plan prepared by Istanbul Development Agency, 11 sectors; health, water resources, energy, transportation, agriculture, public safety, land use and development, materials, infrastructure, ecology and biodiversity and culture and 25 planning areas in those sectors have been determined to analyze. The vulnerability assessment and risk assessment on those sectors has been applied considering the ICLEI publication "Preparing for Climate Change; A Guidebook for Local, Regional and State Governments". Obtained data has been used to rank sectors from the most to the least vulnerability and at-risk. The results of this study highlight which sectors are the most vulnerable and under the greatest risk due to climate change. According to the results of the study the most vulnerable and at-risk sectors in Istanbul are public safety, health, ecology and biodiversity, water resources and infrastructure. The least vulnerable and at risk sector is materials. Determining the vulnerability and risk of climate change on sectors will help decision makers to develop adaptation, mitigation strategies and resilience for further studies.

İKLİM DEĞİŞİKLİĞİ VE KENTSEL DAYANIKLILIK: İSTANBUL İÇİN KIRILGANLIK VE RİSK DEĞERLENDİRMESİ

ÖZET

Küresel iklim değişikliği çağımızın kaçınılmaz bir gerçeğidir ve insan faaliyetleri iklim değişikliği etkilerinin daha da hızlı görülmesine sebep olmaktadır. İklim değişikliği ile kuraklık, sel, aşırı hava sıcaklıkları, olağandışı hava olayları gibi olumsuz etkilerin meydana gelmesi beklenmektedir ve kent sistemleri bu olumsuzluklara doğrudan maruz kalmaktadır. Dünya üzerinde iklim değişikliğinden olumlu veya olumsuz herhangi bir şekilde etkilenmeyecek bir ekosistem, kent veya herhangi bir sistem bulunmamaktadır. Kentler, özellikle metropoliten alanlar gerek ekonomik gelişmenin odağı olduğundan, gerekse çok büyük oranlarda nüfus barındırdığından büyük riskler taşımaktadırlar ve iklim değişikliği etkilerine karşı kapsamlı bir çalışmayla ele alınmalıdırlar. Kentsel alanlardaki nüfus dünyada %50'ye varmıştır ve bunun gelecekte daha da artması beklenmektedir. Bu noktada kentlerin ve metropoliten alanların iklim değişikliğine karşı dayanıklılığını arttırmak odak noktası olmakta ve kentlerin iklim değişikliğine karşı hazırlıklı olması gerekmektedir. Metropoliten alanların iklim değişikliğine karşı hazırlıklı olması olası herhangi bir iklim kaynaklı afet meydana geldiğinde oluşacak kayıp ve felaketleri azaltmayı veya önlemeyi sağlamaktadır. Metropoliten kentlerin iklim değişikliğine karşı hazırlıklı olması için geliştirilecek stratejilerde hangi konuların ve sektörlerin öncelikli olduğunun belirlenmesi, ilk müdahaleye nereden başlanması gerektiğinin saptanması büyük önem taşımaktadır. İklim değişikliğine hazırlık, adaptasyon ve zarar azaltma stratejilerinin geliştirilmesi uzun soluklu bir süreç gerektirmektedir. Bu sürecin ilk adımı risk faktörlerinin tanımlanması, kırılganlıkların belirlenmesi ve öncelikli müdahale alanlarının ortaya konmasıdır. Belirlenecek stratejiler bu adım olmadan anlamsız ve etkisiz kalacaklardır. Müdahale edilecek öncelik alanlarının belirlenmesi iklim değişikliğine karşı dayanıklı kent gelişimi için alınacak kararlarda ve geliştirilecek stratejilerde bir yol gösterici görevi görmektedir.

Türkiye iklim değişikliği ile mücadele konusunda uluslararası protokollere dahil olmuş, ulusal plan ve stratejiler geliştirmeye başlamış ve bazı bölgelerde yerel planlar oluşturulmaya başlanmıştır. İklim değişikliği konusu dünyada önemsenen bir konudur ve bir çok ülke adaptasyon, zarar azaltma stratejileri geliştirilmekteö bu stratejiler hem ulusal hem de yerel ölçekte uygulanmaktadır. Ülkemiz için iklim değişikliği ile mücadele yeni bir olgudur, önemi yeni anlaşılmaya başlanmıştır. Yapılan uluslararası protokoller Türkiye'de yapılan çalışmaların hızlandırılmasında önemli bir role sahiptir. Ulusal ölçekte çerçevesi tanımlanmış stratejiler ve hedefler ışığında Türkiye için iklim değişikliği mücadele ve eylem planı hazırlanmıştır. Bu plan ülke çapında ilk aşama olmakla birlikte bir sonraki aşama olan yerel planların hazırlanması büyük öneme sahiptir. Bu konuda bazı çalışmalar ile ilk adımlar atılıştır ancak hala gereken önem verilmeye başlanmamıştır. Türkiye'nin en büyük metropoliten kenti olan İstanbul için henüz iklim değişikliği odaklı çalışmalar ve

planlara başlanmamıştır. İklim değişikliğinin kentler üzerinde kaçınılmaz etkileri düşünüldüğünde yerel planların hazırlanılması iklim değişikliğinin zararlı etkilerine karşı kentlerin hazırlıklı olabilmesi için büyük öneme sahiptir. İstanbul için bu konudaki eksiklikler ve konunun önemi bu tez çalışmasının motivasyonunu oluşturmaktadır.

Bu çalışma İstanbul metropoliten alanında kent sistemindeki sektörlerin kırılganlık derecelerini ve risk seviyelerini göz önüne alarak öncelikli müdahale edilmesi gereken sektörleri tespit etmeyi amaçlamaktadır. Çalışmanın çerçevesini ICLEI tarafından hazırlanmış olan "Preparing for Climate Change; A Guidebook for Local, Regional and State Governments" yayını oluşturmaktadır. Belirlenen bu çerçeve kapsamında İstanbul metropoliten alanı için hayati öneme sahip 11 sektör ve bu sektörlere bağlı 26 planlama alanı analiz edilmek üzere tanımlanmıştır. Sektörler bir kent sisteminde iklim değişikliğinden etkilenebilecek doğal veya yapılı kaynaklar, ekosistemler ve servisler olarak tanımlanmaktadır. İstanbul için bu sektörler tanımlanırken İstanbul Kalkınma Ajansı tarafından hazırlanmış olan İstanbul Bölge Planı'nda belirlenen İstanbul'un kalkınma stratejileri göz önüne alınmış ve analiz edilecek bu 11 sektör sağlık, su kaynakları, enerji, ulaşım, tarım, güvenlik, arazi kullanımı ve gelişimi, atıklar, altyapı, ekoloji ve biyolojik çeşitlilik ve kültür olarak belirlenmiştir. Sektörlerin her birinin kırılganlık ve risk değerlendirme sonuçlarına göre kırılganlık dereceleri ve risk faktörlerine bağlı olarak taşıdıkları risk büyüklüklüleri üzerinden önceliklendirme analizi yapılmıştır. Analizlerin yapılabilmesi için İstanbul metropoliten alanında yapılan planlar ve plan raporları incelenmiş, konunun aktörü olan veya konu ile ilgili çalışmalar yapan kamu kurumlarının temsilcileri, özel şirket yetkilileri ve akademisyenlerle görüşülmüş, bilgi toplanmıştır. Çalışmanın temel veri tabanını oluşturan bu kişisel görüşmeler Nisan-Aralık 2014 tarihleri arasında 55 kişi ile gerçekleştirilmiştir. Görüşülen kurumlar ve kişiler kamu kurumları, belediye birimleri, özel şirket ve kuruluşlar, konu ile ilgili açlışmalar yapan akademisyenler ve sivil toplum kuruluşlarından seçilmiştir. Kamu kurumları ve belediye birimlerine görüşmelerde ağırlık verilmiştir bunun sebebi kent üzerinde yapılacak plan ve stratejilerde temel karar verici birim olmasıdır.

Bu çalışma, en önce müdahale edilmesi gereken en kırılgan ve riskli olan sektörlerle en az kırılgan ve riskli olan, müdahale önceliği bulunmayan sektörleri tanımlayacaktır. Bu çalışma üç aşamada gerçekleştirilmektedir. İlk aşama kırılganlık analizidir. Bu aşamada kentte belirlenen her bir sektörün hassasiyet seviyesi ve adapte olma kapasitesi belirlenmiştir. Setörle ilgili yasalar, planlar, çalışmalar, iklim değişikliğine karşı mücadelede katkıda bulunan faaliyetler ve engeller tartışılmştır. Bu tartışmalar sonucunda her bir sektör için kırılganlık seviyesi belirlenmiştir. İkinci aşama risk analizidir. Bu aşamada her bir sektör için risk faktörleri ve etkiler tartışılmıştır. Sonuç olarak her bir sektörün risk seviyesi belirlenmiştir. Son aşama ise önceliklendirme analizidir. Bu aşamada önceki analizlerden elde edilen kırılganlık seviyeleri ve risk seviyeleri bir matrixte birleştirilmiş, toplam değerlere ulaşılmıştır. Bu değerlerde en yüksek risk seviyesine ve en yüksek risk seviyesine sahip olan sektör ve planlama alanı en yüksek puanı alarak en öncelikli sektör olarak değerlendirilirken en düşük kırılganlık ve risk seviyesine sahip olan sektör ve planlama alanları en az önceliğe sahip olan olarak belirlenmiştir. Tüm sektörler önceliklendirme analizine dayanarak en yüksek puandan en düşük puana sıralanmıştır. Bu sıralama en öncelikli sektörler ile en az öncelikli sektörleri belirlemektedir.

Yapılan analizlerden elde edilen sonuçlara göre İstanbul'un en kırılgan ve en çok risk taşıyan sektörleri güvenlik, sağlık, ekoloji ve biyoçeşitlilik, su kaynakları ve altyapı olarak tespit edilirken en az kırılgan ve en az risk taşıyan sektörü atıklar olarak belirlenmiştir. Bu çalışmanın sonuçları adaptasyon ve zarar azaltma stratejileri geliştirileceği zaman hangi sektörlerin öncelikli olarak ele alınması gerektiğini ortaya koyacaktır. Bundan sonraki çalışmalarda adaptasyon ve zarar azaltma stratejileri belirlenirken yapılan kırılganlık ve risk değerlendirmesine bağlı önceliklendirme analizinin yol gösterici olması bakımından bu çalışma büyük önem taşımaktadır.

1. INTRODUCTION

It is a scientific fact that the climate is changing, and human activities are exacerbating natural changes in the climate (IPCC, 2001). As Huges et al. (2003), Parmesan and Yohe (2003), and Root et al. (2003) reveal; ecosystems, physical systems and related human actions will be seriously affected from those observed and projected impacts (Tompkins and Adger, 2004).

The ecosystem and human being virtually connected and depended to each other. Ecosystems are shaped by people and people needs ecosystems and the services they provide to sustain their being. The point that problem starts in the globalized world is disconnection of human being from ecosystem and forgetting about integration between economy, society and climate, clean water, food, and any other service that planet supports (Stockholm Resilience Center, 2011).

Although globalized world is developed in terms of technological improvements, economies and existing of society still depends on natural resources that clean air, water, food and any other services. Therefore, societies and economies are integral parts of the biosphere. The point that should be recognized is the nature's contribution to human society in terms of livelihood, health, security, culture. Governing natural capital is an important issue. The solution needs flexible and adaptable actions rather than short term economic gains and stable strategies that addressed by resilience thinking (Stockholm Resilience Center, 2011).

The disintegration of human from nature resulted in many problems, as most serious one climate change. Human activities that threaten the natural resources such as clean air, water resources, ecological balance created global scale problems. There is no such a place in earth that will not be effected by climate change. Therefore new ways of thinking about development and protection should be discussed and implemented.

Globally, the population living in cities passed 50 percent of the world population. Therefore, the primary places of the challenge of adapting to climate change are cities in developing world (Evans, 2010).

Recent OECD paper states "Cities are part of the climate change problem, but they are also a key part of the solution" (Kamal-Chaoui and Robert, 2009, p. 3). Also, 'how cities develop matters to the delivery of a low-carbon, climate resilient future, and it will also determine the feasibility of sustainable economic development across the OECD and worldwide' (Corfee-Morlot et al, 2009).

Climate change is a serious threat to the physical infrastructure and social environment of the cities. All the systems in the city like settlements, infrastructure will be effected by climate change and extreme weather events as a result. Thom et, al, (2009) argue that climate change is expected to give damage on buildings, resources, energy services, infrastructure (Norman, 2010).

The climate change mitigation and adaptation issue carried up to the global stage by IPCC. Global agreements started to take place with national mitigation measures. Increasing the resilience of cities to the climate change became main purpose of many initiatives (Norman, 2010).

The increasing in the recognition of importance of resilience thinking and the possible adverse impacts of climate change, most of world cities have started to build their structure more resilient. In many metropolitan cities in the world such as New York, London, Chicago, Mexico City, Paris, Copenhagen, Tokyo climate based plans have developed. The adaptation and mitigation strategies have been started to be discussed.

In the international platform climate change and environmental protection have been concerned for a long time. The most important step about environmental protection and development and reduction of GHG emissions was taken in Rio Environment Conference. The United Nations Framework Convention on Climate Change is the first international environment convention that aims to reduce GHG at a level that would prevent dangerous effect on climate system. In 1997 Kyoto Protocol established legal bindings for reducing GHG emissions (Türkeş and Kılıç, 2004). The protocol is based on the principle of 'Common but Differentiated Responsibilities'. It puts obligations on developed countries to reduce their GHG

emissions on the basis that they are historically responsible for the current GHG level in the atmosphere. There are 160 countries which are member of the Protocol. Also, it covers more than 55% of the greenhouse gas emissions in the world.

The awareness of the need of mitigation and adaptation to climate change to reduce adverse impacts have already increased globally. Turkey located in Mediterranean basin, is the one of the most affected region from climate change. The concept of the climate change and adaptation-mitigation are newly started to be discussed in Turkey. Turkey became a part of United Nations Framework Convention on Climate Change officially in 24 May 2004. Turkey's participation in Kyoto Protocol was approved on 5 February 2009 by Turkish Grand National Assembly (Pamukçu, 2010).

Turkey Ministry of Environment and Urban Planning prepared "Turkey's Climate Change Adaptation Strategies and Action Plan" in November 2011. This plan is important being substantial increase in the climate based issues in the national level. Also, this framework of the national level plan provides guidance for developing action plans at local levels.

Turkey is in the starting point of the climate based development, mitigation-adaptation concerns to climate change. Recent years the awareness have increased with the global concerns. However, Turkey still have a long path to the resilience. It needs both national and local strategies for more resilient structure especially for metropolitan cities with high population.

The motivation of this study is the filling the missing parts in starting development of more resilient system. As the metropolitan cities in the world, Turkey especially İstanbul being the biggest city in Turkey needs its climate change adaptation and mitigation strategies with a guide that analyzing the vulnerabilities and risks in the city. In the early stages of the recognition of climate based risks in Turkey, the leading studies are highly essential. This study clarifies the local and national level absences, opportunities based on sectors in İstanbul. The study reveals a comprehensive perspective considering all vital sectors in İstanbul, compares the vulnerabilities, risk levels and highlights the path for further resilience development actions.

1.1 Aim

The aim of this study is to provide a guideline for resilience to climate change by adressing the priorities of the system according to the most vulnerable and at risk sectors at local level . İstanbul is chosen for the empirical study for being the biggest city in Turkey in terms of both economic and social perspectives. The viability and resistant of İstanbul is essential for Turkey. The study focuses on the vulnerability level and risk level of the city system. The combined analysis of the vulnerability and risk assessment addresses the prior systems that climate change is expected to affect. The city system is defined with sectors that are important for the sustainability and viability of the city and possible to be affected by climate change.

As first step of comprehensive resilience thinking, this study purposes to enlighten further studies on resilience. The study aims to address the most prior and the least prior systems in terms of sectors in the city which defines the starting point of resilient strategies in terms of adaptation and mitigation measures to the adverse effects of climate change.

1.2 Objectives

The main objective of the thesis is to define priorities in term of climate change impacts on the city system. While reaching that conclusion, the first objective is defining sectors and planning areas in the city that sustain economic social and ecologic existence of the city and have important parts in development. Next, evaluating the vulnerability levels of those sectors and planning areas to climate change and any possible direct or indirect effects. In this sense, investigating the climate and sector relations, the effects of current climate conditions are targeted. The public, private investments, the importance of the issue in the local authorities are investigated. Another objective is evaluating risk level of those sectors and planning areas, their exposure to the climate change impacts and consequences that may reveal. The final objective is determining priority of those sectors and planning areas in terms of their vulnerability and risk level in order to find out the most vulnerable and at risk sector and the least vulnerable and at risk sector in a rank. Figure 1.1 explains the objectives of the thesis based on emprical study.

The results of this study is expected to highlight the risks and hazardous impacts of climate change to the city, the most vulnerable and at risk sectors to climate change, the absence of the system to increase their resilience, the opportunities that may contribute to resilience, the local and national governmental impacts, opportunities and necessities, the sectors that investments and incites should be directed, the comprehensive approach to the resilience thinking in İstanbul.

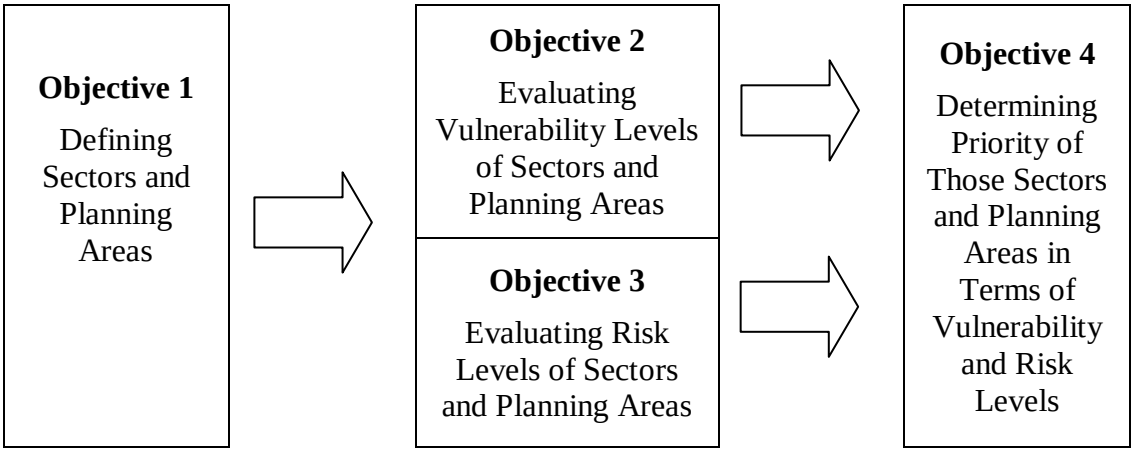

Figure 1.1: Conceptual scheme for the objectives of the thesis.

1.3 Methodology

The methodology of this study consicts of theoretical research based on literature review and developing an empirical study referring the theoretical background.

In this context, first of all literature review was conducted on the concept of resilience. In order to draw a conceptual framework, different definitions by various researchers and institutions were compiled and these definitions were categorized into subject related groups. Urban resilience was investigated as focal issue. Based on definitions, the urban resilience context and resilience steps were examined.

As defined in the literature, essential parts of urban resilience, vulnerability and risk concepts were presented. As framework, ICLEI (2007) "Preparing for Climate Change; A guidebook for Local, Regional and State Governments" publication was deployed. The steps defined in this guidebook to assess vulnerability and risk were followed. By examining the concepts, vulnerable and risk indicators were determined. Relevant sectors and planning areas, that weree vital for a society and city structure and might be vulnerable to climate change, determined on the basis of definitions provided by the guidebook (2007).

Based on definitions and Istanbul's development strategies 11 sectors and 25 planning areas are determined. Those sectors are; Health, Water Resources, Energy, Transportation, Agriculture, Public Safe, Land Use and Development, Materials, Infrastructure, Ecology and Biodiversity, Culture. 25 planning areas are the related subtitles of those sectors.

The empirical study was based on interviews with institutions, decision makers, academics and various actors that have relation with the topic. In-depth interviews are conducted with semi-structured questionnaire. From April 2014 to December 2014, 54 interviews were carried out. In the first part of the questionnaire, the personal information was asked. The second part was about the sector and current climate conditions impacts on it and the precautions to current climate events. The third part was about incites, encouragements, investments and future strategies about the sector that may contribute or contradict to the adaptation and mitigation. The last part of the semi-structured questionnaire was about the possible consequence of climate change impacts and the expected costs to prevent or recover after the disaster. In addition, the reports that published by related institutions, web-sites, suggested documents were referred to as part of these assessments in the 11 sectors and 25 planning areas.

The study was completed in three steps; first one is the vulnerability assessment. In this stage the vulnerability level of the sectors and planning areas were evaluated based on interviews and data collection. The second part was the risk assessment. In this stage the evaluation was made for each sector and planning areas based on interviews and data collected as well. Also, the vulnerability assessment outputs were used since they were directive for the risk assessment. The last part was the prioritization assessment. In this stage the results of vulnerability and risk assessments were combined for each of those sectors and planning areas. The combined scores were ranked from the highest point representing the most vulnerable and most at risk sector to the least point with the least vulnerable and least at risk sector. Figure 1.2 explains the methodology of emprical study step by step. The results of the emprical study determines the prior sectors and planning areas based on their vulnerability and risk levels to climate change impacts.

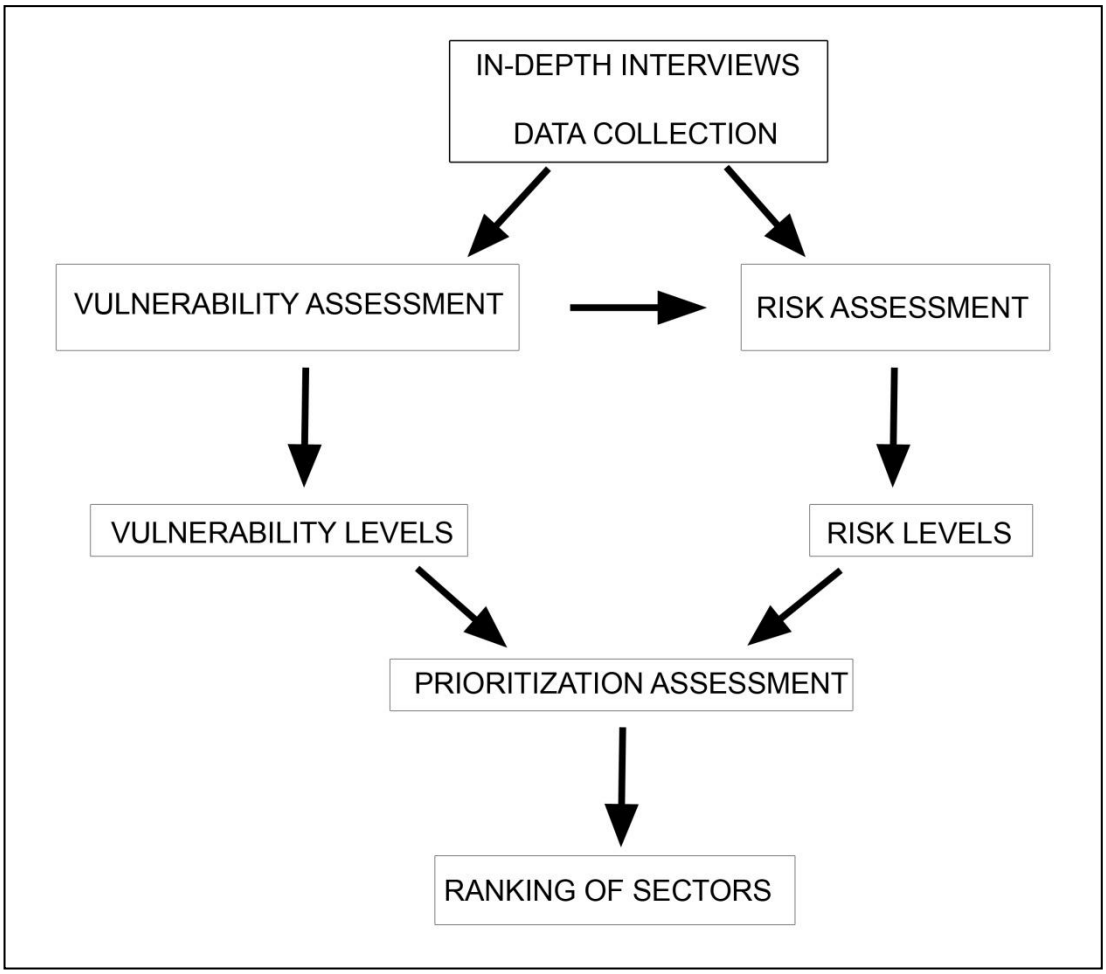

Figure 1.2: Flow chart for the methodology of emprical study.

1.4 Context

The study consists of 5 main parts. The first part is the introduction that presents the aim of the study, its objectives, methodology and context. The second part is the Literature review. In this part the global climate change impacts and the main theoretical background, basic approaches to the resilience are revealed. Different perspectives to the resilience concept and definitions for different sciences are presented. Related definitions about the resilience are also given. In this part, the literature definitions are examined, the relation between climate change and resilience is presented. The components of resilience are introduced and defined in this section. Those components are vulnerability to climate change and risk factors and risk assessment which are examined in detail. The importance of the resilience for the urban structure and the path to the more resilient communities are discussed.

In the third section, the climate change impacts on Turkey and urban vulnerability are discussed. The impacts of climate change in Turkey, projected effects are presented. Later, the national strategies that take place about climate change are discussed. The stage of climate change and resilience studies, the awareness about the issue and the role of Turkey in international platform is presented. The local studies in Turkey's cities are discussed. Then, Climate change impacts on Istanbul, studies, strategies to climate change for Istanbul is revealed.

The fourth section is the empirical study. Istanbul is chosen for the case study because of its population, geographic, cultural, historical and economic importance. Istanbul is socio-economic center of Turkey which makes it important for studies about resilience and climate change. The studies on national level in Turkey has newly started and there is a gap on local level climate based comprehensive studies. Istanbul have the priority for climate change studies as a biggest metropolitan city in Turkey. In this section, sectors and planning areas are defined, the methodology of the study revealed. The data is collected from reports or plans and in-depth interviews. The empirical study is completed in three steps.

The first step is the vulnerability assessment for the defined sectors and planning areas. For all sectors and related planning areas the vulnerability level is evaluated using the information from interviews and reports.

The second step is the risk assessment for each sector and planning areas. Likewise, the risk level is evaluated for each of them.

The final part is the combining the results of vulnerability assessment and risk assessment to prioritize the sectors and planning areas. In this part the sectors and planning areas are ranked as their priority.

The fifth and last section of the study concludes the research. The results of the study is presented. In this part the absence and the opportunities for the resilience is discussed. The role of the local and central government in cooperation with private sector, initiatives and investments are discussed. The suggestions towards more resilient city is presented. The contribution of the study to literature is evaluated. The flow chart of the study is as following Figure 1.3.

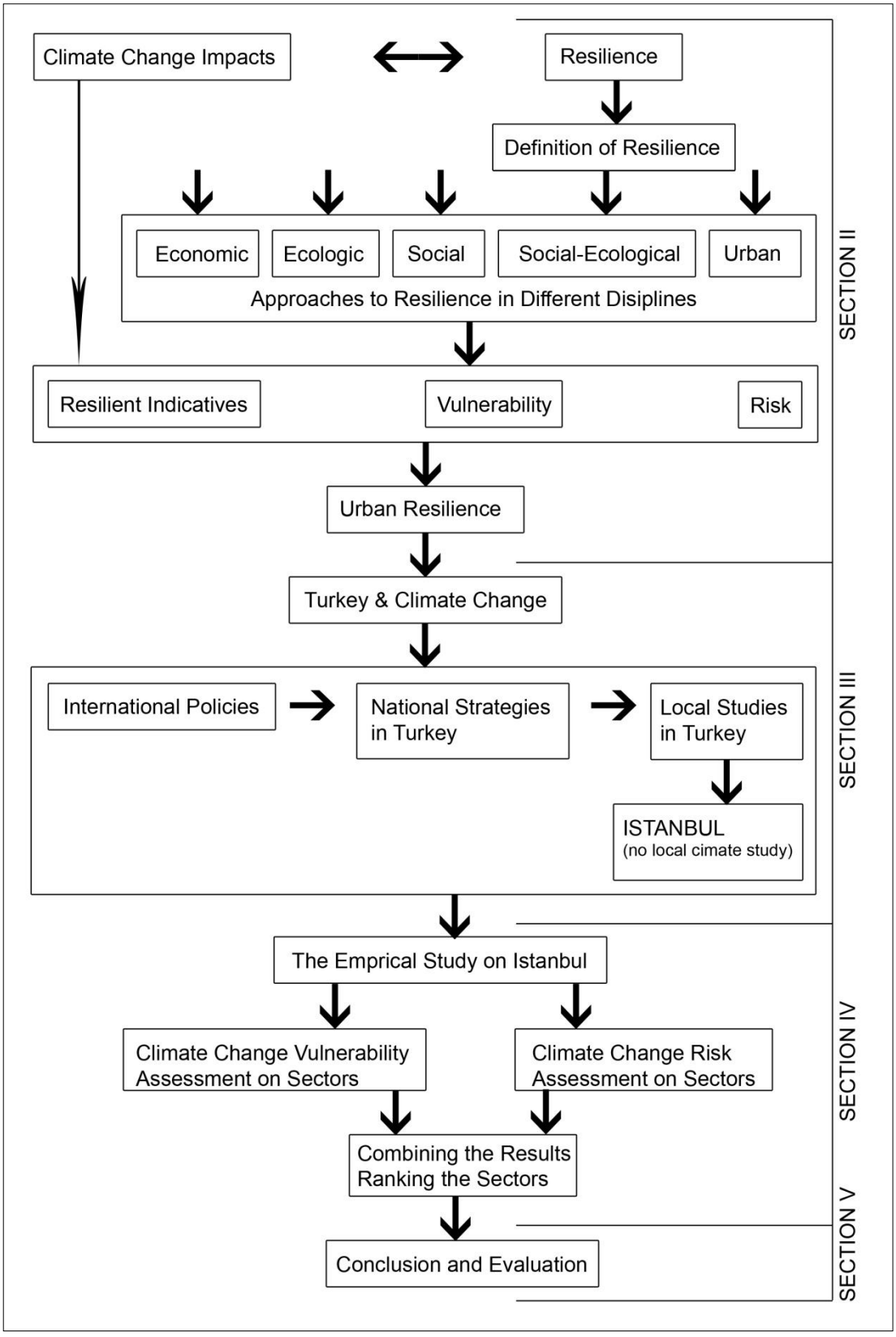

Figure 1.3: Flow chart of the thesis.

2. CLIMATE CHANGE AND RESILIENCE

2.1 Global Climate Change and the Scenarios on Climate Change

The climate change, temperature increase are above the natural level of climatic system and expected to be worse than the best estimate of the future temperatures (Blakely, 2007). Climate change is a reality of the global. As a human induced greenhouse gas emissions, weather patterns have changed in temperatures, sea levels, storm frequencies. The significant raise in global temperatures have been observed over the past years. The seasons, their length and timing are changing. The climate based disasters like floods are more frequent and sea levels are increasing. It is undeniable fact that climate change will affect cities and urban areas. Affecting many sectors climate change has become a major challenge for cities in terms of development, investment, economic and social issues (ISDR, 2008).

Climate change impacts will be like; slow changes in mean climate conditions, increased seasonal and annual variability, increased frequency of extreme events and sudden climate changes that cause shifts in ecosystems (Tompkins and Adger, 2004).

According to IPCC 5th Assessment Report, the temperature increase in climate is certain and reached a level that had never been observed since 1950's. According to this report the temperatures have increased 0.85^{o}C in 1880-2012 period. In global scale cold day and night amount has decreased while hot day and night amount has increased since 1950's with the certainty of %90-100. Oceans get warmer between 1971-2010 period 0.11 ^{o}C for each 10 years. Global average sea level rise between 1901-2010 is 19cm. The sea level rise ratio increased in 20th century comparing 19th century. CO2, CH4 and N2O gases increased in atmosphere comparing the levels before industry with the percentage of 40, 150, 20 respectively (Türkeş at al., 2013).

The climate scenarios revealed by IPCC projects 1, 5-2 ^{o}C increase in temperatures until the end of 21th century. More increase than 2 ^{o}C is not expected. The temperature increase will continue after 2100. The surface temperature will increase 0, 3-0, 7 ^{o}C between 2016-2035 comparing to 1986-2005. The temperature increase

in oceans will continue in 21th century and affect ocean circulation. The sea level rise will continue to increase during 21th century (Türkeş at al., 2013).

That is very important moment for the cities. The way cities are managed in their growth of urbanization, decentralization and domestic capital market while dealing with vulnerabilities is very critical (ISDR, 2008). Climate change will affect future city patterns, growth and development. The urbanization process in rapid in the world; 50% of the global population lives in cities and it is expected to increase to 61% by 2030. Urban areas are the most threaten places by climate change impacts since people, resources and infrastructure are concentrated (ISDR, 2008).

The 13th Conference of the Parties to the United Nations Framework Convention on Climate Change at Bali in December 2007 confirmed that city governments are willing to take actions for the climate change. Large cities and their leaderships are cooperating for adaptation, preparedness and mitigation (ISDR, 2008).

2.2 Resilience: Conceptual Framework

Resilience concept have been used in many disciplines in literature such as; psychology, ecology, engineering, planning, management and anthropology (Foster, 2006).

Ecological scientist use resilience term to understand the natural phenomena, such as different recovery level of natural elements. They define resilience as a measure of vulnerability to surprises and shocks. In this approach they associated resilience with low vulnerability (Foster, 2006).

Resilience concept firstly used by C. S. Holling (1973) in study on "ecologic system". In the first time the resilience concept was used, it represented the theoretical approach of "modelling the change" in order to sustain stability of ecologic system against the structural and functional disturbance (Walker et al., 2006).

Resilience is not a term that applies a system as a whole, but to system elements. Those elements are including infrastructure, information, physical environment, natural resources, economic systems, etc.. The resilience may differ between elements in a system. One element of the system may be resilient while the other may not be. Resilience is not a stable concept it can be developed (Foster, 2006).

Resilience is the ability of the system to deal with any stress and continue to develop in the long-term. Low resilience may lead to undesired changes in a system. The question of how the resilience can be increased in natural, social or structural system is becoming increasingly important when the dynamics and potential stresses to the any community are perceived. Investing in resilience can be seen as insurance against future shocks (Stockholm Resilience Center, 2011).

Resilience is the ability of a system to deal with any stress or change and continue to develop. That system might be an individual, natural resource, a city or an economy (Stockholm Resilience Center, 2011). It is about renewal and innovative thinking against any shocks and disturbances like a financial crisis or climate change. Resilience thinking incites learning, diversity and most importantly reminding of human and nature are strongly connected (Stockholm Resilience Center, 2011).

Resilience thinking is about generating ways about how we can deal with unexpected events and crises by strengthening the capacity of system within a sustainable way for humans (Stockholm Resilience Center, 2011).

The concept of resilience was introduced by C.S. Holling in ecology in 1973 (Applegath, 2012). He defines resilience as a response to environmental disturbance or re-organization of habitats and ecosystems after a disturbance (Collier et al. 2013). In the book "Resilience Thinking, Sustaining Ecosystems and People in Changing World" by Brain Walker and David Salt resilience is defined as "The capacity for a system to absorb disturbance and still retain its basic function and structure." (Applegath, 2012, p. 2).

Resilience is highly discussed and interdisciplinary concept. It can be used in different nuances (Porter and Davoudi, 2012). Resilience can be used to describe a response to environmental disturbances (Holling, 1973) and the vulnerability of a system to inevitable shocks (Adger, 2006). It can describe the adaptive capacity of a system, the ability to learn and adapt (Ernstons et al., 2010).In urban studies perspective it can be defined as ability of a city to tolerate alteration (Alberti at al., 2003). From social studies perspective, social resilience introduced as mirror of ecological resilience for accomplishment of sustainable development (Adger, 2000; 2006). In order to manage complex system, the importance of the combining multiple perspectives is understood. Also, the community side of the resilience is

explored including local stakeholders, authorities and experts for generating resilience to uncertainty by Folke et al. (2005), (Collier et al., 2013).

2.3 Approaches to Resilience in Different Disiplines

Resilience is a wide concept that is taken into consideration by many different disiplines. For years it has been used in psychology, ecology, engineering, planning, management and anthropology (Foster, 2006). Every dicipline created its own definition on resilience conserning their special crisi and disturbances. In this part the definitions on resilience is categorised under main topics and the different approaches are presented.

2.3.1 Economic resilience

Economic resilience is defined by Brock et al. (2002) as transition probability between states as a function of the consumption and production activities of decision makers. Perrings (2006) defines economic vulnerability as the ability of the system to withstand either market or environmental shocks without losing the capacity to allocate resources efficiently.

2.3.2 Ecological resilience

Ecological resilience first defined by Holling (1973) as measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables. Holling and Gunderson (2002) define ecological resilience as a measure of vulnerability to surprise and shocks, rather than as a response to such stresses.

2.3.3 Social resilience

In social perspective resilience is usually described as adaptation capacity to disturbances (Luthar and Cicchetti, 2000). Adger (2000) defines social resilience as the ability of groups or communities to adapt social, political or environmental stresses. Trosper (2002) emphasize that a resilient society must have ability of buffer disturbance, self-organize and learn and adapt (Tompkins and Adger, 2004).

2.3.4 Social - Ecological resilience

The concept of social-ecological resilience emerged for interrelationships between ecosystems and society (Deppisch and Hasibovic, 2010) as defines the ability of interdependent social-ecological systems to tolerate stresses (Adger, 2000; Berkes et al., 2003; Folke et al., 2002; Walker et al., 2006). It is corporation of social and ecological systems to maintain vital functions and structures in unexpected and sudden events (Deppisch and Hasibovic, 2011).

2.3.5 Urban resilience

Urban resilience is defined as the degree to which cities are able to tolerate alteration before reorganizing around a new set of structures and processes. Urban resilience can be measured by how well a city can simultaneously balance ecosystem and human functions (Alberti et al., 2003). ResilientCity.ogr defines vulnerability as the capacity of a city's economic, social, political and physical infrastructure systems to absorb shocks and stresses and still retain their basic function and structure.

Urban areas are center of production and consumption as well (Elmqvist, 2013). They as a center of attention, depends on natural resources with an increasing demand by inhabitants (URBES, 2014). Nature serves food, water, materials etc. for the inhabitants of the cities (Elmqvist, 2013). The urbanisation pressure on natural areas decreases the resilience of the city to climate change and natural disaster events (URBES, 2014). The resilience of the urban area is highly connected to sustainability of the development. Urban development in the perspective of sustainability with its three components; economy, economy and society contributes to achieve urban resilience. The connection and interdependance of human, human activities and nature is the key point of development in sustainable and resilient way.

Urban sustainability focuses on the how to manage natural resourcess to ensure today's and future's generations welfare. The concept of urban sustainability is about the impact of urbanisation to the planet. On the other hand, the urban resilience focuses on the absorbtion of external schocks and disturbances. For resilience thinking it is important to consider the concept wider than a responce to sudden schoks. In urban development, sustainability and resilience come together as two parts of a whole. Sustainability can be seen as the goal while resilience as the characteristic of the urban system (URBES, 2014).

2.4 Climate Change and Resilience Relation

"There is no such thing as "natural disasters." Natural hazards - floods, earthquakes, landslides and storms - become disasters as a result of human and societal vulnerability and exposure, which can be addressed by decisive policies, actions and active participation of local stakeholders. Disaster risk reduction is a no-regret investment that protects lives, property, livelihoods, schools, businesses and employment." From the Chengdu Declaration of Action, August 2011 (UNISDR, 2012, p. 15).

There are many reasons to prioritize resilience as part of sustainable development strategies. Reducing risk can be an opportunity to improve economic, natural and social conditions, to deal with future unpredictable or uncertain shocks and make the community more secure than before (UNISDR, 2012). Decreased resilience means increased vulnerability for a community that generates risk for uncertainties and surprises. The decrease in resilience cause system crises or chaos in smaller disruptions or stresses (Resilience Allience, 2007).

The global stress that threatens the future of the earth is global climate change. Reducing risk of climate change and adaptation to new climatic conditions is important for societies. Resilience is a bridge for more sustainable and reduced risk future in terms of economic, social, cultural and ecologic perspectives.

Human activities like burning fossil fuel and land use decisions have emitted greenhouse gases into the atmosphere. The heat from sun is captured in atmosphere because of greenhouse gases which cause increase in temperatures, greenhouse effect and as a result climate change. The main characteristics of climate change are global warming in reflection to annual temperatures, changes in precipitation, ice melting, decreased snow cover, and increased ocean temperatures (UNFCCC, 2007).

The rapid change in climate made the issue of reducing vulnerabilities of countries to climate change, increasing the adaptive capacity and implementing national resilience plans seriously concerned. Climate change impacts are inevitable but how countries developed on the resilience is the key factor of future vulnerability (UNFCCC, 2007). Urban systems have complex dynamics with a mixture of multiple land uses and natural areas, resources as such provide the large scale experiences of climate change effects (Resilience Alliance, 2007).

Resilience is defined by Stockholm Resilience Centre (2011, p. 3) as "the capacity of a system, be individual, forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking". Resilience is introduced as a key factor for the external shocks such as financial crisis, climate change, disasters and related to the systems capacity, ability to adapt and new way of thinking to develop.

Climate change have various impacts on cities but beyond direct impacts, indirect impacts can be much wider such as health problems, damages on buildings, infrastructure. The systems in cities are closely connected within themselves and other cities and regions, affected any failure of that complex structure. Floods can damage residential areas, business sites, loss of jobs, trouble with services, and maintenance of energy, transport or clean water. Heatwaves can be detrimental for health, reduce the ability to work, cause troubles on services, social life. Also, can damage on roads that result in problems on supply of goods. All of those can put the city in an economic pressure (EEA, 2012). Thus adaptation to climate change requires a broader perspective of sustainable development and resilient response (Tompkins and Adger, 2004).

Munasinghe (2000) states that the Intergovernmental Panel on Climate Change emphasized the importance of sustainability in its Third Assessment Report in 2001 and define the pathway to development, equity and sustainability (EEA, 2012). The European Environmental Agency (2012) argues that "a system's capacity for resilience, which involves its ability to absorb perturbations without being undermined or becoming unable to adopt and learn, is an important element of any sustainable response to climate change". While some natural and social systems have ability to adapt adverse circumstances easily, some need to learn to become resilient (EEA, 2012).

The world population is concentrated in cities and their urban landscapes and in the future it is expected to increase. Cities are engines of economic growth and development which bring the opportunities for sustainability, on the other hand confront challenges of climate change impacts. There are many example of natural disasters that damage cities over the history which emphasize the need for urban systems to deal with unexpected urban shocks. Resilience is particularly important in

areas that have high value, people concentrate, and upon which society depends (Resilience Alliance, 2007).

2.5 Resilience Indicatives

The definitions of resilience from different perspectives and approaches from different studies has already presented in previous topic. From those expressions some common points can be caught. All definitions concentrate on the vulnerability of the system to any external shock or stresses and the isk factos that the system may confront. With this information resilience indicatives can be categorised as vulnerability and risk factors. In resilience thinking the vulnerability and risk assessment are important indicators for the system.

2.5.1 Vulnerability to climate change and vulnerability assessment

Vulnerability is the main component of the resilience. There are many definitions about vulnerability depending on the context. United Nations International Strategy for Disaster Reduction (2009, p. 30) defines vulnerability as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard."

IPCC (2007, p. 6) defines vulnerability to climate change as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of the system". Similarly, ICLEI (2007, p. 6) defines vulnerability to climate change as "the susceptibility of a system to harm from climate change. Vulnerability is a function of a system's sensitivity to climate change and the capacity that system to adapt to climate changes. In other words, systems that are sensitive to climate and less able to adapt to changes are generally considered to be vulnerable to climate change impacts".

Urbanization have many benefits such as economic growth, culture, innovation, however, there are increasing problems such as social inequality, poverty, pollution, disease and political instability. The most important question here is "how much and which kinds of disturbances can cities absorb without shifting to alternative less desirable system regimes?" (Resilience Alliance, 2007). With the opportunities of

cities the urban population increases rapidly in global aspect whereas the climate change will impact the future development of cities. The vulnerabilities to climate change impacts of cities where population centralized is the main concern to be reduced (ISDR, 2008).

The vulnerability of a city to climate impacts and natural disaster have several factors such as geography, disaster history, city size, density. Other factors can be listed as city management, capacity to generate financial resources, investments to build environment, economic range, early warning and disaster response system. Those factors are related to policies, regulations, investments, development axes and capacity building which are tools for reducing vulnerabilities (Trohanis, Shah and Ranghieri, 2009). Climate data as well as non-climate data including different sectors and socio-economic data are the main requirements of reducing vulnerability. Particularly the poverty stands a major data which is recognized as a major factor of vulnerability (UNFCCC, 2007).

Climate change have direct and indirect effects on communities and cities which is complex to analyses and assess vulnerability. The dependence of cities on vulnerable external services is significant but under future climate conditions the maintenance of service provision can be organized strategically (EEA, 2012).

2.5.2 Risk factors of climate change and risk assessment

Risk is defined as "the chance of injury or loss as defined as a measure of the probability (likelihood) and severity of an adverse effect to health, property, environment or other things of value." (Disaster resilient communities initiative, 2004, p. 22). According to ISO 31010 the general definition of risk is the combination of consequences of a hazard and the probability of its occurrence (European Commission, 2010).

Understanding of risk factors and the risk that cities face is essential for a meaningful disaster risk reduction strategies. The risk analysis and risk assessment are needed to inform decision makers, prioritize projects, determine risk reduction measures, identify high-medium-low risk areas considering vulnerabilities, cost, effectiveness and interventions (UNISDR, 2012).

Cities are complex systems with various services and their interconnection. Thus, urban areas and cities confronts with disaster risk issues. The factors that create risk in cities are (UNISDR, 2012):

- Urban population growth and density increase with their pressure on land and services, increasing urban development and settlements in unsafe areas.
- Instead of local government, central level concentration of resources and capacities and uncertainties of disaster response measures in local level.
- The weakness of local government and making plans and urban decisions without local stakeholders' participation.
- Inadequate urban infrastructure system such as water resource management, sewage systems, drainage systems, solid waste management that may cause disasters and health problems.
- Loss of natural resources and ecosystem because of human activities such as pollution, urban sprawl that decrease the potential of beneficial services from nature.
- Unqualified infrastructure and building stock.
- Lack of coordinated emergency services to be prepared or respond natural disasters.

Based on the exposure and vulnerabilities, each local and urban structure is affected from climate change and natural hazards differently and have different level of risk (UNISDR, 2012).

2.6 Urban Resilience to Climate Change

Urban resilience is the degree to which cities have capacity to absorb changes before reorganizing around a new set of structures and processes (Holling, 2001; Alberi et al., 2003). The balance of the ecosystem and human activities in a city in any disturbance is the indicator of resilience of the city (Resilience Alliance, 2007). A resilient city have the capacity to adapt, minimize cost and losses in the exposure to any hazard. The enhancing factor of resilience is minimalizing the vulnerabilities (Trohanis, Shah and Ranghieri, 2009).

The process of urbanization and planning and the specific actions to decrease the risk are the indicators of how the city resilient (UNISDR, 2012).

A resilient city is the one that minimized the vulnerabilities with well-organized services and infrastructure to the settlements, sustainable building codes and without informal settlements in risk areas such as flood plains or slopes. It have the local government that concern about sustainable development, well organized and able to manage the process before, during and after hazard. It is the one where the risk and vulnerabilities are surely understood by authorities and the population. The city that the citizens are encouraged to participate on deciding, planning and have knowledge about resources and capacities. It invests on predicting and mitigating the disturbances using early warning technologies to protect city system with its citizens, infrastructure, culture, environment, economy and minimizing the losses in any hazard. It is the one that able to recover immediately the basic services and ensure the proceed social, public and economic activities (UNISDR, 2012).

There is no city that is entirely safe from disasters, but they can be more resilient to the external adverse impacts with the capacity to absorb the impact, ability to adapt and maintain basic functions during the stress and recover (UNISDR, 2012).

2.6.1 Adaptation to climate change

IPCC defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities".

2.6.2 Mitigation to climate change

IPCC defines mitigation as "an anthropogenic intervention to reduce the source or enhance the sinks of greenhouse gases".

As presented in IPCC Fourth Assessment Report (2007), Goklany (2005) defines the mitigation as reduces positive or negative impacts and adaptation challenge while he defines the adaptation as selective that can take advantages of impacts and reduce disadvantages.

2.7 Evaluation of Climate Change and Resilience

Climate change is a fact of the world which the impacts have already been observed over temperatures, seasonal changes, climate events frequency and severity, sea level rises. Climate change is the problem of all countries in the world because there is no

place that would not be affected by climate change. Governments and international committees have already started studies about climate change. Metropolitan areas, cities are at risk due to climate change impacts in ecologic, economic and social impacts. Resilience is a key factor while dealing with climate change impacts. Resilience involves ability to absorb stresses, adapt and learn without losing the main function of the system. Resilience is about decreasing vulnerabilities and risks, increasing adaptive capacity.

Understood from definition of resilience, it has two components; vulnerability and risk. Increased vulnerabilities address low resilience to any climate change impacts. Therefore the path to more resilient communities passes through decreasing vulnerabilities. Low vulnerability level of the system represents its low sensitivity to stresses, perturbations and high adaptive capacity to new conditions. The other factor is risk which depends on probability of occurrence and severity. Disaster risk reduction strategies are essential for more resilient communities.

Increasing urban resilience means the minimized vulnerabilities, well organized services, built structures, able to manage the process before, during, after hazard (UNISDR, 2012). During the increasing of urban resilience adaptation and mitigation strategies to decrease negative impacts and to be prepared for the disturbances have significant roles.

3. CLIMATE CHANGE AND RESILIENCE: TURKEY'S AGENDA

3.1 Climate Change Scenarios on Turkey

Turkey is located in the Mediterranean basin where one of the most affected areas in the world according to 4th IPCC Assessment Report. Therefore, in adapting and mitigating of climate change predicting future climate of Turkey carries an important role. For Turkey and its surroundings, modelling studies on climate change impacts are very limited (Demir et al., 2008).

As Demir and others (2008) revealed, there are several climate change scenarios in Turkey, one of them is prepared by General Directorate of Meteorology and ITU Eurasia Institute of Earth Sciences and estimates 2-3^{o}C increase in temperatures in the year 2071-2100 according to IPCC SRES A2 scenario. Also, decrease in precipitations in Aegean and Mediterranean shores, increase in precipitation in Black sea shores are forecasted. Another projection conducted by Giannakopouls and others, 2005 produced for WWF indicates 2^{o}C increase in temperatures comparing to before industrialization values. According to the study, the temperatures will increase 1-3^{o}C in 2061-2090 comparing the annual temperatures of 1961-1990. The study estimates that maximum temperature increase will be more than minimum temperatures increase, annual precipitation will decrease 20% in general but increase in Black sea region, the largest decrease in the precipitation will occur in summer period.

A2 scenario estimates 4-5^{o}C increase in temperatures in shores of Turkey, comparing 1961-1990 period in 2071-2100. That means average increase of 5.12oC in annual temperatures of Turkey (Demir et al., 2008). In regional aspect, in winter the west side of the Turkey will have 3-4^{o}C increase in temperatures while the east side will have 4-6^{o}C increase. In spring, general increase in temperatures will be 4-5^{o}C, in Black sea shores 3-4^{o}C, in East Anatolia 5-6^{o}C. In the summer period the increase in temperatures will be more in the west side regarding the east side of Turkey. The increase in temperatures will be 4-5^{o}C in South-east Anatolia while 6-7^{o}C in Inner

Aegean Region, Pond Region, and West Black sea Region. In autumn, the average increase will be 4-5^{o}C (Demir et al., 2008).

According to A2 scenario, the precipitation change have differentiation in regions. The percentage of decrease rises from east to west. Aegean, Thracian, East and Middle Mediterranean, South-east Anatolia and Central Anatolia will have 30-40% decrease of precipitation while East Anatolia and Black sea Region will have less 5% decrease (Demir et al., 2008).

As a water resource, snow depth is important. The scenario estimates Eva. Another important indicator is evaporation. Parallel to the decrease in precipitation and increase in temperatures, evaporation will increase as a result, water loss will increase (Demir et al., 2008).

Turkey is one of the under risk country in terms of climate change impacts. The negative effects will be felt as loss of water resources, forest fires, drought and desertification and related to those, ecological deteriorations (Türkeş et. al., 2000). The global climate change effects on Turkey are projected to be as (Türkeş, 1994):

- Depending on longer and hotter summer period, increase in frequency of forest fires and its hinterland.
- Changes in agricultural production pattern (Increase or decrease depending on the location or region)
- Climate zone will shift in the world, which make the Turkey's climate hotter and arid. The floras and faunas that cannot adapt to new climate zone will disappear.
- Increase in the number of pests and illnesses will be harmful for terrestrial ecosystems and agricultural production.
- Human pressure on vulnerable ecosystems like mountains, valley, and canyon will increase.
- The problem about water resources will increase and agricultural and usable water demand will raise.
- The hotter and longer summer period, the more desertification, salinization, erosion problem.
- The increase in the number of hot days will affect the human health.

- Related to urban heat island effect, the night temperatures in big cities will increase which cause more energy consumption for cooling.
- Infection because of the change in water supply and heat stress will cause increase in health problems.
- The power of wind and number of windy days and sunshine duration and volume may change depending on the region which will affect renewable energy resources.
- Turkey's shores which is important for urbanization, tourism, agriculture and low lands may be affected by sea level rise.
- The snow depth and snow land area will decrease. Sudden snow melting and avalanche may increase.
- The change in time and volume of snow melting may affect agriculture, water resources, transportation and recreation.

3.2 Turkey in International Platform of Climate Change Policies

It is an undeniable fact that climate change and greenhouse gas emission have negative effects globally. The most important step to decrease GHG emissions and keep them on a level was taken in 1992 in Rio de Janerio with United Nations Conference on Environment and Development (UNCED). The most critical output of the conference was "United Nations Framework Convention on Climate Change". The purpose of the convention was defined as to stop accumulation of greenhouse gases preventing human based effects. The responsibility of the developed countries was defined as to keep human based greenhouse gas emissions at 1990 level until 2000. The convention inured in 1994 March with approval documents of 50 countries. 186 countries and communities have become a part of the convention (Türkeş and Kılıç, 2004).

In 1997, the countries opined that the convention was insufficient on GHG emission reduction responsibilities. In order to strengthen the responsibilities of countries, Kyoto Protocol which defined the actions after 2000 was accepted. The protocol aims 5% reduction of GHG emission according to 1990 level by 2008-2012. The restrictions and reduction responsibilities were defined for each countries for individual actions or cooperation (Türkeş and Kılıç, 2004).

Turkey is a growing country with its economy which is associated with increase in GHG emissions. Pamukçu reveals based on TURKSTAT (2009) and Apak and Ubay (2007) that GHG emissions have increased 119% between 1990 and 2007 from 170.06 million tons to 372.64 million tons carbon dioxide equivalent.

Turkey became a part of United Nations Framework Convention on Climate Change officially in 24 May 2004. Turkey's participation in Kyoto Protocol was approved on 5 February 2009 by Turkish Grand National Assembly (Pamukçu, 2010).

3.3 Turkey's National Strategies on Climate Change and Resilience

Climate change studies is firstly coordinated in 2001 under the name of "Climate Change Coordination Council" and reconstructed in 2004, 2010, 2012 with participation of related public institutions, private sector and representatives of NGOs. The most important policy document published by council is 'National Climate Change Strategy Document' which covers 2010-2020 strategic decisions. This document covers the mitigation, adaptation, financial, technological policies with Turkey's national facility and international finance and donation's accessibility (Çevre ve Şehircilik Bakanlığı, 2013).

Turkey Ministry of Environment and Urban Planning prepared "Turkey's Climate Change Adaptation Strategies and Action Plan" in November 2011. The plan emphasis on the threats of climate change, barriers on sectors' developments and opportunities. The plan focuses on 5 important area; water resources management, agriculture and food insurance, ecosystem services, biodiversity and forestry, natural hazard risk management, human health.

Turkey's Climate Change Adaptation Strategies and Action Plan (2011) defines the basic problems and needs as; absence of high quality data and information, not bringing together the information, insufficient scientific researches, difficulties on producing projects, natural hazard risk management, weaknesses of the relation of health and climate change, not determining the effects of climate change in livelihood and human health, need for comprehensive models to determine the effects on climate based sectors, determination of effects, measuring and projecting, as a result not clarifying the affectability assessment. Also, the financial strategies and support mechanism for climate change adaptation and mitigation are absent.

The climate change and its increasing risk factor is not considered in traditional development policies in terms of its results and governments or private sectors investments in Turkey.

Although the planning studies for climate change adaptation has not started in Turkey, some measurements and adaptation actions are implemented that based on the information about climate change effects. Those actions are mostly on water resources such as; using modern irrigation techniques, researches on increasing effectiveness of irrigation in scarcity of water, cultivating crop types that yield high quality crop even with low quality water, cultivating crop types that are resistant to drought and salinization. Also, financial supports are supplied for the producers who use those kind of techniques.

The efficient adaptation policies and implementations get complicated due to Turkey's rapid population growth, urbanization and priorities in economic strategies. However, existing sustainable development policies and targets are already support climate change adaptation. Some examples to those supportive implementation is various sectors are forest management, smart techniques in water usage in agriculture, integrated basin management, rural development policies and contemporary approaches to water resources management.

The climate change adaptation policies are focused on increasing water scarcity and drought problem. Drought is prior for Turkey among climate based disasters. In this sector, disaster warning systems and information flow are studied. In order to prevent possible water resources problem as a result of climate change, developing strategies, legal regulations, water policies based on scientific researches and rapid implementation of those are main focused studies. Although there are studies on Turkey's socio-economically important basins about global climate change impacts, more scientific researches are needed.

Evaluation and monitoring climate change adaptation in conjunction with the related sectorial strategies and implementation is in an early stage in Turkey. There are three main reasons for this:

- Rejected truth of maladaptation in some policies and implementations: Ineffective water policies, agricultural policies, permitting the threating

activities in vulnerable natural areas, wrong water policies in metropolitan cities can be examples of this subject.

- Insufficient coordination between public institutions: Contradictory authorities in land use planning, many ungrounded legal or regulation changes, contradictions between ecosystem sustainability and legal regulation are examples of the subject.
- The insufficient institutional and technique capacity of necessary sustainability supportive initiatives: Not defining the potential adaptation projects, absence of priority determination, insufficient capacity to reach international adaptation funds are some examples on this issue.

Recently, with the awareness of the missing points and potentials in Turkey about climate change adaptation plan, Ministry of Environmental and Urban Planning have prepared the first climate change adaptation plan focusing on 5 main topics; i) water resources management ii) agriculture and food assurance iii) natural hazard management iv) ecosystem, biodiversity and forestry v) human health.

3.4 Local Urban Studies on Climate Change and Resilience in Turkey

Local and regional studies on climate change has increasing in Turkey especially those where the impacts are seriously observed on natural and economic structure. There are 8 municipality in Turkey participated in the 'Covenant of Mayors' (www.convenatofmayers.com). Climate change adaptation and mitigation strategies have already started to take place in development plans, strategic plans.

Gaziantep Climate Change Action Plan (2011) one of the first examples of local plans in Turkey. In this plan firstly the GHG emissions and energy balance was studied for each sector; housing, services, industry, transportation, urbanization, solid waste materials and water resources. Current policies and studies are evaluated. For the more sustainable urban life, climate change plans are organized in 3 axes; urban renewal management, urban development planning, indirect intervention. The emphasized actions are; energy efficiency, eco-regions, creating 'Energy Information Points', 'Local Energy Agency', sustainability in industrial areas, recycling of energy, public transportation development and shift to the green technology, decrease in water consumption and water loss, energy efficiency for waste water treatment plants. Finally, the implementation strategies are developed, suggestion on climate

change institutional organization is declared. This study is a good example on local climate change studies.

Antalya metropolitan municipality published 'Antalya Institutional and Urban Scale Carbon Footprint Inventory Report' in 2013. This report stands as the first step of ‘Sustainable Energy Action Plan'. The inventory is a base study for monitoring the emissions and reduction through the targets. The carbon footprint inventory was prepared using the methodology of IPCC TIER-1 and TIER-2. 2012 was selected as reference year. According to the results, the energy consumption and transportation constitute the highest proportion of total emissions. For the action plan, strategies will be developed on those sectors. This study is one of the first carbon footprint studies in urban scale for Turkey (AMM, 2013).

Adana, Çukurova Municipality concerned the climate change impacts in their 2010-2014 strategic plan under the title of 'Environment Protection and Climate Risks'. In this plan increasing adaptive capacity to climate change states as a strategic purpose. The actions determined to reach this purpose; usage of renewable energy sources, water saving by using pressure irrigation system for parks and gardens, increasing the capacity of adaptation to climate change by organizing seminars with participation of chambers, NGOs, universities.

Konya Ovasi Project Action Plan has started in second quarter of 2012 considering drought, water quality and climate change based problems. The agency is aimed to develop an environmentally concerned approach to the plan. The plan is constructed on sustainability of natural resources, strengthen of economic structure, development on infrastructure and urbanization, and strengthen of social structure and development of institutional capacity.

3.5 Istanbul from the Perspective of Climate Change and Resilience

Istanbul has the challenge of being the biggest metropolitan city of Turkey. On one side there are rapid population growth, huge investments on development, sprawl of the city, economic viability while on the other side, the natural resources that are under pressure of human activities, decreasing quality of life.

The latest local development plan (2009) concerns about the natural areas' protection and directs the development in the frame of sustainability. However, the central

government insist on mega projects that are not included in Istanbul environmental plan such as 3rd bridge, 3rd airport, and Canal Istanbul projects. Those projects are contradictory to protection strategies and sustainability. Chamber of city planners (2010) published a report about 3rd bridge project about its possible hazards to natural resources and sustainability of Istanbul. Economic considerations are prior for central government rather than natural protection in Istanbul.

There are implementations that contribute to resilient in Istanbul such as public transportation investments (Istanbul Transportation Plan, 2011). However, still climate change and increasing resilience is not prior concern for the decision makers and authorities.

3.6 Evaluation of Climate Change and Resilience in Turkey

Turkey located in Mediterranean basin, one of the most risky countries in terms of climate change impacts. The impacts like temperature increase, seasonal changes, warmer winters and hotter summers, drought and water scarcity especially in summer period have already been observed. Turkey is a growing country which triggers the urbanization process. Urbanization increases the pressure on natural areas, water resources, cause more emissions and pollutions. Besides natural phenomena, human activities put the country in a disadvantageous position.

Turkey has started to take place in international policies on climate change. In 2004 Turkey become a member of Kyoto Protocol. With this step, the interest in the climate change adaptation and mitigation strategies have increased. Turkey has published national climate change strategies action plan. Moreover, in local level, municipalities started give importance to sustainable development. They have included the climate change strategies inti their development and strategy plans.

Although it is a new concept in action for Turkey the attention to struggle with climate change is increasing. There is a long way toward more resilient cities in terms of mitigation, protection, sustainability, adaptation. İstanbul as the biggest metropolitan city of Turkey, carries great importance to be focused to increase resilience. For now on the studies on İstanbul is limited. More studies should be conducted on İstanbul.

4. URBAN VULNERABILITY AND RISK ASSESSMENT IN ISTANBUL

4.1 Introduction

Istanbul is the biggest metropolitan city of Turkey with its population of 14.160.467 (TurkStat, 2013). Istanbul is located on two sides of Bosporus, European side and Anatolian side, have cost on Black Sea and Marmara Sea. With its rapidly growing population it is important for tourism, culture and industry (IER, 2011). The city is expanded 5512 km^2 (IMP, 2009).

Istanbul has a special value with its history, natural beauty and geographical location among world's metropolitan cities. It is a center of national and international trade, culture and tourism. In national level it has the highest urban services and most important center (IMP, 2009).

Istanbul's service hinterland extends other 80 provinces with its social facilities, central offices of national or international institutions. Istanbul's employment rate in services covers one fifth of Turkey with its GDP (IMP, 2009).

Economically powerful location of Istanbul make it a center of immigration among Turkey. Since 1950, Istanbul has become center of migration from other cities especially eastern part of Turkey. The need of increase in economic activities has emerged with rapid population growth and migration. Creating new employment area is costly and Istanbul suffered from the imbalance of immigration and employment opportunities. Therefore, the average income level and life standards have decreased in the city (IMP, 2009).

According to economic structure indicators of Istanbul Master Plan referenced to DPT 2000 data, the GDP per person is 2657$ in Istanbul while it is 1837$ in Turkey. The share of GDP in Turkey is 22.11%. The unemployment rate is 12.7% while it is 6.5% in Turkey.

Istanbul with its high population, migration rate, being economic and cultural center represent an important role in adaptation and mitigation to climate change effects. Any climate based adverse impact to Istanbul would be destructive for both the city and Turkey. For the sustainability of vital economic, social activities, increasing the resilience of the city is essential. Although Istanbul has an advantageous considering its economic and social structure, it is highly vulnerable any destructive external stresses. It is in a position as an engine of Turkey which makes the careful consideration of hazards necessary.

In a path to more resilient structure of the city, estimating potential impacts, determining vulnerabilities and risk, developing adaptation and mitigation strategies in local and national level is essential.

4.1.1 Aim and objectives

In this study, Istanbul is chosen for the case study because of its geographical location, cultural values, economically importance in Turkey. Since it is the most important center in terms of economic activity and population, Istanbul should be considered in terms of negative impacts of climate change urgently.

The aim of this study is to investigate the vulnerability and risk levels to climate change impacts of sectors in Istanbul. According to vulnerability and risk levels, priorizating the sectors in Istanbul is the purpose of this study.

The objectives of this study can be listed as:

- Presenting the climate change effects to the sectors in Istanbul
- Evaluating the sensitivity of sectors considering current and future climate conditions.
- Investigating the current strategies that contributes to climate change adaptation or mitigation for each sectors.
- Investigating the absence of the necessary preparations for climate change impacts.
- Investigating contradictory strategies to climate change adaptation or mitigation for each sectors.
- Revealing the advantageous of sectors to climate change impacts.

- Presenting the barriers that make the adaptation or mitigation implementations more difficult to execute.
- Evaluating the adaptive capacity of each sector to climate change impacts.
- Assessing the vulnerability levels of sectors and ranking them considering their vulnerability scores.
- Estimating the ecologic, social, economic and cultural consequences of the climate change risks.
- Assessing the risk level for each sector and ranking them considering their risk score.
- Prioritizing the sectors according to their vulnerability and risk scores.
- Ranking the sectors of Istanbul with their combined scores of vulnerability and risk scores.
- Determining the most and least important sectors to consider in adaptation strategies planning.

The results of this study indicate the most vulnerable and at most risk sector that have priority to develop adaptation plans and the least vulnerable and at least risk sector. The results enlighten the path towards building the more resilient city defining the starting point in terms of vital sectors for the city.

4.1.2 Methodology and context

In this study, the methodology defined by ICLEI (2007) in the publication of "Preparing for Climate Change; A guidebook for Local, Regional and State Governments" has been deployed as framework of vulnerability, risk assessment and prioritization analysis. According to the definitions in that guidebook, 11 sectors and 26 planning areas are identified. The 11 sectors are defined considering Istanbul's development strategies that may be affected by climate change and critical to health of citizens and the economic viability of the city. Related planning areas are defined in the frame of ICLEI definition that cover major urban issues and important for the services of the city. The determined sectors are health, water resources, energy, transportation, agriculture, public safe, land use and development, materials, infrastructure, ecology and biodiversity, culture.

The data are gathered from relevant institutions, plan reports, relevant studies. The information taken from institutions are; their current programs, policies that may

contribute to climate change adaptation or mitigation, climate change projections, future expectations about demographic, structural or economic structure, their investments and plans. In addition, in-depth interviews are conducted with experts, representatives of companies and institutions, scientists, academics and researchers. 54 interviews were conducted between April - December 2014. Interviews were carried out in a semi-structured questionnaire.

The semi-structured questionnaire is aimed to learn the approaches of different sectors and variety of actors' approaches to climate change issue, their direct or indirect contributions to climate change adaptation and mitigation strategies, the awareness of the importance of the issue, different perspectives to the climate change issue. As a result it is aimed to reach the vulnerability and risk level of sectors in the perspective of relevant actors' attitude to the climate change issue.

The semi-structured questionnaire that was conducted at in-depth interviews consists of four main parts. The first part is about personal information of the person who is interviewed, including institutional information and professionalized area. The second part is about the climate and sector relation. In this part the current climate conditions and their impacts on sector is asked. The projected climate change and its projected impacts on the sector is asked as well. The questions aimed to learn the current and possible future sensitivity of sector to climate events. The third part is about the studies on the sector that are directly or indirectly related to climate change and its impacts. In this part the incites, encouragements by government, any investments by any actor, future plans or strategies that is related to the issue is discussed. Here both contributing and contradicting activities and strategies are aimed to learn. The advantages and disadvantages of sector in terms of climate change studies are asked. The purpose of this part is to learn the opportunities and barriers to increase the capacity of adaptation to climate change. In the last part the possible impacts and their consequences on urban system is asked. The expected cost of the climate change on the sector to prevent and to recover the any hazardous impact is aimed to reveal. This part is purposes to learn the proposed risk for the sector. In the interviews people's comments, expectation, suggestions and evaluations in their perspective are also considered (See App. A.1). Table 4.1 presents the structure of semi-structured questionnaire that is conducted during the interviews.

Table 4.1 : Content of semi-structured questionnaire.

<table>
<tr><td>I</td><td colspan="3">Personal Information</td></tr>
<tr><td rowspan="2">II</td><td>Current Climate Impacts on Sector</td><td rowspan="2">Sensitivity of Sector</td><td rowspan="5">Vulnerability</td></tr>
<tr><td>Future Climate Impacts on Sector</td></tr>
<tr><td rowspan="2">III</td><td>Relevant Studies to Climate Change Investments/Incites/Strategies/Plans</td><td rowspan="2">Adaptive Capacity of Sector</td></tr>
<tr><td>Opportunities/Barriers</td></tr>
<tr><td rowspan="2">IV</td><td colspan="2">Consequences of Climate Change Impacts</td><td rowspan="2">Risk</td></tr>
<tr><td colspan="2">Cost for Preventing and Recovery</td></tr>
</table>

The Interviewed institutions can be categorized as; Public Institutions, Private Institutions, Non-Governmental Organizations, Academics. In this sense, the distribution of 55 interviews are (See App. A.2);

- 43 of them are with Public Institutions
- 5 of them are with Private Institutions
- 4 of them are with Academics
- 3 of them are with Non-Governmental Organizations

Table 4.2 presents the list of interviewed public institutions, private institutions, academics and NGOs.

Table 4.2 : Categorized interview list.

Public Institutions	• Istanbul Metropolitan Municipality o Planning Department o Urban Renewal Department o Dwelling Department o Transportation Planning Department o Transportation Coordination Department o Traffic Department o Strategy Development Department o Environment Preservation Department o Solid Waste Management Department o European Side Road Maintenance Department o Public Transportation Department

Table 4.2 (continuation) : Categorized interview list.

	○ Sea Transportation Department ○ Parks and Gardens Department ○ Green Areas Department ○ Fire Department ○ Historical Environment Preservation Department ○ Disaster Coordination Center • Housing Development Administration (TOKI) • Istanbul Water and Sewerage Administration (ISKI) • Regional Directorate of Forestry • Provincial Directorate of Environment and Urban Planning • National Palaces • Cultural and National Heritage Preservation Board • Regional Directorate of State Hydraulic Works (DSI) • Istanbul Directorate of Provincial Food Agriculture and Livestock
Private Institutions	• ISTAC Inc. (State Economic Enterprise) • Energy Inc. (State Economic Enterprise) • VARYAP
Academics	• ITU, Department of Meteorological Engineering • ITU, Faculty of Civil Engineering • ITU, Eurasia Institute of Earth Sciences
NGO's	• Istanbul Chamber of Commerce • Istanbul Chamber of City Planners • Platform of Northern Forests Defense • Electricity Producers Association

Each interview is connected to the related sector. Some institutions have studies or effects on more than one sector. In that case the questionnaire is conducted for each related sector. The sector and interviewed organization/institution can be seen in Table 4.3.

Table 4.3 : Sectorial interview list.

The Sector	Interviewed Organisation/Institution
Health	• ITU, Department of Meteorological Engineering • ITU, Eurasia Institute of Earth Sciences
Water Resources	• IMM, Strategy Development Department • Istanbul Water and Sewerage Administration (ISKI) • Regional Directorate of State Hydraulic Works (DSI) • ITU, Faculty of Civil Engineering
Energy	• IMM, Strategy Development Department • Energy Inc. • Electricity Producers Association
Transportation	• IMM, Planning Department • IMM, Transportation Planning Department • IMM, Transportation Coordination Department • IMM, Traffic Department • IMM, Strategy Development Department • IMM,European Side Road Maintenance Department • IMM, Public Transportation Department • IMM, Sea Transportation Department
Agriculture	• Istanbul Directorate of Provincial Food Agriculture and Livestock • ITU, Department of Meteorological Engineering
Public Safe	• IMM, Fire Department • IMM, Disaster Coordination Center • Istanbul Water and Sewerage Administration (ISKI) • Istanbul Water and Sewerage Administration (ISKI) • ITU, Department of Meteorological Engineering
Land Use & Development	• IMM, Planning Department • IMM, Urban Renewal Department • IMM, Dwelling Department • IMM, Transportation Planning Department

Table 4.3 (continuation) : Sectorial interview list.

	• IMM, Strategy Development Department • Housing Development Administration (TOKI) • Istanbul Water and Sewerage Administration (ISKI) • Provincial Directorate of Environment and Urban Planning • VARYAP • Istanbul Chamber of City Planners
Materials	• IMM, Solid Waste Management Department • ISTAC Inc. • Istanbul Chamber of Commerce
Infrastructure	• IMM, Planning Department • Istanbul Water and Sewerage Administration (ISKI) • Regional Directorate of State Hydraulic Works (DSI)
Ecology and Biodiversity	• IMM, Strategy Development Department • IMM, Environment Preservation Department • IMM, Parks and Gardens Department • IMM, Green Areas Department • Regional Directorate of Forestry • Provincial Directorate of Environment and Urban Planning • Platform of Northern Forests Defense
Culture	• IMM, Historical Environment Preservation Department • National Palaces • Cultural and National Heritage Preservation Board

The assessment is defined in three steps in the framework of ICLEI. The first one is the vulnerability assessment that determines vulnerability levels and scores for each sector and planning area. The second one is the risk assessment that reveals the risk levels and risk scores for each sector and planning area. The final step is the prioritization assessment that combines vulnerability scores and risk scores and rank

the sectors and planning areas according to their combined scores from most vulnerable and at risk sector and planning area to least vulnerable and at least sector and planning area.

Vulnerability assessment: ICLEI Guidebook (2007) defines vulnerability as “the susceptibility of a system to harm from climate change. Vulnerability is a function of a system's sensitivity to climate change and the capacity of that system to adapt to climate change". Figure 4.1 shows conceptual presentation of vulnerability.

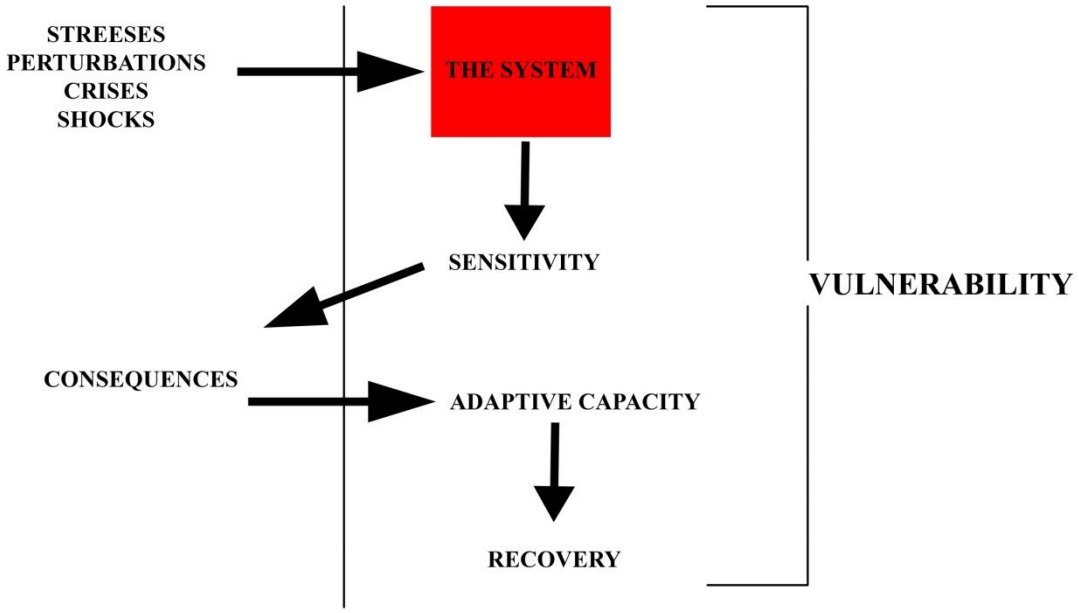

Figure 4.1: Vulnerability concept.

Considering ICLEI definition, vulnerability assessment is conducted in two parts; sensitivity analysis and adaptive capacity analysis. Figure 4.2 indicates the steps of vulnerability assessment.

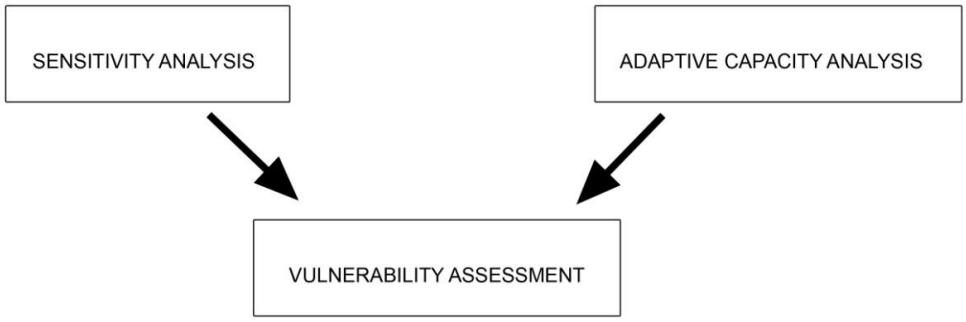

Figure 4.2: Vulnerability assessment concept.

The first part of the vulnerability assessment is sensitivity analysis. The sensitivity level is determined according to the questions outlined in ICLE Guidebook. Those questions include Current and Expected Stresses to Systems, Known Climate Conditions Relevant to Systems, How Known Climate Conditions Currently Affect Systems, and How Known Climate Conditions are projected to Change, Projected Impacts of Changes to Systems, and Projected Change in Stresses to Systems (Table 4.4). The final assignment of sensitivity level is made by the researcher subjectively using the information gathered at the beginning of the study. The sensitivity level is assigned as high, medium or low according to the impact of climate change. A planning area that would experience great impact from climate change was rated as high sensitivity, while an area would have little or no impact was rated as low sensitivity.

Table 4.4 : Sensitivity analysis methodology sample.

Sector	Planning Area	Sensitivity Analysis						
		Current & Expected Stresses to the Systems	Known Climate Conditions Relevant to Systems	How Known Climate Conditions Currently Affect Systems	How Known Climate Conditions are Projected to Change	Projected Impacts of Changes to Systems	Projected Change in Stresses to Systems	Degree of System Sensitivity to Climate Change

The second part of the vulnerability assessment is the adaptive capacity analysis. The questions to assess adaptive capacity are, Current and Expected Stresses to Systems in This Planning Area, Projected Impacts of Changes to Systems in This Planning Area, Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Costs, Barriers and Facilitators to Improving Resiliency (Table 4.5) which are outlined in ICLEI Guidebook. As in sensitivity analysis, considering gathered information, final evaluation is made by the researcher subjectively. Adaptive capacity is ranked as high, medium or low as well. A planning area having the ability to absorb climate impacts well and few barriers to adopting was ranked as high adaptive capacity level whereas, an area that does not have the ability to absorb climate impacts and faces restrictive barriers was ranked as low adaptive capacity.

Table 4.5 : Adaptive capacity analysis methodology sample.

Sector	Planning Area	Adaptive Capacity Analysis				
		Current & Expected Stresses to Systems in This Planning Area	Projected Impacts of Changes to Systems in This Planning Area	Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Costs	Barriers & Facilitators to Improve Resiliency	Adaptive Capacity of This Planning Area

The final part of the vulnerability assessment is evaluating sensitivity analysis and adaptive capacity analysis together. The combination of the sensitivity level and adaptive capacity level gives the result of vulnerability level. In order to evaluate quantitative result, scores from 1 to 3 are given to the sensitivity levels and adaptive capacity levels. Sensitivity levels are scored as 3: high sensitivity, 2: medium sensitivity, 1: low sensitivity while adaptive capacity levels are scored as 3: low adaptive capacity, 2: medium adaptive capacity and 1: high adaptive capacity. Table 4.6 presents the sensitivity and adaptive capacity levels with score matrix of vulnerability assessment.

Table 4.6 : Vulnerability assessment scores

	High Sensitivity = 3	**Medium Sensitivity = 2**	**Low Sensitivity =1**
Low Adaptive Capacity = 3	6	5	4
Medium Adaptive Capacity = 2	5	4	3
High Adaptive Capacity = 1	4	3	2

The combined scores are ranked as; 6-5: high vulnerability level, 4: medium vulnerability level, 3-2: low vulnerability level (Table 4.7).

Table 4.7 : Vulnerabiity level scores

The Score	**Vulnerability Level**
6-5	High Vulnerability
4	Medium Vulnerability
3-2	Low Vulnerability

Risk Assessment: ICLEI Guidebook (2007) defines risk with two components; consequences of an impact and probability or likelihood of an impact.

$$\text{Risk} = \text{Consequence X Probability} \qquad \textbf{(4.1)}$$

Consequence of an impact represents the known or estimated consequences of a particular climate change impact. For example; the cost, the size of the population or land area affected by climate change impacts. In this study consequences are investigated in four main topics; economic consequences, ecological consequences, social consequences, cultural consequences. Economic consequences are about how costly will be the damage or repair, the cost of the measurements. Ecological consequences are based on how the environment and ecosystem will be affected. Social consequences replies how the citizens will be affected, is there any life threatening impact, which group of the citizens will be affected. Cultural consequences are about whether any effect on culture, if there is, how it may change cultural behavior. The cumulative result of consequences is evaluated as high, medium or low.

Probability or likelihood of an impact answers the question "how likely is it that a projected impact will occur?" Some climate change impacts are certain and can be observed in current situation while some impacts are uncertain. Considering the degree of those changes affect existing problems or lead to new problems the certainty level is determined. The evaluation based on the certainty and uncertainty of impacts is ranked as high, medium, low probability.

The information collected for vulnerability assessment is used to estimate the consequence, probability and as a result risk of climate change impacts to systems. Table 4.8 indicates the risk assessment questions to be answered in order to assess the risk.

Table 4.8 : Risk assessment methodology sample.

Sector	Planning Area	Current & Projected Stresses	Projected Impacts	Risk Analysis					
				Consequence of Impacts				Probability of Impact	Estimated Risk Level
				Economic	Ecological	Social	Cultural		

The final risk level is evaluated considering both consequence results and probability of impacts. In order to combine those results, quantitative scores are given for each. Consequences are scored as 3, 2, 1 for high, medium, low results respectively at the same time probabilities are scored as 3, 2, 1 for high, medium, low respectively as well. Table 4.9 presents the score matrix of risk assessment.

Table 4.9 : Risk scores.

Consequence / **Probability**	**High = 3**	**Medium =2**	**Low =1**
High = 3	6	5	4
Medium =2	5	4	3
Low =1	4	3	2

The cumulative scores are used to determine the risk level of each sector and planning area. The scores are ranked as 6-5: high risk level, 4: medium risk level 3-2: low risk level (Table 4.10).

Table 4.10 : Risk level scores.

The score	**Risk Level**
6-5	High Risk
4	Medium Risk
3-2	Low Risk

Prioritization Assessment: The prior planning areas and sectors are those determined to be most important given community's vulnerabilities and associated risks to

climate change. The high risk and high vulnerability planning areas are defined as prior (ICLEI, 2007).

For this assessment the results of vulnerability assessment and risk assessment is used. The scores for each assessment and each planning area are summed and combined scores are obtained. Those scores are ranked from highest to the lowest point presenting the most prior planning areas with highest score to the least prior planning areas with lowest score. Table 4.11 presents the prioritisation assessment titles in a sample.

Table 4.11 : Prioritization assessment sample.

Sector	Planning Area	Vulnerability Score	Risk Score	Combined Score	Sector Average Combined Score

In the empirical part of the study firstly the aim objectives and methodology of the study is introduced in detailed. Why Istanbul is selected to analyzed, what the expected results and outputs are to get, what the framework of the study is and how the results are aimed to reach explained in depth. In the second part of the empirical study is about definition of sectors and planning areas that are attempted to analyze. The selected sectors and planning areas are introduced and explained with the cause of selection. The third part of the study is vulnerability assessment of sectors and planning areas in Istanbul. Here, the analysis is conducted to each sector and planning areas and the level of vulnerability is determined for each of them. In the next part the vulnerability assessment results for all sectors and planning areas are presented and compared. The most and least vulnerable sectors and planning areas are introduced. The fifth part of the empirical study is risk assessment for all sectors and planning areas. In this part the analysis about risk is conducted for each sector and planning areas and risk levels of each is determined. In the next part the risk assessment is summarized presenting and comparing the all sectors and planning areas risk levels. Here, the most at risk sectors and planning areas are explained. The seventh part of the study is the prioritization analysis. In this part vulnerability level scores and risk level scores of each sectors and planning areas are combined to assess

the most and least prior sectors and planning areas. The last part of the study is conclusion and evaluation. In this part the results are explained and discussed.

4.2 Definition of Sectors and Planning Areas

ICLEI (2007) defines sectors as "any resource, ecological system, species, management area, activity, or other area of interest that may be affected by climate change". In this study, sectors are determined considering Istanbul's development plan and vital urban systems. Those sectors are: Health, Water Resources, Energy, Transportation, Agriculture, Public Safety, Land Use and Development, Materials, Infrastructure, Ecology and Biodiversity, Culture.

Planning areas are defines by ICLEI (2007) as "the areas in which a government or community manages, plans, or makes policy affecting the services and activities associated with built, natural, and human systems". Planning areas can be identified as subset of sectors. In this frame 25 planning areas are determined associated with sectors. Those are;

- Health: Air Quality, Heat
- Water Resources: Water Quality, Water Supply
- Energy: Energy Production, Energy Demand
- Transportation: Public Transit, Road and Bridge Maintenance, Sea Transit
- Agriculture: Crop Diversity, Agricultural Land Maintenance
- Public Safety: Disaster Response, Urban Risk Areas, Fire Safety
- Land Use & Development: Affordable Housing, Urban Renewal, Urban Planning, Social Facilities
- Materials: Waste Collection and Recycling
- Infrastructure: Storm Water Management, Sewage System
- Ecology & Biodiversity: Urban Forest Management, Green Spaces, Biodiversity
- Culture: Cultural and Historical Heritage

Table 4.12 indicates all selected sectors to be analised for the Istanbul case study and the planning areas that are related to the sectors.

Table 4.12 : Selected sectors and planning areas for the emprical study.

SECTORS	**PLANNING AREAS**
Health	Air Quality
	Heat
Water Resources	Water Quality
	Water Supply
Energy	Energy Production
	Energy Demand
Transportation	Public Transit
	Road & Bridge Maintenance
	Sea Transit
Agriculture	Crop Diversity
	Agricultural Land Maintenance
Public Safety	Disaster Response
	Urban Risk Areas
	Fire Safety
Land Use & Development	Affordable Housing
	Urban Renawal
	Urban Planning
	Social Facilities
Materials	Waste Collection & Recycling
Infrastructure	Storm Water Management
	Sewage System
Ecology & Biodiversity	Urban Forest Management
	Green Spaces
	Biodiversity
Culture	Cultural and Historical Heritage

4.3 Vulnerability Assessment of Sectors in Istanbul

In this section of the thesis, vulnerability assessment is conducted to each sectors and planning areas. The assessment is completed in three steps; as first the sensitivity analysis, as second the adaptive capacity analysis and as third and final, evaluating vulnerability level of the planning area. Here, vulnerability levels of the each planning area is concluded and presented.

4.3.1 Health - air quality

The first sector is 'Health' and the first planning area of this sector is 'Air Quality' to be analised. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.1.1 Sensitivity analysis of air quality

Weather and climate always affect human health and welfare. Increasing air pollution, changes in the amount of the pollens and spores in the air, increase in greenhouse gases in the atmosphere due to industrial activities are all part of environmental pollution. Changing amount of pollens and spores in the air causes increase in allergic diseases, asthma, respiratory diseases. Ozone layer depletion cause increase in ultraviolet rays coming to the earth. That increase causes weakening the immune system which cause raising risk of cancer. Moreover, sunburn causes decrease of skin flexibility which results early ageing (Tekbaş et. al., 2005).

Air pollution affects children more than adults. Therefore, children are under great risk. They are sensitive due to their lungs (Tekbaş et. al., 2005).

Clean weather contains 78% nitrogen, 21% oxygen, 1% other gas, dust, water vapor. Those ratios are natural weather components. Deterioration of those ratios of components cause air pollution that may be detrimental to human health, ecosystem, environment (IER, 2011).

The negative effects of pollutants CO, NO2, O3, PAN & Aldehydes, SO2 & Particles are presented at Table 4.13.

Table 4.13 : Pollutants effects on human health.

POLLUTANT	EFFECT
CO	Disruption of oxygen carrying in blood stream, negative effects on nervous system, disruption on visibility, headache, increase in heart problems
NO2	Negative effect on respiratory system
O3	Disruption on pulmonary function
PAN & Aldehydes	Irritation in eyes
SO2 & Particles	Increase in chronic respiratory diseases

The main reasons for air pollution can be categorized as (IMP, 2009);

- Unplanned development which is mostly illegal and informal
- Industrial facilities located in the city
- Large industrial facilities located close to the city due to economic concerns
- Increasing population and increasing number of car ownership in the city

4.3.1.2 Adaptive capacity analysis of air quality

Ozone increase in the air depending on heat and sun light. Breathing ozone causes respiratory diseases in short term. Studies have shown that air pollution depending on ozone level increases the risk of asthma. Effect of air quality on health changes depending on person, time spending outside and physical activities. Children and outside workers are under risk (Çelik et. al., 2008).

Observations should be done continuously in order to understand the effect of climate change on human health and to struggle with it (Çelik et. al., 2008).

Air quality is concerned in the urban planning level. Some measures are taken to sustain air quality and decrease pollutant sources, such as; traffic, urban spread, urban heat island effect. Although this planning area is severe for human health, it is not prior concern for authorities. There is not enough study or research about the issue.

4.3.1.3 Vulnerability level of air quality

Air quality affects human health, especially old, sick people and children. There are some measures to improve air quality and prevent air pollution. However, urbanization, loss of green areas, traffic create problem in terms of air quality. Therefore, both sensitivity level and adaptive capacity level of Istanbul for air quality is medium.

The overall score for vulnerability level is medium as seen at Table 4.14.

Table 4.14 : Vulnerability level of air quality.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
Medium (2)	Medium (2)	Medium (4)

4.3.2 Health - heat

The analised second planning area is 'Heat' under the sector of 'Health'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.2.1 Sensitivity analysis of heat

Climate change has caused 1^0C increase in night temperatures related to heat island effect. The primary reasons for that increase are; unplanned urban development, destruction of natural areas and deforestation. When last fifty years maximum and minimum temperatures are observed, narrowing in daily temperature differences is seen. According to RegCM3 simulations, Istanbul's temperatures will increase 2-3 ^{0}C annually with the worst scenario by 2100 (IMP, 2009).

Climate change is expected to cause hotter summers and warmer winter. Although, it is not expected to observe changes in seasons, average temperatures will increase which cause more heat wave in the summer, less cold wave in the winter. Hot summer time frequency was 310 years, however with climate change the frequency is 5-6 years now. That situation shows that temperatures will continue to increase (Tekbaş et. al., 2005).

Heat waves, frequent extreme weather events caused by climate change directly affect human health and cause diseases and deaths. Depending on the increasing temperatures on the earth, seasonal deaths have been observed. Increasing

temperatures causes increase in the number of vectors like mosquitos. That means diseases spread faster and more dangerously (Tekbaş et. al., 2005).

Deaths due to heat wave seen on people that have respiratory diseases. Sick, unhealthy and elder people are the most effected group. Climate change leads to decrease in winter deaths while increase in summer deaths. Data obtained until now shows that total deaths are increasing and climate change is affecting human health negatively (Tekbaş et. al., 2005).

Some diseases are very sensitive to heat and precipitation. That situation is observed in developing and undeveloped countries more. The poorest part of the city is affected heavily from even slight changes in climate. Poor citizens living in cities and rural have serious health problems due to environmental deterioration (Çelik et. al., 2008).

McMichael (2006) states that ıf temperatures increase 1^0C upon starting value, death rate will increase between %0.2 and %5.5 (Çelik et. al., 2008). The sensitivity changes depending on age, state of health, body structure, activity level, extreme heat level. Elder people, children, people living in cities, sick people, uneducated people, outside workers are the sensitive group to the heat. Cities are the center of the risk due to urban heat island effect.

4.3.2.2 Adaptive capacity analysis of heat

The most obvious consequence of climate change is the increased temperatures. It is expected to be warmer winters and hotter summers with more frequent heat waves. Change in temperatures, frequency and intensity of extreme weather events. Heat waves directly affect the human health. Adverse changes may cause diseases and deaths. Epidemic illnesses and deaths because of extreme heat will increase (Tekbaş et. al., 2005).

In order to adapt the new conditions, physiological, infrastructural, behavioral measures may be taken. However, according to models, those precautions will not prevent health problems, deaths will increase (Tekbaş et. al., 2005).

Since winter temperatures increases as well, winter deaths will decrease. However, this does not mean total death rate will decrease. In summer time deaths due to heat or epidemic illnesses will increase. Elder people, children, outside workers are the

most risky group. Cities especially metropolitan areas also have high risk because of urban heat island effect (Çelik et. al., 2008).

4.3.2.3 Vulnerability level of heat

Heat directly affects all citizens in the city. Heat causes diseases, increase in illnesses even deaths. Due to urban settlement pattern in Istanbul sensitivity is high and adaptive capacity is low.

As resulted in Table 4.15, vulnerability level is high.

Table 4.15 : Vulnerability level of heat.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Low (3)	High (6)

4.3.3 Water resources - water quality

The second sector is 'Water Resources' and the first planning area of this sector is 'Water Quality' to be analised. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.3.1 Sensitivity analysis of water quality

Water resources in Istanbul are under threat due to urban settlements without sewage system and leakage from large sanitary landfill. The threat of leakage increases in rainy days, underground water resources get polluted (IER, 2011). In order to prevent that leakage is collected in abounded landfills that threatens the water basins (ISTAC). Rapid population growth due to migration, unplanned and informal urban development, industrialization, wrong land use decisions have caused extreme water pollution.

Sea level increase also threatens the aquifers close to the sea. Natural pollution occurs when sea water interfuse to the aquifers. In Istanbul aquifers in sea shore are mostly salinized or about to be salinized.

Sewage of settlements and industries are discharged to rivers, lakes or sea in Istanbul. Although, discharges are controlled and treated for some points, there are uncontrolled and illegal discharges. That situation creates a serious water pollution

problem. Another threat is erosion that carries agricultural fertilizer or chemical into the water resources (IER, 2011).

Within water quality observation studies, DSI determines water pollution by observation wells in various regions.

The greatest threat to the water resources is urban sprawl and unplanned settlement development. Some basins are occupied by settlements, some are under pressure of urbanization. There are illegal settlements in water basins (IER, 2011). ISKI is working on protecting water quality and sustainable water resources punctiliously. Within potable water basin protection regulation, ISKI tries to prevent urban development in water basin as well as clean the basins that already occupied by settlements (Interview with Hakan Eminoglu, 03.06.2014).

4.3.3.2 Adaptive capacity analysis of water quality

Water from resources are treated in water treatment plants. ISKI supplies necessary infrastructure system to distribute quality water to citizens. Moreover observations, controls and analysis for the quality of water are done by ISKI (iski.gov.tr). Within water quality control, water treatment plants, water pipes, ISKI reservoirs are controlled in terms of physical, chemical, bacteriological by ISKI periodically (IMP, 2009). 'Water Quality Report' for city water supply is published each month (iski.gov.tr).

All facilities that produce waste water should be controlled and observed according to Ministry of Environment and Urbanization Water Pollution Control Regulation. According to that regulation, waste water should be treated properly before discharge to the resources. Direct discharge without treatment of waste water is forbidden. Moreover, ISKI is responsible for control of waste water sources, as well as protect water basins from illegal urban development. ISKI and DSI measures water quality in reservoirs periodically in order to determine pollution. Local health authority controls the convenience of potable water to health standards by getting samples (IMP, 2009).

4.3.3.3 Vulnerability level of water quality

Water quality is highly sensitive to the climate change. Water resources are open to pollution and measures are not enough. There are some regulations and actions to

protect water resources and water quality. Distributed water is controlled regularly in terms of its quality. Although it is costly, some precautions are taken to supply water quality. Therefore, adaptive capacity of this planning area is medium.

The overall score in terms of vulnerability level is high as seen at Table 4.16.

Table 4.16 : Vulnerability level of water quality.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
High (3)	Medium (2)	High (5)

4.3.4 Water resources - water supply

The second analised planning area under the sector of 'Water Resources' is 'Water Supply'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.4.1 Sensitivity analysis of water supply

The annual precipitation in Istanbul is between 3.780 and 5.400 million m^3. The supplied water is 715 million m^3 in Istanbul considering both underground and over ground. Also, 235 million m^3 water is supplied from Istarncalar. It can be said that; the reel usable water in Istanbul is 950 million m^3 annually and gross water consumption is 235 liter per person (IMP, 2009).

Istanbul has suffered from drought for centuries not having rich water resources. In order to overcome that problem many solutions have suggested. Only water resource of Istanbul is rains (Interview with Ahmet Kose, 21.05.2014)

DSI, ISKI, IMM are responsible institutions to supply water for Istanbul and water resources are under control and management of those institutions. Institutions supply drinking and industrial water for the city needs. Water demand for agricultural purpose is supplied from different ponds that are managed by IMM. Reservoirs, regulators and wells are used for potable and industrial water supply. DSI is responsible for constructing reservoirs and water pipes to the water treatment plant. Treatment and distribution of water is within ISKI's responsibilities (Interview with Hakan Eminoglu, 03.06.2014).

Table 4.17 shows potable water system of Istanbul with their name and the storage capacity (dsi.gov.tr).

Table 4.17 : Potable Water Systems in Istanbul.

Name of Facility	**Storage Capacity**
Omerli Dam	220 hm^3/y
Terkos Dam	142 hm^3/y
Buyukcekmece Dam	70 hm^3/y
Darlik Dam	97 hm^3/y
Alibey Dam	36 hm^3/y
Sazlidere Dam	50 hm^3/y
Yesilcey System	145 hm^3/y
Elmali Dam	15 hm^3/y
Y,A,S	24 hm^3/y
Kemerburgaz - Alibey Derivation	5 hm^3/y
Yesilvadi - Darlik Dam	10 hm^3/y
Other Historical Dams	5 hm^3/y
TOTAL	**819 hm^3/y**

There are 4 regulators as water resource; Agva, Melen, Sile, Istrancalar. Melen Dam is under construction. When the construction of dam completed regulator will be removed and water will be supplied from reservoir. There are 13 dams in Istanbul; 4 of them are managed by DSI others are managed by ISKI. In Catalca and Silivri wells are used as water resource (Interview with Hakan Eminoglu, 03.06.2014).

Underground water resources and wells are widely used in new urban development areas and industrial areas in Istanbul. Due to inefficiency of the infrastructure system, high cost of city water, wells has started to be used for commercial purposes to sell water to constructions or industries around. Laws and regulations do not permit that kind of commercial activities. Also that kind of activities consume water resources rapidly which is strategically important and vital when drought, war, disaster happens. Institutions responsible for protecting water resources against pollution and over consumption should be reinforced and law about underground water should be enforced (IMP, 2009).

4.3.4.2 Adaptive capacity analysis of water supply

The total capacity of water treatment plants of Istanbul is 3.608 million m^3/day. According to projections the water demand will be 3.4 million m^3/ day in 2030 and 3.8 million m^3/day in 2040 (ITO, 2010).

Future demand for water is planned to be supplied by building new dams. Istrancalar is thought as new water resource for any future water problem (Interview with Tunay Carpar, 21.05.2014). Investments for the future and plans guarantee supply of water for Marmara region if drought occurs for 2 years successively (Interview with Ahmet Kose, 21.05.2014).

There is no system or project to collect rain and reuse of water. Water is not collected or storage except pools (Interview with Hakan Eminoglu, 03.06.2014).

Protection of water resources is an important topic. ISKI works on protection of water basins, prevention of urban development on those areas (Interview with Hakan Eminoglu, 03.06.2014).

4.3.4.3 Vulnerability level of water supply

Sensitivity level of water supply is high. Istanbul does not have adventurous in terms of water resources. It depends on the reservoirs around the city. Urbanization is a serious threat for limited resources. Investments have guaranteed that Istanbul has enough water supply for arid periods. There are plans for more water supplies but they are costly investments. Adaptive capacity level of the planning area is medium.

Overall score in terms on vulnerability level is high as seen at Table 4.18.

Table 4.18 : Vulnerability level of water supply.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
High (3)	Medium (2)	High (5)

4.3.5 Energy - energy production

The third analised sector is 'Energy' and the first planning area of this sector is 'Energy Production'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.5.1 Sensitivity analysis of energy production

In Turkey energy production is 27.4 million tap while energy consumption is 70.2 million tap. Turkey is able to support only 40% of energy demand from its own energy resources. The importance of the energy investment is under estimated by government which creates dependence to the other countries on energy issue (IER, 2011).

In 2010, energy need is supplied from natural gas (45.9%), domestic coal (18.4%), hydraulic resources (24.5%), imported coal (6.9%), liquid fuel (2.5%), wind (1.35%) and geothermal and biogas (0.47%). When it is compared with the data from 2009, it can be seen that proportion of wind and hydraulic resources have increased while domestic coal and natural gas have decreased. 54.6 % of the production is supplied by private sector (IER, 2011).

Istanbul has coal and natural gas reserves in Istanbul. The coal reserves have been managed since 1908. They have supplied the energy need of the city and neighbor cities. However, the coal production has decreased over years. There are limited natural gas reserves in the region. TPAO has been searching for natural gas in the region (IMP, 2009). In Istanbul there is limited coal mine reserve, but there are lignite reserves in Silivri and Sile. Hydraulic and nuclear energy is not used. Istanbul has poor resources in terms of geothermal energy (IER, 2011).

Naturel gas having low carbon content, has 1/3 lower CO_2 emission than solid fuel, 1/2 lower CO_2 emission than liquid fuel. Therefore, it is considered as clean energy. In Istanbul, natural gas was started to be used in 1992. In Silivri province of Istanbul natural gas is produced from natural gas wells belong to TPAO (2011). Natural gas usage has spread almost all over Istanbul. Therefore, air pollution in the city has decreased cause by coal (Interview with Sezgin Yazici, 28.05.2014).

Researches and investigating about solar fields are still continuing. Wind energy is used at its maximum level of Turkey's infrastructure capacity. Since the line capacity is fully used new wind energy facility cannot be used. For 45 mw fossil energy production, 10 mw wind energy can be connected to the system which is full in Turkey. Solar energy capacity is not fully used. Wind and sun energy is not constant which creates fluctuation in the system. However HES do not have such kind of a

problem since water can be stored. Therefore HES produce constant energy (Interview with Sezgin Yazici, 28.05.2014).

There is one thermal plant in Istanbul, Avcilar which belongs to Elektrik Uretim AS. That thermal plant is one of the biggest plant in Turkey. There are two parts working with fuel-oil and natural gas (IER, 2011).

The natural gas usage for automobiles is proposed to be extended. Public transportation vehicles of IETT use natural gas. There is only one filling station in Alibeykoy and operations to extend those filling station are maintained (Interview with Sezgin Yazici, 28.05.2014).

4.3.5.2 Adaptive capacity analysis of energy production

Turkey's energy production is not enough for the demand. Therefore, Turkey is a depended country to the other countries in terms of energy. The demand for energy is 70.2 million tep while the supply is 27.4 million tep. Turkey can only produce 40% of its demand (IMP, 2009).

Energy production is supplied with "build - operate - transfer" model. Energy companies and government work together on that subject. Potential of green energy exists in Turkey such as wind and solar energy however it is not used efficiently for energy production. Investment cost for alternative energy is high however, operation cost is low. There is no encouragement by government for alternative energy investment (Interview with Sezgin Yazici, 28.05.2014).

Istanbul suffered from air pollution because of coal used for heating. Since natural gas lines are extended almost all over Istanbul, air pollution caused by coal has decreased (Interview with Sezgin Yazici, 28.05.2014).

Istanbul provincial directorate of environment and forestry supplies credits for the investors in forest villages in order to encourage green energy usage and decrease fossil fuel usage. It is aimed to supply clean and cheap energy for forest villages. Technical support is also supplied to get and place solar energy panels (IMP, 2009).

The other alternative energy source used in Istanbul is solid waste landfills. 2-3 months after storage of solid waste, methane gas occurs. In solid waste landfills methane gas is collected by pipes and directed to energy production plant. Produced

energy is transferred to the energy line. Energy production from methane gas is used actively (Interview with Volkan Erc, 26.05.2014).

4.3.5.3 Vulnerability levet of energy production

The energy demand pattern is expected to change with climate change. The supply of energy is 40% from natural resources. There are some investments on green energy such as wind and solar energy. However, it is not sufficient yet. There is no encouragement for alternative energy investments.

The overall score for energy production vulnerability level is high as seen at Table 4,19.

Table 4.19 : Vulnerability level of energy production.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Low (3)	High (5)

4.3.6 Energy - energy demand

Under the sector of 'Energy' the second planning area to be analised is 'Energy Demand'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.6.1 Sensitivity analysis of energy demand

Energy demand is tried to be supplied by natural gas instead of fossil fuel in Istanbul. Natural gas is cleaner and do not have sera gas effect like fossil fuel. Therefore in residents, industries and commercial structures, natural gas is used (IMP, 2009).

Energy efficiency is an important factor for controlling the demand. Energy A.S. works as Consultant Company on energy efficiency. Studies and researches on energy efficiency is done by that company. Also, Energy AS works on energy efficiency in Istanbul metropolitan municipality buildings and other properties that belong to municipality. In this context, solar energy usage is tried to be extended, efficient bulbs are used, conscious is tried to be supplied. The main aim is keeping the energy demand at minimum level (Interview with Sezgin Yazici, 28.05.2014).

Climate change is supposed to cause the change in demand; decrease in heating energy demand, increase in cooling energy demand. Warmer winters and long hotter summer days will need less heating energy, natural gas, more cooling energy,

electricity. In order to supply that demand, energy efficient buildings should be constructed and climate compatible urban design should be implemented.

There is a regulation on energy efficiency in Turkey, however, Turkey is not yet ready to enforce that regulation. According to efficiency regulation all buildings should have an energy manager and should make efficiency survey regularly. Moreover, that regulation contains rules about carbon emission. It suggest a tax regulation depend on carbon emission (Interview with Sezgin Yazici, 28.05.2014).

Energy demand for transportation is another important part. In order to decrease demand for transportation energy, investigations on rail system are made. IETT buses use natural gas. Natural gas usage for public transportation vehicles is aimed to spread and studies on this are continuing.

4.3.6.2 Adaptive capacity analysis of energy demand

Climate change will lead to warmer winters and longer hotter summers. That change will have effect on energy demand. Demand for heating energy will decrease and demand for cooling energy will increase. Total energy demand is supposed to be increased.

Energy demand is tried to be decreased with energy efficiency measures. Energy AS, a company of Istanbul Metropolitan Municipality, works on energy efficiency as consultant company (Interview with Sezgin Yazici, 28.05.2014). However, its studies on efficiency is restricted with municipal properties.

Energy efficiency measures cannot be enforced in Turkey. Although there is a regulation on energy efficiency, government do not consider that topic as prior.

Transportation energy demand is tried to be decreased by rail system investments (Interview with Sezgin Yazici, 28.05.2014). On the other hand, investments on motorway are still excessive. Motorway investments in Istanbul lead to more automobile usage. That situation creates a dilemma on decisions. While transportation energy demand aimed to be decreased, investments that cause increase in transportation energy demand are made.

4.3.6.3 Vulnerability level of energy demand

Increasing population leads to increase in energy demand. Energy demand increases in summer time for cooling while decreases in winter time due to climate change impacts. There are some precautions about energy efficiency to decrease demand but, they are not effectively in action. Energy efficient buildings are constructed generally for high income group. Decreasing demand is not a prior issue in governmental level. More investments and studies should be done about the topic.

The overall vulnerability level of energy demand to climate change is medium as seen at Table 4.20.

Table 4.20 : Vulnerability level of energy demand.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Medium (2)	Medium (4)

4.3.7 Transportation - public transit

The fourth sector analised is 'Transportation' and the first planning area of this sector is 'Public Transit'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.7.1 Sensitivity analysis of public transit

The public transportation is Istanbul can be divided into three; motor-way, railway and sea transportation. Motorway transportation vehicles are buses, services, minibuses, dolmus and taxi (IMP, 2009). The distribution of motor way public transportation is; 37% bus, 28% minibus, 1% dolmus, 12% taxi, 22% servis. The length of railway in the city is 137.9 km with metro, LRT, tram, funicular, nostalgic tram, local train, cable car. The distribution of railway modes in public transportation is; 35% LRT, 34% tram, 15% local train, 14% metro (IMP, 2009). Sea transit system involves city lines, sea buses and sea motors and carries 160.000 passenger in a day.

Metropolitan Municipality, District Municipalities, Ministry of Transport, General Directorate for Highways are authorized institutions for transportation sector. Municipalities and ministry of transportation is responsible for plans while general directorate of highways in corporate with ministry of transport, is responsible for constructing. "Istanbul Transportation Master Plan" prepared in 2011. For the master

plan, all plans prepared by various institutions were collected and Istanbul Environmental Plan was taken into consideration (Interview with Berna Çalışkan, 20.05.2014).

The Istanbul Transportation Master Plan regards climate change. Therefore, the plan suggests strategies to reduce carbon emission. Within social and environmental evaluation, sustainability, transportation-environment relation were included. Some strategies in sustainability context are; extensification of public transportation, enlarging railway network all over the city, making public transportation more attractive creating transfer centers, integrate different transportation modes, charging automobiles in order to reduce traffic in old city center (ex: Fatih district). Proposed transportation system target is pedestrian and public transportation system. That plan made in 2011 and should be updated. Studies to update plan is continuing (Interview with Berna Çalışkan, 20.05.2014).

Sustainability is an important part of the plan. Therefore, green transportation, cycling are proposed. Although there are bicycle paths in some part of the city (ex: Bostanci), it is not preferred by citizens due to geographic and cultural reasons (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Sustainable transportation strategies suggests radical changes. Regulations are lack of enforcement for those radical changes. Implementation of those plans and strategies are up to manager's decision. Therefore, there may be some delay or trouble may occur about implementation of plans (Interview with Berna Çalışkan, 20.05.2014).

Implementation of railway projects like metro, tram have already begun. Budget for the public transportation project has already sustained (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

The huge population of the Istanbul and its complex development creates difficulties in emergency situations. When an unexpected situation occurs, the system cannot solve the problem quickly, it takes some time to solve and adapt (Interview with Berna Çalışkan, 20.05.2014). Instant responses are generated in emergency situations. Pro-active management system has not adopted yet. It needs time. (Interview with Musa Yazici, 27.05.2014).

4.3.7.2 Adaptive capacity analysis of public transit

Istanbul Transportation Master Plan contains more sustainable and environmentally friendly solutions for the transportation system. In this context public transportation is prior in order to reduce carbon emission. The plan strategies focus on public transportation especially metro lines and railway transportation modes (Interview with Berna Çalışkan, 20.05.2014). The railways under construction are 133. 4km and projects are 119 km (IMP, 2009). It also suggest some strategies to reduce number of cars in city centers. Public transportation is tried to become more popular by integrating transportation modes, creating transfer stations. Pedestrians and public transportation modes have priority in this plan (Interview with Berna Çalışkan, 20.05.2014).

Moreover, within sustainable transportation context, green transportation, pedestrian path, bicycle paths have important place in the plan. However, due to cultural and geographic reasons, those transportation mode is not preferred by citizens (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Buses and metrobus is the main public transportation modes in Istanbul. In order to reduce carbon emission from those vehicles, action plan was prepared by Ministry of Environment and Urban Planning. Within that plan, buses used for public transportation in the city started use natural gas instead of fuel. Another action to be done in this context is spreading rail systems all over the city. There is no intervention about dolmus/ minibuses yet (Interview with Musa Yazici, 27.05.2014).

Environmentally friendly vehicles for public transportation is aimed to use. Therefore, new regulation will not allow the public transportation vehicles older than 10 years old in traffic. This regulation is proposed to get into action after July 2014 (Interview with Musa Yazici, 27.05.2014).

Metrobus have contributed to the public transportation and reducing carbon emission caused by transportation. After metrobus went into action, carbon emission reduced 613 ton carbon (Interview with Musa Yazici, 27.05.2014).

The budget for the implementation of rail system is ready and construction has been started. Since the municipality give importance to the public transportation, budget is not a problem (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

However, some radical decisions in the plan are hard to implement because of managers and regulations (Interview with Berna Çalışkan, 20.05.2014).

The system is not ready for any unexpected situation. When any emergency or unexpected situation occurs, the system cannot react instantly or solve it. The reason for that are; being lack of emergency action plan, the complex structure of the city and the large population of the city. The system needs time to adapt the new situation and generate a solution (Interview with Berna Çalışkan, 20.05.2014).

4.3.7.3 Vulnerability level of public transit

Although investments for public transit increases, demand for transportation and number of cars in traffic increases. Climate change affects and as a consequence extreme weather events cause problems such as; long lines in transportation stations, crowd, and traffic jam. However, improvements on public transportation is concerned by municipality. Different transportation modes are constructing, more sustainable modes are improved. Public transport focused plans are generated. Public transportation in Istanbul is sensitive but can adapt.

The vulnerability level of public transportation in Istanbul is high as seen at Table 4.21.

Table 4.21 : Vulnerability level of public transit.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
High (3)	Medium (2)	High (5)

4.3.8 Transportation - road & bridge maintenance

The second planning area analised of sector of 'Transportation' is 'Road & Bridge Maintenance'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.8.1 Sensitivity analysis of road & bridge maintenance

Roads and bridges are open to any weather event and should be controlled constantly. GIS is a useful tool to create transportation information system. This system is used by municipality to observe and inform about traffic situation (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Bridges and viaducts are important as the most sensitive structures to the climate events. Municipality has 25 meteorological forecasting office used for early warning system to snow, rain, icing, black ice. This system is actively used, also citizens and drivers are warned using traffic signs and message boards. Technology is used for climate based traffic events actively. Early warning systems are developed, related institutions are informed in any adverse condition, and early provision is made. Urban observation cameras are also used to determine any condition. In order to intervene in extreme situation instantly, fleet and equipment are always ready Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Although early determination of coming weather events is possible, climate events create problems in the city because of lacking emergency action plans. There are 3.5 million vehicles in the traffic. In any emergency situation caused by climate, the large population, unwary citizens, insufficient road network make the problem more dangerous (Interview with Kursat Sensoy and Ali Unal, 20.05.2014).

The maintenance and repairment of roads, asphalts continue 12 months of the year. Area determination teams controls asphalt deteriorations, surface cracks, leaking rain and snow water to the ground. When any problem determined, repairment is done by the teams. According to largeness and severity of the problem, the pavement is renewed totally or patches are used for necessary areas. Sensors are able to warn about icing earlier which make it possible to make provision against. Bridges and viaducts are highly sensitive to icing (Interview with Murat Çetin, Ali Can Arı, 27.05.2014).

In any emergency situation, citizens are warned via media and traffic boards. Problems like car accidents in bad weather condition is not because of the inefficient provision to the roads, but uncarefull drivers and their mistakes (Interview with Murat Çetin, Ali Can Arı, 27.05.2014).

Another problem that increases with the heat is collapses caused by heavy vehicles. Determination and provision are done whenever necessary. Also extreme heats make asphalt melt and become slippery. In order to prevent this, the material used for asphalt should be changed with more durable material to the heat. He studies to improve asphalt's quality is conducted by ISFALT AS (Interview with Murat Çetin, Ali Can Arı, 27.05.2014).

The most serious problems occur in winter time because of precipitation. When precipitation increases, insufficient infrastructure creates problems. Bridges, lower areas are critical points. Those critical points are determined by teams and they are first places to intervene in necessary situations. In those places infrastructure is tried to be improved however, it is not possible to renew all the infrastructure system. The action plan for heavy precipitation is ready. Therefore, the necessary equipment is always ready to intervene, it is determined that which team will intervene which area, where is the most critical area, which area is the prior to intervene. Although the precautions are sufficient, the problems because of drivers or inefficient storm water system cannot be prevented (Interview with Ali Çağlar Aydın, 27.05.2014).

4.3.8.2 Adaptive capacity analysis of road & bridge maintenance

Climate has a strong impact on roads and bridges. In any extreme situation roads and bridges and viaducts being open to any weather event are always affected. In order to prevent any negative effect of weather events, early warning system is used to predict icing, heavy snow with municipality's 25 meteorological station. Citizens and drivers are warned using traffic message boards and traffic signs (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Technology is very importing adapting climate change and it is used actively. Early warning systems are developed, smart systems are used to control traffic, warn citizens and prevent problems. The teams and equipment are always ready for any emergency situation. Despite all of those technological improvements, when climate based adverse situation occurs, the system cannot work properly. The reason of this trouble is being lack of emergency action plan. The large population is another reason of the problem (Interview with Halime Tekin and Nesim Karaca, 20.05.2014).

Technical equipment and systems are resistant to both winter and summer conditions. They work properly in any climate condition. Therefore adaptive capacity of the system is high (Interview with Kursat Sensoy and Ali Unal, 20.05.2014).

The system is energy efficient with used smart systems, solar energy warning systems, sustainable systems. Led lighting used for signalization has sustained 80% energy saving. Measures like informing people, reducing speed, sustaining order in

traffic are taken to manage the traffic (Interview with Kursat Sensoy and Ali Unal, 20.05.2014).

The maintenance of the roads, asphalt and bridges continues all year. Wherever repairment is required, teams are directed to the area. Sensors warns about icing and any adverse condition that could happen. Immediately precautions are taken for the risk factor (Interview with Murat Çetin, Ali Can Arı, 27.05.2014).

Istanbul is divided into 9 districts in terms of intervene areas. All districts have their own team and equipment to interfere. The aims of those teams are keep traffic flow and prevent accidents. Among all teams division of labor and cooperation is supported (Interview with Murat Çetin, Ali Can Arı, 27.05.2014).

The most dangerous situations occur in winter time. However, critical points are known by the authorities. Therefore, before predicted events occur, teams are assigned in those risky areas priory to prevent any trouble. Unsufficient infrastructure is the most severe problem. When heavy rains and snow happen, flood on the roads is inevitable because of infrastructure. Although municipality have required equipment for flood event such as pumps and combined tank units, it may not prevent the problem. In order to struggle this situation, infrastructure lines are wiped out regularly and renewed if necessary. However, it is impossible to keep infrastructure lines always clean or renew all the lines in Istanbul, totally preventing of the problem is not possible (Interview with Ali Çağlar Aydın, 27.05.2014).

4.3.8.3 Vulnerability level of road & bridge maintenance

Roads and bridges are highly sensitive to climate conditions. Extreme weather events cause disruptions, cracks on the roads. Also extreme heat affects asphalt. Technological improvements are used to maintain roads and bridges. They are regularly controlled and repaired. Therefore adaptive capacity is high.

The vulnerability level of the planning area is medium as seen at Table 4.22.

Table 4.22 : Vulnerability level of road and bridge maintenance.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
High (3)	High (1)	Medium (4)

4.3.9 Transportation - sea transit

The third analised planning area of the sector 'Transportation' is 'Sea Transit'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.9.1 Sensitivity analysis of sea transit

Sea transit is directly correlated with climate events. In heavy weather conditions like heavy wind, raining, snowing, and Fog Sea transit round stop.

Transition between two sides; Anatolia and Europe is the major issue for Istanbul. There are various transportation modes for transition between two sides of the city such as; sea transit, metrobus, buses, 2 highway bridges, recently completed marmaray project. Mostly ferries are used by people who live close to the pier and sea side. People who live far away from sea side usually prefer other transit modes. Especially after metrobus and marmaray started to operate, demand for ferries have decreased. People usually choose the transportation modes that offer less transfer. The main am is always reaching fastest and most easy way. Therefore, sea transit, ferries, is not popular among the city (Interview with Münir Küçük, 27.05.2014).

The parallel trips to the cost line is not preferred because of long travel time and being costly. Therefore only 2 trip is scheduled in the morning and in the evening for parallel transportation.

Ferries' carbon emission is less than automobiles. Sea pollution is regularly controlled by institutions like; coast guard, environmental protection agency and directorate of sea services. Sea transit agencies are regularly controlled for environmental standards to give permit of operation (Interview with Münir Küçük, 27.05.2014).

Sea transport is important in terms of reducing traffic on Bosporus bridges. Car ferries can be used as an alternative to highway transit. However there is not enough piers to sustain that services, especially in the north of Fatih Sultan Mehmet Bridge (Interview with Münir Küçük, 27.05.2014).

4.3.9.2 Adaptive capacity analysis of sea transit

Istanbul is a big city in two part; Anatolia and Europe. The connection of those two part is vital for people's daily life. Transition from one side of the city to the other side is supplied by buses, ferries, metrobus and marmaray. Also there are 2 bridges over Bosporus for highway connection. Sea transit is the one that most affected by climate conditions and hard to adapt.

Sea transit is a costly mode of transportation. People do not prefer ferries because of time limit. In order to increase the speed, some technical improvements should be made which is costly. The faster the ferries, more expensive operation. Smaller ferries would be more efficient for the transportation and speed (Interview with Münir Küçük, 27.05.2014).

Climate change would result in increasing sea levels. When sea levels increase, the distance between two sides increases which means more operation cost for sea transit. In windy days ferries cannot operate because of not able to be controlled. The Bosporus is always open to shipment. İn adverse climate conditions, vertical trips are stopped in order to prevent any accident. All canceled trips are detrimental for operator's profit. Moreover, some climate conditions may cause damage on ferries, create extra cost (Interview with Münir Küçük, 27.05.2014).

4.3.9.3 Vulnerability level of sea transit

Sea transit is highly sensitive to climate change effects. In any adverse weather like fog or storm cause cancellation of trips. There are limited actions to adapt this planning area to the climate change. Therefore its adaptive capacity is low.

The overall score for the sea transit of Istanbul is high as seen at Table 4.23.

Table 4.23 : Vulnerability level of sea transit.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
High (3)	Low (3)	High (6)

4.3.10 Agriculture - crop diversity

The fifth analised sector is 'Agriculture' and the first planning area in this sector is 'Crop Diversity'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.10.1 Sensitivity analysis of crop diversity

Agriculture falls behind when the employment by sectors viewed in Istanbul. It is 0.6% while industry is 36.7% and services is 62.7% (TURKSTAT, 2009). Agricultural product that is raised in Istanbul is not sufficient for the population in city. Therefore, it is supplied from other cities in Turkey. It can be said that Istanbul is a large market in terms of agricultural product (IER, 2011). The main crops are wheat, sun, flower, barley. Also, nut and apple production are important (IER, 2011).

In the city, wheat, barley, oat, paddy, corn, broad bean, chickpea, bean, tare, sugar beet, sun flower, potato, clover are produced and the most important agricultural crops are wheat, sun flower and barley (IER, 2011).

Briefly, he crop land distribution in Istanbul is; 24885 ha fruit, 36616 ha vegetable, 21 ha decoration plant, 749 ha field crops, 267 ha greenhouse crop (IER, 2011).

The crop production decreased 25% from 1997 to 2002. In 2002, 370000 ton agricultural product raised, 69.5% of them are field crops, 28% are vegetables and 2.5% are fruits (IMP, 2009).

Greenhouse is used for vegetable raising generally. The crops are; cucumber, lettuce, onion (IMP, 2009).

There is no information about organic agriculture (IER, 2011).

The risk for crop diversity always exists. Some types of crops are able to adapt climate conditions however, not the all. Decrease in fertility have been observed in Marmara region (Interview with Levent Saylan, 02.06.2014).

The studies on drought resistant crop type are conducted by Trakya Agricultural Research Institute. Agricultural pattern can be determined with agricultural basin program. Farmers should be educated and convinced about which crop type should be cultivated in which period (Interview with Nadir Şimşek, 03.06.2014).

4.3.10.2 Adaptive capacity analysis of crop diversity

The ministry of agriculture prepared "Struggle Strategy and Action Plan for Agricultural Drought" in 2014. That plan analyses the climate conditions and drought risk for the agriculture and defines the strategies in every stage of the drought. The crop diversity in different climate periods are defined in the plan. The plan suggests

that; when the precipitation falls 40% under the average for a long time, drought resistant crops such as cereal and pulse kinds will be cultivated, usage of organic fertilizer will be extended and chemical fertilizer will be restricted.

Table 4.24 shows the crop diversity in normal conditions in irrigated farming.

Table 4.24 : Crop diversity in percentages for İstanbul.

The Crop Type	**The Area (%)**
Barley	0.10
Sunflower	0.59
Wheat	0.12
Paddy	2.99
Corn	19.94
Potato	0.08
Sorghum	0.05
Sugar beet	0.06
Tare	8.87
Dry bean	0.15
Beet	0.10
Clover	0.95
Vegetable	39.91
Fruit	27.00
Decoration Plant	0.60

Table 4.25 shows the crop diversity in drought periods in irrigated farming.

Table 4.25 : Crop diversity in percentages for İstanbul in drought period.

The Crop Type	**The Area (%)**
Barley	8
Sunflower	15
Wheat	35
Cole	5
Oat	3
Vegetable	20
Fruit	14

Agricultural Monitoring and Information System (TARBIL) is a useful study for adaptation. It informs farmers and orient them considering ministry procedures and climate conditions. Crop yield maps are created for Turkey. Remote sensing systems are established.

4.3.10.3 Vulnerability level of crop diversity

The crop diversity always depend on climate conditions. Some types can adapt while some cannot. Drought resistant crops are chosen to be cultivated. The sensitivity level is medium. The ministry and institutions study on monitoring, predicting drought and determine crop pattern. Remote sensing techniques and modellings are used. The adaptive capacity is medium.

The overall vulnerability level of the planning area is medium as seen at Table 4.26.

Table 4.26 : Vulnerability level of crop diversity.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
Medium (2)	Medium (2)	Medium (4)

4.3.11 Agriculture - agricultural land maintenance

The second planning area of the sector 'Agriculture' is 'Agricultural Land Maintenance'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.11.1 Sensitivity analysis of agricultural land maintenance

Comparing with Turkey, agricultural employment, agricultural production is low in Istanbul (Table 4.27).

Table 4.27 : Value of agricultural production.

Indicators	**Turkey (DPT-2000)**	**Marmara Reg. (DPT-2000)**	**Istanbul (DPT-2000)**	**Rank Within 81 prov.**
(%) Value of Agricultural Production	100	16.13	0.75	51
Value of Agricultural Production per rural pop. (million TL)	1124	1187	216	81

The land distribution in Istanbul is; 50% forest and heath, 25% agricultural land, 23% industry and urban settlement, 1% meadow and range.

Turkey and Istanbul are in a rapid urban development process. The number of mass housing, vacation villages, second housing have increased over years. Those developments create pressure on agricultural land (IER, 2011).

Demand for green areas increase and the natural cover for those areas which grow in Istanbul's climate is needed. Therefore some land assigned to produce sapling (IER, 2011).

The pollution is the greatest threat to agricultural land. Air pollutant have negative impacts on agricultural land. Pollutants such as sculpture dioxide, acid aerosols, carbon monoxide, particulate matter, etc. merge into soil with precipitation. That pollution accumulates in soil and cause decrease in soil quality. Acid rains cause soil acidification and deterioration on plant cover. The acid pollution is not at dangerous level in Turkey because of characteristic of soil (IER, 2011).

Fertilizers, pesticide, soil improver and hormone that are used to increase the agricultural production and quality cause soil pollution. Also, discharge of solid and liquid waste, sludge, using dirty water for irrigation cause soil pollution. As a result the quality of the soil decreases (IER, 2011).

Another problem is drought. Drought decreases the fertility and the value of agricultural land. In Agriculture Ministry, meetings are organized in every 3 months. Drip irrigation facilities, using ponds for irrigation are in discussion (Interview with Nadir Şimşek, 03.06.2014).

4.3.11.2 Adaptive capacity analysis of agricultural land maintenance

It can be said that there is nothing to do for polluted land but abandon in practice. This is a start for ending. The investigation and studies about soil pollution in Istanbul is not sufficient (IER, 2011).

The soil is poor in Istanbul in terms of fertility. The organic matter component in soil is very low. In order to observe the change in soil fertility 77 observation points are selected in large soil groups in Istanbul (IER, 2011).

In order to increase soil fertility, proper crop rotation should be obtained. The soil should be cultivated vertical direction to the slope instead of parallel. Using technology in agriculture is important.

In order to prevent soil pollution, urban and industry development in fertile agricultural land should be prevented and green areas should be increased. Waste materials should be collected and disposed considering the damage on soil and natural resources. The wrong practice on using fertilizer and pesticide should be prevented and controlled (IER, 2011).

Drought is another climate based threat to the agricultural lands. The studies to follow agricultural drought started in cooperation with Istanbul Technical University, however, the financial problems made the project canceled (IDPFAL, 2014).

Education is another method to increase adaptive capacity. By the ministry, education program is maintained. The main purpose is to extend the use of less inlaid agricultural techniques, prevent burning of stubble, encourage and teach of irrigation methods that need less water, inform people about unconscious water usage and problem of drought.

The struggle plan against pests and illnesses is prepared by ministry.

The main strategies in agricultural drought action plan are; estimation of risk and crisis management, sustainable water supply, management of agricultural water demand, supportive R&D studies and education service, improvement in institutional capacity (IDPFAL, 2014).

The integrity of agricultural land is important and governmental studies are continuing in regulation level. The area of the agricultural land will not be divided into smaller pieces than determined by government (Interview with Nadir Şimşek, 03.06.2014).

4.3.11.3 Vulnerability level of agricultural land maintenance

Agricultural lands are under pressure of urban development and industrial settlements on them. They are sensitive in terms of pollution, climate conditions and urbanization. The studies in governmental level are continuing such as educating farmers, developing irrigation systems, protecting the integrity of agricultural lands.

The overall vulnerability level of the planning area is high as seen at Table 4.28.

Table 4.28 : Vulnerability level of agricultural land maintenance.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Medium (2)	High (5)

4.3.12 Public safety - disaster response

The sixth analised sector is 'Public Safety' and the first planning area of this sector is 'Disaster Response'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.12.1 Sensitivity analysis of disaster response

After 1999 earthquake that affected Istanbul seriously, the importance of disaster response was understood by authorities. After that studies on disaster response gained speed but most of them are based on earthquake.

Disaster management is grouped under main topics by AFAD. In emergency plans, all sectorial roles and interventions are determined on communication, transportation, rescue, removal of wrack, first aid and health, pre - damage assessment and temporary settlements, safety, agriculture, infrastructure (IER, 2011).

The scenarios about disasters are studied on drought, tsunami and earthquake. The system needs wider perspective and consider other kind of disasters. Climate based disasters may cause severe lost and damage in the city. The city should be prepared for those disasters. The perspective is insufficient considering climate change impacts.

4.3.12.2 Adaptive capacity analysis of disaster response

Climate change is expected to cause drought, severe storms, heavy rains which create danger for the city and citizens. Since Istanbul is on earthquake zone, most of disaster response studies focused on earthquake.

There are studies on future danger and disasters for Istanbul but they are limited. Climate conditions is not considered as it is needed. Almost all projections are based on today’s climate conditions and climate change impact and future conditions that climate change would create are underestimated. Since it is a controversial and including uncertainty issue, considering climate change impacts comprehensively is difficult.

4.3.12.3 Vulnerability level of disaster response

Climate disasters like flooding, storm, and drought are not rare in Istanbul. Climate change will create more severe disasters. Istanbul's urban development pattern is sensitive to climate change. Also, the emergency action plan is not ready for all kind of climate based disaster. There are prediction systems for early warning. Those kind of system increases the city's adaptive capacity.

The overall score of the planning area is high as seen at Table 4.29.

Table 4.29 : Vulnerability level of disaster response.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Medium (2)	High (5)

4.3.13 Public safety - urban risk areas

The second analised planning area under the sector of 'Public Safety' is 'Urban Risk Areas'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.13.1 Sensitivity analysis of urban risk areas

The major climate related risk factors in Istanbul are; flood, fire, air pollution, drought. Disaster Coordination Center (AKOM) in Istanbul is the department that in charge in any disaster event. The department make preparations, observations, and examinations, determines risks and coordinates all divisions in any disaster case. AKOM and academics from ITU (Orhan Şen and Zeka Şen) has researched climate change, its impacts on water resources, and flooding.

Istanbul suffer from flooding in heavy rains. ISKI researches on rivers and make reclamation plans considering 1000 years rainfall discharge. Ayamama - Kurbagalidere is an example that have reclamation plan against flooding (Interview with Ahmet Köse, 21.05.2014). Flood plain regarding annual rainfall, 50,100,500 years rainfall are calculated by ISKI. All rivers' flood plain in Istanbul have not determined yet, studies are continuing. According to those studies, buffers around rivers and housing restrictions, plinth level are determined and related planning divisions are informed about the results. While determining flood plain, 30-40 years

rainfall trends are used. Climate change and its impacts of rainfall is not considered while calculating flood plain (Interview with Tunay Çarpar, 21.05.2014).

Urban renewal is an effective way to reduce risk in Istanbul. Because there are considerable amount of housing in flood plains that are informal and unqualified. Those houses creates great risk for the citizens. Urban renewal should consider those settlements in order to reduce risk factor. Car parking areas are also important in planning. Car parked on streets may be dragged during flood, creates barriers and multiply the effect of flood (Interview with Ahmet Köse, 21.05.2014).

Fire is another urban risk related to climate. AKOM has created fire risk maps for the city. All kind of fires are considered and the action plan is efficiently used (Interview with Ahmet Köse, 21.05.2014).

Air pollution is measured to determine the risk areas. In Turkey, studies aimed reducing air pollution, carbon emission are important subject however there is no regulation in force yet (Interview with Ahmet Köse, 21.05.2014).

The other important risk factor is drought. Drought is a natural phenomenon and preparations for drought periods are completed. Istanbul is ready for 2 years successive arid period (Interview with Ahmet Köse, 21.05.2014).

Urban planning is very important in terms of urban risk. Wrong decisions in urban planning may cause disasters that may result in death. Disaster may start with one type and then turn into other. Therefore the city should be ready for every situation and risk. Since 2013, AKOM is work on a project about Multiple Risk Analysis (Interview with Hamdi Cinal, 21.05.2014).

4.3.13.2 Adaptive capacity analysis of urban risk areas

Istanbul's complexity is a problem in terms of urban risk areas. Istanbul under risk of flood, air pollution, drought and fire. Although there are several studies to reduce risk, most of them are inefficient considering climate change.

Flood risk is tried to be reduced by reclamation plans on rivers and urban renewal (Interview with Ahmet Köse, 21.05.2014). Informal settlements are generally located in flood plains. Serious amount of expropriation should be made for those areas which is costly. Urban renewal cannot be used efficiently to reduce risk in practice. While determining flood plains, current and past situation based models are used.

Since climate change would change current precipitation trends, it should be considered for flood models (Interview with Tunay Çarpar, 21.05.2014). Climate change is underestimated in studies that decrease the adaptive capacity. For after flood operations, teams and equipment are always ready to intervene (Interview with Mustafa Özsert, 28.05.2014).

Flood warning systems are tried to be developed to increase the adaptive capacity to flood. Also some regulations (i.e. width of roads) for urban planning considering heavy precipitation are studied, but cannot be implemented yet (Interview with Ahmet Köse, 21.05.2014).

Drought is also a serious risk for the city but investments on water supply system increases adaptive capacity. Istanbul can resist 2 years arid period with the help of new dam projects (Interview with Ahmet Köse, 21.05.2014).

Studies on detecting air pollution and reducing pollutants are still not in action. Some regulations on reducing carbon emission and pollutant are discussed to reach word standards, however implementation is not ready (Interview with Ahmet Köse, 21.05.2014).

Urban planning is very important to reduce risk and be prepared to any disaster. Unfortunately, the development pattern in Istanbul have serious disadvantages. Disasters may create different kind of disasters after they happen and severe losses even deaths may occur (Interview with Hamdi Cinal, 21.05.2014).

4.3.13.3 Vulnerability level of urban risk areas

Istanbul urban development pattern is highly sensitive to climate change effects. Illegal and unplanned settlements are generally in flood plains, risk areas and unqualified. Urban renewal is essential to reduce risk in those areas. However, it's not possible to renew all those settlements.

The overall score for the urban risk areas vulnerability level is high as seen at Table 4.30.

Table 4.30 : Vulnerability level of urban risk areas.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Low (3)	High (6)

4.3.14 Public safety - fire safety

The third analised planning area under the sector of 'Public Safety' is Fire Safety'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.14.1 Sensitivity analysis of fire safety

Forest, residential, industry fires are risk for the urban areas. Forest fires are correlated with heat, drought and increase in summer period. Whereas, residential, structural fires occur because of heating need in winter period, usually originated from natural gas or coal usage. Since coal usage decreases with natural gas usage expansion, fires in winter have reduced.

Forest fires create danger for both urban areas and environment and species. Fodders on the sıde of hıghways, roads, empty spaces may burn because of any reason and expand quickly. People activities like throwing out cigarette butt, not extinguish camp fire usually main reason for big fires (Interview with Mustafa Özsert, 28.05.2014).

Fire department in cooperation with AKOM and Regional Directorate of Forest deals with all kind of fires in the city. In order to interfere to fires, necessary equipment and teams are always ready and they work in an order. The main purpose is the most effective and fastest intervene to the situation. Therefore emergency action plans for all situations and all type of fires are prepared, implemented when necessary. Latest technology is used to increase performance of equipment and efficiency of the intervene. The fire department can reach every part of the city in 6 minutes when an emergency fire situation happens in settled area. The purpose of the department is decreasing reaching time to 5 minutes. In order to supply that purpose, they need more station in the settled area. Supplying appropriate place for fire stations may be a problem because of complexity of the Istanbul. Also that need is usually underestimated in the development plans (Interview with Mustafa Özsert, 28.05.2014).

For the villages that settled in Istanbul but away from central settlements, volunteer fire stations are established. In other words forest villages are control of those volunteer stations when emergency happens to make first interfere. The fire

department aims to deploy this system for all forest villages around the city (Interview with Mustafa Özsert, 28.05.2014).

4.3.14.2 Adaptive capacity analysis of fire safety

Climate change is expected to cause increase in heat waves, drought. Forest fires may increase as a consequence of climate change impacts. Fire department of Istanbul works with AKOM and Regional Directorate of Forest to extinguish the fire. The department have adequate quality in terms of interfere techniques. It uses latest technology in their equipment for more efficient interfere. It can be said that the department is ready for more severe and frequent fire events (Interview with Mustafa Özsert, 28.05.2014).

Moreover, the department considers mitigation to climate change. Therefore, they use low carbon emission vehicles, smart buildings for their stations, solar panels for heating water (Interview with Mustafa Özsert, 28.05.2014).

In Istanbul, the location and the quantity of stations should be increased. Although fire department can reach to the every point in the city in 6 minutes, the reaching time should be decreased for more effective action. Also, the volunteer fire departments in the surrounding forest villages should be located in each of them. The department considers that need and works on the issue (Interview with Mustafa Özsert, 28.05.2014).

4.3.14.3 Vulnerability level of fire safety

Residential fires have decreased after extended usage of natural gas. Forest fires increase in summer time. The organization of fire department works efficiently about any fire. It is highly qualified and uses technological improvements for more efficient intervention. That increases adaptive capacity level.

The score of vulnerability level is low for the planning area of fire safety as seen at Table 4.31.

Table 4.31 : Vulnerability level of fire safety.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
Medium (2)	High (1)	Low (3)

4.3.15 Land use & development - affordable housing

The seventh sector is 'Land Use & Development' and the first planning area of this sector is 'Affordable Housing'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.15.1 Sensitivity analysis of affordable housing

The most efficient actor in housing is TOKI. The major vision of TOKI is providing house demand in a fastest way for all income groups.

First of all TOKI determines the housing demand in an area, if it is necessary, they produce houses for low income group. Those houses are formed regarding their prices and their target group. For low income group and poor people, affordable hoses are saled with credits and affordable payment plans (Interview with Mehmet Öç, 08.05.2014).

TOKI creates its own budget with land selling, revenue sharing, luxury housing construction and selling with profit. That budget is used to produce affordable housing, renewal of slum settlements (Interview with Mehmet Öç, 08.05.2014).

The purpose of the TOKI is just producing houses in mass amount. Therefore, climate change is not considered in plans. Green and smart buildings are not constructed since their cost is high. Another reason for not constructing smart, green energy efficient buildings is that, there is no obligation and regulation on that subject (Interview with Hakan Ilcın, 08.05.2014).

Energy efficient practice in affordable housing is restricted with central heating system and isolation. Solar panels, systems collecting storm water and reuse it are suggested in some project but they cannot implemented (Interview with Hakan Ilcın, 08.05.2014).

The other institution on producing affordable housing is IMM department of dwelling and estate. They make plans for the land that in municipality's ownership. Those plans includes low cost affordable housing, social facilities, and green areas. However, recently those municipality's lands are used for high class residential (Interview with Rasim Bulut, 12.05.2014).

The principles of that department is exchanging lands in slum area with houses. They take the land that established on risk areas or that informal unqualified houses, give affordable houses from that department produce. For the value difference, municipality gives credits to home owners with 20 years respite (Interview with Rasim Bulut, 12.05.2014).

Eyüp, Alibeyköy renewal project can be an example to the departments working principles. In those regions there are slums that are unqualified a located in flood area. Around 1000 slums will transferred to the affordable houses constructing in that area. There will be 3000 new houses produced by municipality, some of them to sell to create budget. The risk areas are considered in the project to clean out settlements and expropriation (Interview with Rasim Bulut, 12.05.2014).

The house is not sold with profit purpose. The main purpose is to produce new and affordable hoses for the slum residents in a cheapest way. Therefore those affordable houses are not environmentally friendly, green, smart buildings, they are standard buildings. Climate change impacts and building resilience to climate change is not taken into consideration. The only measures for energy efficiency are; isolating, central heating system and in some buildings solar panels (Interview with Rasim Bulut, 12.05.2014).

4.3.15.2 Adaptive capacity analysis of affordable housing

TOKI and Housing Department of Municipality are mail suppliers of affordable housing. While TOKI supply cheap houses for low income group, Housing Department aims to transfer citizens living in slum area to more affordable and qualified houses.

Istanbul's population is growing rapidly. Housing is main necessity for the citizens. TOKI aims to supply housing demand for income groups as fast as possible. It offer easy payment conditions and affordable prices for low income group (Interview with Mehmet Öç, 08.05.2014).

Transferring people living in slums to more suitable houses is very important because most of those slum areas illegally developed in risky areas. That transformation would decrease the risk factor for citizens (Interview with Rasim Bulut, 12.05.2014).

However climate change impacts is not considered by any affordable house supplier institutions. Those institutions aim to produce houses cheap and fast (Interview with Hakan Ilcın, 08.05.2014). Therefore buildings are lack of sustainable features like energy efficiency. Also, there is no regulation or obligation for producing more sustainable houses. Sustainable and affordable houses could only be built if any legal obligation would exist (Interview with Hakan Ilcın, 08.05.2014).

In Istanbul slums are major problem and amount of slum settlements is very high. It is not possible to renew all those areas while supplying affordable houses for people living in (Interview with Rasim Bulut, 12.05.2014). Since municipality has limited budget and limited reserved land, the affordable housing production is not enough.

4.3.15.3 Vulnerability level of affordable housing

In Istanbul there are different authorities to produce affordable housing such as municipalities and TOKI. They supply housing demand and transfer people living in risk areas to affordable houses. Housing production is continuously supplied. However, the houses that produced for income group is lack of sustainable and efficient facilities. Mass amount of housing production may contribute to affordable housing demand.

The vulnerability level of affordable housing is medium as seen at Table 4.32.

Table 4.32 : Vulnerability level of affordable housing.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Medium (2)	Medium (4)

4.3.16 Land use & development - urban renewal

The second analised planning area under the sector of 'Land Use & Development' is 'Urban Renewal'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.16.1 Sensitivity analysis of urban renewal

In Turkey, the institutions that have authority on urban renewal decisions are Ministry of Environment and Urban Planning, TOKI, Metropolitan Municipalities, District Municipalities. They can decide the area, make project and implement them.

There are 2 regulation about urban renewal in planning law; Disaster Renewal law no 6306 and 73th clause.

73th clause is regional, comprehensive, participatory, not compulsive plan. The renewal is not building based, it covers the all buildings and open spaces in the area. The important part of this renewal way is consensus of all residents in concerned renewal area. Therefore, the implementation is difficult and not preferred by authorities (Interview with Andaç Erdem Çakır, 05.05.2014).

Disaster Renewal law no 6306 works with different principles. This law aims to determine risky structures and renew them. According to this law, building standards have changed to more resistant to earthquake and any disaster. Therefore, buildings built before 2000, according to old standards, are generally risky and should be renewed. With this law, 25,000 buildings are under transformation among 2 million buildings in Istanbul. 12km^2 area is declared as risk area for renewal (Istanbul's surface area is 5461 km^2). That renewal system deals with buildings separately, settlement pattern remains most of the time (Interview with Andaç Erdem Çakır, 05.05.2014).

The main purpose of the transformation is reducing risk against earthquake and disasters. Therefore unqualified buildings are demolished, new, and durable and proper to the standards buildings are constructed. Since there is no regulation about sustainability on buildings or mitigation to climate change, those concept are underestimated. Also, those systems are costly, which only be preferred to use in luxury buildings. In short, reconstruction of buildings is done by contractors and deciding which facilities would be in building is depend on that contractor (Interview with Andaç Erdem Çakır, 05.05.2014).

Risk areas are determined by the municipality and renewal studies to reduce risk starts. Climate change is not considered while planning the urban renewal, but, it contributes to reduce sensitivity of the city. Because it deals with no quality housing and risk areas in the city (Interview with Andaç Erdem Çakır, 05.05.2014).

4.3.16.2 Adaptive capacity analysis of urban renewal

In Istanbul, 25,000 buildings of 2 million are under transformation in the concept of urban renewal. Those buildings are generally old, unqualified and risky buildings. This transformation process is important for reducing risk, sustaining more qualified

housing and increasing quality of life. However, the transformation do not lead to more sustainable, energy efficient, affordable smart housing. Because of not having any obligation on that subject, investors prefer standard housing because of their cost. After basic standard for new building is sustained, constructers may add more sustainable and efficient facilities in order to increase the buildings value (Interview with Andaç Erdem Çakır, 05.05.2014).

Implementation is done by municipality or by contractors. Renewal projects by municipality are general nonprofit purposed. They rebuilt just for the population living in that area. They do not expect to increase the population of planning area. However, constructors are profit based actors. In those projects density would increase to get profit from the project. The population would increase in the area. That method also helps to sustain increasing demand for housing by increasing population (Interview with Andaç Erdem Çakır, 05.05.2014).

Urban renewal project do not have any budget problem. There are alternative ways to create budget such as; privet sector, public/private, public/public cooperation. This sector is open to alternatives which has high adaptive capacity (Interview with Andaç Erdem Çakır, 05.05.2014).

4.3.16.3 Vulnerability level of urban renewal

Istanbul city is under renewal process for a while. Since calamity regulation carried out, urban renewal gained speed all over the city. Old, risky, unqualified buildings are reconstructing. However, the settlement pattern is underestimated while renewal is implemented. The transformation only based on buildings, not the living environment. There are legal encouragements for the renewal. Also private sector is willing to invest on that sector. Therefore, its adaptive capacity is high.

The overall score of the planning area urban renewal vulnerability level is low as seen at Table 4.33.

Table 4.33 : Vulnerability level of urban renewal.

Sensitivity Level	**Adaptive Capacity Level**	**Vulnerability Level**
Medium (2)	High (1)	Low (3)

4.3.17 Land use & development - urban planning

The third analised planning area under the sector of 'Land Use & Development' is 'Urban Planning'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.17.1 Sensitivity analysis of urban planning

The authorized institutions on planning sector are Metropolitan Municipality, District Municipalities, TOKI, Ministry of Environment and Urban Planning and Ministry of Culture and Tourism. 1/100.000 Istanbul Environmental Plan prepared by Istanbul Metropolitan Municipality is current plan for Istanbul. This plan is made for the 16 million target population (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

The climate conditions that effect planning sector are flooding because of heavy precipitation, extreme heat in summer period, energy consumption. Planning department has not started to consider climate change impacts for plans. Climate change is not prior for the department of planning. However, sustainable, suitable plans and creating more healthy living spaces are the topics that planning department work on. Those decisions would contribute to climate change resilience as moderately (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Istanbul Environmental Plan have decisions on public transportation, development pattern, multi-centralization. First of all, it aims to develop more public transportation, and suggest big projects extending all over Istanbul. Railways systems are the essential mode for the plan. The density of highway is aimed to decrease with metro lines. Some of those projects have completed and some of them are under construction. Compact and mixed used patterns are suggested to protect environment. Multi-centralized system and hierarchy of centers are important to decrease dependency of 2 sides of the city. The balance between 2 sides is expected to sustain with creating new central business districts. Moreover, development patterns like transit oriented development, smart growth are under discussion. Those decisions on regional scale are started to implement in urban scale. Yenisahra, Kartal central business district implementation plans could be example of that (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Istanbul has problems in terms of active green spaces and penetrable surfaces. Active green space is 2.57 p/m^2 in current situation. The most problematic districts are old and unplanned developed areas. In order to increase amount of green space, expropriation, urban renewal, planning empty public spaces as green area are alternative suggestions. Zeytinburnu-Hipodrom axis, Maltepe Regional Park and bulkhead lines can be examples of that kind of decisions on increasing active green spaces (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Flooding risk is considered in plans and development in those areas is not allowed. ISKI determines flood plains and directives of that institutions are used as input in planning. ISKI prepares flooding maps for annual, 50 years, 100 years, 500 years events. Also, the institution prepares reclamation plans for streams. Flooding maps for all streams in Istanbul has not been prepared yet. There are 13 finished, 20 continuing, 30 waiting for updating projects (Interview with Tunay Çarpar, 21.05.2014). After preparation of flooding map, development conditions are prepared for the area to reduce risk. The height, density, and suitable areas are determined by ISKI and related planning institutions are informed (Interview with Burcu Saraç and Burçin Kapucu, 21.05.2014). The main problem here is illegally and unplanned settlements since most of them located in flood plains. That creates great risk for the people living in those settlements especially low income citizens live in those areas and frequently confronts with flood risk. Recently, flood in Alibeyköy caused by Ayamama River can be an example for that risk. Cleaning out those settlements form risk areas and reconstructing qualified settlements is difficult and debated issue (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Old settlements are main problem for the city and planning. Urban renewal is the basic tool to improve the conditions in those areas. However, this is not sufficient for the whole city. In new development areas, increasing living standards and creating healthier living spaces are considered (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Energy efficiency and energy saving projects have not considered in urban scale yet. Private sector invest on green and energy efficient buildings and get energy certificates for their buildings. However, those projects are limited amount and there is no encouragement for that kind of construction (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

4.3.17.2 Adaptive capacity analysis of urban planning

1/100,000 Istanbul Environmental Plan have suggestions on more sustainable development. Investments on public transportation by Istanbul Metropolitan Municipality, decentralization of the city, more compact development are positive decisions of plan. Although the plan do not consider climate change affects and do not take measurements on adapt and mitigate climate change impacts, the decisions contributes to the issue moderately.

In the plan green spaces, flood plains, risk areas, old settlements, public transportation and sustainable development are taken into consideration. New development areas are planned for more qualified living standards which decreases the risk factor. Energy efficiency is not the sector that plan make suggestions but some investments are made by private sector on that subject. However, those investments are not sufficient and limited (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

After implementation plans are ready, budget is sustained by municipalities or with the help of free market. Expropriation is sustained from municipality's budget. Although it is costly, sustaining persistence is possible. The budget is sustained to the projects according to their importance. Public transportation projects are major investments for municipal strategies (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

Istanbul needs Climate Change Master Plan to understand effects of climate change and develop adaptation and mitigation strategies. Climate analysis are essential which is not consider in current plans. The main reason of not considering climate change in the plans is; not being a prior subject for the city. Istanbul confronts more severe risk; earthquake. Therefore major concern of planning department is taking measures to coming earthquake (Interview with Adnan Cihat Özdemir and Selçuk Alkan, 28.04.2014).

4.3.17.3 Vulnerability level of urban planning

The current master plan of Istanbul considers sustainable development strategies. The climate change and its impacts is underestimated but, the suggested development pattern contributes to the issue. There are still problem and risk areas in the city which are difficult to solve.

The overall score for the vulnerability level of urban planning is medium as seen at Table 4.34.

Table 4.34 : Vulnerability level of urban planning.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Medium (2)	Medium (4)

4.3.18 Land use & development - social facilities

The forth analised planning area under the sector of 'Land Use & Development' is 'Social Facilities'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.18.1 Sensitivity analysis of social facilities

Social facilities is an important factor determining quality of life in the city. For a quality urban place, quality services, sufficient spaces, equality in access to the social and urban facilities are main determinants. Settlement areas are indicator of citizen's life quality. Those areas should offer citizens sustainable and renewable urban spaces, safety for families, working places, recreation areas, entertainment, education, health facilities besides sheltering need (IMP, 2009).

Istanbul have been experiencing uncontrolled and rapid urbanization process. The population increased 4.5% annually in 1950's. As a result of that rapid urbanization, problems emerged in producing quality and planned urban settlements. Unquality, low costly, out of plan urban development started. This situation caused the development without comprehensive approach and created urban places that lack of urban facilities (IMP, 2009).

The big cluster housing projects that TOKI or Municipality planned, usually have the social facilities that residents would need. Moreover TOKI can produce social facilities besides housing projects such as; mosque, school, health center, commercial center (Interview with Mehmet Oc, 08.05.2014). Cluster development plans by municipality also supplies social facilities in the area that citizens can use (Interview with Rasim Bulut, 12.05.2014). For the new development areas, the social facilities are considered however, in old and dense settlement areas it constitutes problems.

The most problematic districts in terms of social facilities are those with slam settlements having the highest population and density in Istanbul. Being lack of social facilities decreases the quality of life in those areas and creates greater risk for the adverse impacts of changing climate.

4.3.18.2 Adaptive capacity analysis of social facilities

Istanbul has a rapidly growing population since 1950's. The need for housing of growing population caused uncontrolled, fast and unplanned development. Due to high land value and high cost of constructing urban facilities, high rise, dense and non-identity housing settlements were produced (IMP, 2009).

Although the high density in Istanbul for residential areas, urban facility amount is under it should be. In terms of urban life quality, Istanbul have deficient education, health, urban administrative area, cultural area, social, religious, dormitory, fairground, convention center facilities and unequal distribution of those facilities in districts. Lacking of adequate facilities, creates unhealthy settlement areas (IMP, 2009). Table 4.35 shows the social facilities, their legal standards per person, their area covered in Istanbul and the need of area per person.

Table 4.35 : Social facilities area in İstanbul comparing to standards.

Facility	**Area in Istanbul (per person)**	**Legal Standards (per person)**	**Needed Area (per person)**
Education	0.50 m^2	4.5 m^2	4 m^2
Health	0.11 m^2	4 m^2	3.89 m^2
Cultural	0.13 m^2	2.5 m^2	2.37 m^2
Social	0.09 m^2	1.5 m^2	1.41 m^2
Religious	0.32 m^2	0.5 m^2	0.18 m^2
Green Space	1.65 m^2	10 m^2	8.35 m^2

The area of social facilities is significantly lower than it should be. Esenler, Sultanbeyli, Güngören, Bağcılar, Kağıthane, Gaziosmanpaşa, Ümraniye are the districts that have the lowest social facility area. Those districts are also the most dense and populated districts in Istanbul. The main reason of being lack of social facilities is immigration and squatter settlements without governmental control in those settlements. The problem is; it is difficult to place any social facility in those

districts. The land value is high and all the area has already settled. Expropriation can be a solution but, it is costly. The way urban renewal implemented in Istanbul - reconstructing of old buildings- cannot generate a solution for the insufficient social facilities.

4.3.18.3 Vulnerability level of social facilities

The urban facilities in the city is not enough for the population. The new development areas are planned with their need for urban facilities. However, in old settlement areas green areas and other facilities are less than needed. It is difficult to sustain urban facilities for old and dense urban districts.

The score of vulnerability is high as seen at Table 4.36.

Table 4.36 : Vulnerability level of social facilities.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Low (3)	High (5)

4.3.19 Materials - waste collection & recycling

The eighth sector analised is 'Materials' and the planning area of this sector is 'Waste Collection & Recycling'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.19.1 Sensitivity analysis of waste collection & recycling

Waste materials are collected from neighborhoods by district municipalities and brought to the transfer stations. Istanbul metropolitan municipality is responsible for carrying waste materials from transfer stations to solid waste landfills. There are 3 transfer station in Asia side of Istanbul and 4 in Europe side. Also there are 2 landfills, 1 for each side. Waste collection and transfer made by municipalities everyday regularly. Daily average waste materials amount is 15,000 tone in Istanbul (Interview with Yasemin Sibel Gültekin, 26.05.2014).

Before solid waste landfill system was established, waste materials are removed with uncontrolled dumping. Those areas abounded and tried to rehabilitate and reuse. For the rehabilitate, danger is reduced, gas and liquid are collected with simple systems, and land is cleaned and reused for different purposes (Interview with Yasemin Sibel

Gültekin, 26.05.2014). There are some examples about transformation of old uncontrolled dumping area. Umraniye now designed as open sports spaces. Ekimbasi and Hasdal are rehabilitated, covered and detrimental gas is collected to be used energy production (Interview with Volkan Erç, 26.05.2014).

The municipalities are only responsible for collection of residential waste materials. Medical wastes are collected separately and burned. There are separated land for industrial waste disposal.

The major problem on this sector is stink that occur especially in summer time. Seepage water is collected with pipes and sent to sediment tanks to prevent leakage into underground water resources (Interview with Yasemin Sibel Gültekin, 26.05.2014).

Landfill areas are selected according to suitable standards. Usually they are located in forest area by the permission of Ministry of Forest. Criteria for a suitable landfill is environmental and affectability to any natural disaster. For all landfill area the capacity and the expiration date are calculated and future projects are taken into consideration in a sustainable way. Landfills are regularly controlled to prevent any environmental problems like leakage. Appropriate technical measures are taken (Interview with Volkan Erç, 26.05.2014).

In order to recycle waste materials, they should be separated before they are collected. In Istanbul, separating is not efficient; only 20-25% of waste materials can be collected separately. Although studies on separation of recycling materials, it could not be used efficiently (Interview with Volkan Erç, 26.05.2014). Street collectors are active actors on collecting recycling materials in neighborhoods. They work individually, collect materials and sell them to recycling companies (Interview with Yasemin Sibel Gültekin, 26.05.2014). Also there are some companies that collect materials and sell them to recycling companies such as; Yuceler kagit, Halkali Kagit, Ozercam ect. Those actors contributes to recycling of waste materials (Interview with Volkan Erç, 26.05.2014).

Waste materials brought in landfills can be separated by sieve and bands. Also, workers distribute recyclable materials by hand in landfills (Interview with Volkan Erç, 26.05.2014).

Energy production from methane gas is used since 2008 in both landfills. This technics also contributes to reduce air pollution and alternative energy resources (Interview with Volkan Erç, 26.05.2014).

4.3.19.2 Adaptive capacity analysis of waste collection & recycling

Waste collection from neighborhoods are done by municipalities, carried to transfer station and from the station to the solid waste landfills. This system works efficiently. There are 2 solid waste landfills in both side of Istanbul and 7 transfer stations. Municipalities have necessary equipment and vehicles to collect residential waste. In solid waste landfills, only residential waste are buried, medical waste are burned and industrial waste are buried separately (Interview with Yasemin Sibel Gültekin, 26.05.2014).

Uncontrolled dumping is prevented and landfills are used today. Old uncontrolled dumping areas are rehabilited and used with new functions. The landfills areas are determined considering environmental issues and any disaster. In order to prevent any damage to environment, technical measures are taken. The methane gas is collected by pipes. Seepage water is also collected in the sedimentation tanks. Regular controls are made about underground water to determine leakage. Wind and storm may cause fly of waste materials around and that problem is prevented with nets around landfill area (Interview with Volkan Erç, 26.05.2014).

Waste material collecting, recycling and removing is completed in sustainable way. Storage waste materials is cheaper than burning, therefore it is preferred (Interview with Yasemin Sibel Gültekin, 26.05.2014). If any landfill reaches its capacity, new landfills will be established. The prediction of time to reach their limits and future projects are ready. Incineration plant is under process and expected to be operated in 2020 (Interview with Volkan Erç, 26.05.2014).

2-3 months later buried waste materials generate methane gas. Methane gas is collected by pipes and used for energy production. Produced energy is used in city's energy system actively (Interview with Volkan Erç, 26.05.2014). Also, compost is produced from organic materials and they used as fertilizer (Interview with Yasemin Sibel Gültekin, 26.05.2014).

Recycling is not efficient in Istanbul. Citizens are unconscious about the issue and they should be educated. Separated collecting works 20-25% efficiency which is

very low. Some private companies and separate collectors collect recyclable materials and sell them to recycling companies. Also, in some facilities workers separate recyclable materials by hand or using sieve and bands. Although those kind of activities contribute to collecting recyclable materials and recycle, the recycling does not work efficiently in Istanbul (Interview with Volkan Erç, 26.05.2014).

4.3.19.3 Vulnerability level of waste collection & recycling

Waste materials are collected and buried in storage yards. Disruptions may occur while collecting waste materials. Precautions to prevent environment and underground water resources are taken. There are improvements about collecting and storaging the waste materials with technology. For the new storage areas environmental issues are taken into consideration.

The vulnerability level of the waste materials and recycling is low as seen at Table 4.37.

Table 4.37 : Vulnerability level of waste collection and recycling.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Low (1)	Medium (2)	Low (3)

4.3.20 Infrastructure - storm water management

The nineth sector analised is 'Infrastructure' and the first planning area of this sector is 'Storm Water Management'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.20.1 Sensitivity analysis of storm water management

In Istanbul, 95% of waste water and storm water collecting systems are separated. In rural areas and very old settlements combined system is still used. The storm water collected with separated system is directly discharged to the sea or streams. There is no system on reuse of storm water or there is no study on the issue by municipality (Interview with Tunay Çarpar, 21.05.2014).

Although ISKI prepared plans for separated systems in practice, storm water diffuse in waste water collecting systems. In practice the infrastructure system is combined or partially combined. As a result, in heavy precipitation, the infrastructure system

overflows and threated public health. Also storm water collected in sewage system affects the treatment projects and increase the cost (IER, 2011).

Insufficient control of residential waste water and storm water collection, maintenance of the street collector creates problems and enable the illegal connections to the system (IER, 2011).

Especially in heavy rainy days surface flow cannot fall in the grids on roads which indicates insufficiency of storm water system. Surface flows cause flooding especially in lower sites as a result. Grids on roads are not placed in order, most of them are not at the lower point of the road or not at the same level with road which create surface flow problem. Also roads ware nor constructed considering right slope, reconstructed without surface flow consideration (IER, 2011).

Istanbul have a strategy on separating storm water and sewage system in long term. In some part of the city this project has been completed. Storm water system was constructed in subordinate level, discharging in to the streams (IER, 2011).

4.3.20.2 Adaptive capacity analysis of storm water management

The storm water penetrates into sewage system illegal or unplanned methods. The infrastructure system is separated in plans however in practice it is combined or partially combined. As a result the pipelines usually overflow in heavy rains and threaten the public health. In master plan storm water management is considered and suggestions are made about existing and future urban settlements (IER, 2011).

The project studied in 1971 by DAMOC and Scandia consult suggests separated systems in every stage of infrastructure system. In the study conducted by Camp-Tekser in 1976, this principle was adopted for all new infrastructure system. However, it was understood that, re - laying down subordinate sewage and storm water lines separately in existing system was not easy in terms of budget and feasibility (IER, 2011).

The grids on roads to collect surface flow are not suitable in terms of their distance to each other, their location or their direction. While roads are renewed, the place of grids may be changed or left higher or lower than road level. The slope of road may be changed. Those interventions prevents efficient collection of surface flows, cause accumulation of water on the road (IER, 2011).

The pipelines are not sufficient in every part of the city. Also, future projections about future population and climate conditions is not considered in projects. The sizes of pipelines may need to be enlarged. In order to prevent overflows, infrastructure system should be separated in all city. Regular cleaning and maintenance should be controlled. The places for the street collector grids should be well organized. The illegal connections to the sewage system should be prevented. All of those precautions are high costly.

4.3.20.3 Vulnerability level of storm water management

Istanbul has separated infrastructure system; waste water and storm water pipelines. Heavy rains cause over flows when heavy rains occur. That is because of inadequate size of water lines. Therefore, the sensitivity to more extreme weather events is high. Istanbul has an advantageous having separated infrastructure system but, the pipelines should be changed with larger and should be cleaned regularly.

The vulnerability level of planning area is high as seen at Table 4.38.

Table 4.38 : Vulnerability level of storm water management.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Medium (2)	High (5)

4.3.21 Infrastructure - sewage system

The second planning area that is analised under the sector of 'Infrastructure' is 'Sewage System'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.21.1 Sensitivity analysis of sewage system

The most of the settlements in the center of Istanbul are connected to the infrastructure system, however, in periphery of Istanbul the amount of houses connected to infrastructure system decreases. Sultanbeyli (80%), Silivri (59%), Gaziosmanpaşa (25%) are the most problematic districts that have houses without connation to the infrastructure system (IER, 2011).

Waste Water is collected by ISKI and treated in treatment plants. Climate does not any effect on the system. The amount of population affects the system. Sewage system is organized by dividing into basins in Istanbul. Each system is collected in

its own basin and directed to the treatment plant. The size of the pipelines are determined according to the population. The max. standards per person is used. If population and density increase in the area, the central institution (ISKI) is informed and pipelines are changed considering new population size (Interview with Tunay Çarpar, 21.05.2014).

4.3.21.2 Adaptive capacity analysis of sewage system

The problem about sewage system in Istanbul is combined systems in some part of the city (waste water and storm water systems) and the density. Combined systems legally or illegally cause overflows in heavy rain. In the dense districts the capacity of pipes may not be sufficient for the population.

Adaptation needs separation of waste water and storm water pipelines and increase in size of the pipes. The growing population and density makes the alteration inevitable. Those implementations might be costly for the government.

4.3.21.3 Vulnerability level of sewage system

The sewage system is controlled by ISKI. The water is collected, treated and discharged. In some districts it is directly discharged. The climate change is not expected to affect the sewage system. Growing population need more capacity for infrastructure. Which means change of pipelines. Also investments on new waste water treatment plant have already started.

The overall level of vulnerability is low as seen at Table 4.39.

Table 4.39 : Vulnerability level of sewage system.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Low (1)	Medium (2)	Low (3)

4.3.22 Ecology & biodiversity - urban forest management

The tenth sector analised is 'Ecology & Biodiversity' and the first planning area of this sector is 'Urban Forest Management'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.22.1 Sensitivity analysis of urban forest management

The forest areas cover 44.38% of Istanbul city border. Those forest areas are largest ecosystem sites in Istanbul. Forest areas in Istanbul are defined as "Absolute Protection Areas" in 1/100.000 Istanbul Environmental Plan. In Istanbul 6% of forest areas are degraded forest lands, 6% of forest areas are the land that have forest status but do not have tree on it (potential forest land) and 88% are normal forest land (IER, 2011).

Forest land in Istanbul has 3 main function; economic, ecologic, social. Economic function is wood reserve and any plant, animal, mineral and water resources. Ecological function is preservation environment, preventing erosion and preserving hydraulic reserves. Social function is recreate usage (IER, 2011).

Environmental conservation sites are intra vires of Provincial Directorate of Forestry. After the change in related regulations and law, conservation area description and conservation status redefined. According to that regulation all environmental conservation areas should be examined, researched and new status should be determined. Those determined status will be used in deciding land use decisions on and around of those areas. That study has not been completed for Istanbul yet (Interview with Hüseyin Şen, 29.05.2014).

The current status and borders of the conservation areas are controversial. Areas are not examined properly, endemic species are not determined. The criteria for the status is not clear. Flora and fauna in the areas, species under risk of extinction are not determined. Therefore, all environmental conservation areas should be redefined (Interview with Hüseyin Şen, 29.05.2014).

Legally the forest are is not shrink, borders remain but, in practice, Istanbul lost its forest area because of urbanization (Interview with Mesut Tandoğan and Ercan Özyürek, 28.05.2014).

4.3.22.2 Adaptive capacity analysis of urban forest management

In central government, studies on climate change and its impacts, national adaptation strategies are in process. Ministry of Forest is the most important contributor of the studies. However, the amount of forest area is decreasing because of urbanization (Interview with Mesut Tandoğan and Ercan Özyürek, 28.05.2014).

Afforestation is done by public institutions or private organizations in order to increase forest areas, decrease air pollution, prevent erosion, increase tourism, create recreation areas, and prevent unplanned development. From 1986 to 2008, 2594 ha was afforested (IER, 2011).

There are protection levels and conservation status for the natural conservation areas. The current borders and protection levels are questionable because of not having and standard or level definition. While determining conservation status, essential analysis were underestimated such as determination of fauna and flora, extinction species. Therefore new regulation suggests new criteria for determining protection level. According to that law, all conservation areas should be given new status considering new criteria and borders should be defined again. Those borders determines the development strategies in and around of those areas. The current protection perspective is only restricting urban development and control urbanization on forest land. However, there is no strategy to protect environment, species, flora and fauna (Interview with Hüseyin Şen, 29.05.2014).

4.3.22.3 Vulnerability level of urban forest management

Urban forest areas are under risk of urbanization. In the city afforestation studies are continuing. However, it is nor well organized. Climate change effects put forest areas in danger. Trees get weaken and no strategy is developed against. The natural protection areas are questionable and changeable.

The overall score of the vulnerability level is medium as seen at Table 4.40.

Table 4.40 : Vulnerability level of urban forest management.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Medium (2)	Medium (4)

4.3.23 Ecology & biodiversity - green spaces

The second planning area that is analised under the sector of 'Ecology & Biodiversity' is 'Green Spaces'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.23.1 Sensitivity analysis of green spaces

Istanbul Metropolitan Municipality Department of Green areas is responsible for revision of parks, new parks, implementation of plans for green areas, forestation, organizing highway sides, planting flowers, organizing urban forests for usage of citizens (Interview with Mustafa Torun, 27.05.2014).

Another department responsible of green areas in the city is department of parks and gardens. That department is responsible for maintenance of green areas. They determine sick and damaged trees, detrimental factors. Also, works on maintenance of those areas. They register old trees and take them under protection. In any tree downthrown event, that department organizes the repairment and measures (Interview with İrfan Onat, Nilgün Özdingiş Tarakçı, 27.05.2014).

While forestation green areas, climate conditions are taken into consideration. Trees that compatible with Istanbul's climate are chosen. The suitable plant types have been determined and grouped regarding the region that could be used. Greenery area at the side of highways are organized regarding traffic rules and any danger that cause fire or accident. Therefore, evergreen, less water need and short plants are preferred for that areas. For irrigation of in city green areas, well water is used (Interview with İrfan Onat, Nilgün Özdingiş Tarakçı, 27.05.2014).

Measures to protect green areas from fire or any danger is taken. In any fire case, hydranths are placed in appropriate places for more efficient intervene. In order to prevent flooding, storm water canals are constructed (Interview with Mustafa Torun, 27.05.2014).

4.3.23.2 Adaptive capacity analysis of green spaces

Green areas are organized by municipality. Although climate conditions are considered in forestation and planting of green areas, there is no study on climate change impact on green areas (Interview with İrfan Onat, Nilgün Özdingiş Tarakçı, 27.05.2014).

The risk in green areas are reduced by cooperation with related institutions like fire department and ISKI. Especially measures for fire and flood are taken in design of urban forests. Biodiversity is an important issue while designing green areas.

Therefore, natural materials are used and habitats of species are not disrupted. Irrigation is supplied with well water (Interview with Mustafa Torun, 27.05.2014).

The budget for maintenance, design and implementation of green area plans are sustained by municipality's budget (Interview with Mustafa Torun, 27.05.2014).

4.3.23.3 Vulnerability level of green spaces

The extreme weather conditions may be harmful for green areas. Drought may cause irrigation problems. Those conditions weakens the trees and create illnesses. The municipality works efficiently for maintenance of green areas. However, the extreme conditions are not considered.

The vulnerability level is medium as seen at Table 4.41.

Table 4.41 : Vulnerability level of green spaces.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
Medium (2)	Medium (2)	Medium (4)

4.3.24 Ecology & biodiversity - biodiversity

The third planning area that is analised under the sector of 'Ecology & Biodiversity' is 'Biodiversity'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.24.1 Sensitivity analysis of biodiversity

Forest areas in Istanbul consists of deciduous trees such as; oak, alder, chestnut, linden, in laws and evergreen trees such as; black pine, red pine, pine etc. 86% of forest areas are broad-leafed kind of tree and 14% are coniferous kind of tree (IER, 2011).

The wetland ecological sites are threaten by agricultural purpose usages or urban development purposes, pollution of industry, agriculture and urbanization, overconsumption of water resources, wrong and over hunting activities (IER, 2011).

In Istanbul, Büyükçekmece, Küçükçekmece, Terkos, Büyükkokmuşgöl, Küçükkokmuşgöl, Riva, Ağva, Kamil Abduş Lake are most important wetlands of the city. Those areas have rich aquatic plant population and bird population (IER, 2011). Büyükçekmece Lake having 631.6 km^2 basin and 27.5 km^2 lake area supplies

water for the city and offers a habitat for migratory birds. The convention on wetlands of international importance (Ramsar) defines Büyükçekmece Lake as internationally important wetland in terms of bird population. All the basin are under protection against pollution. However, the urban development and economic activities that create negative impact on lake ecosystem could not be prevented (IER, 2011).

Küçükçekmece Lake is an important wetland for migratory birds however, it is not in protection status. Terkos Lake is also an important lake for birds, fishes, and endemic plants. It is partially under protection. Terkos lake end surrounding have importance in terms of its plant diversity. The rich wetland, swamp, dune, heathland, coppice forest create diversity and a rich habitat (IER, 2011).

Although those areas are important in terms of biodiversity, they cannot protected properly. Urbanization is a severe threat to ecosystem in those areas. Also, if afforestation is implemented to wrong sites with strange trees to the habitat, it can be seriously detrimental for the ecosystem. Some of those areas confront the threat because of afforestation. It is an emergency that those fragile areas should be defined as absolute protection areas and any pressure on those areas should be prevented (IER, 2011).

1/100.000 Istanbul Environmental Plan suggests protection for ecologically important areas.

4.3.24.2 Adaptive capacity analysis of biodiversity

Ecosystem is able to treat any deterioration caused by natural reasons. However, the external pressures to ecosystem and the deteriorations cannot be treated if those pressures exceed ecosystem's tolerance level.

In Istanbul, some of important habitats are under protection with related regulations and law, however, some of them are lack of protection status (IMP, 2009).

There is no study on endangered animals, their kind, amount and protection in city level. Also there is no organization in coordination with governorship, municipalities and volunteers to protect animals and their right to live. Only volunteer organizations work on that issue (IER, 2011).

Although wetlands have the richest biodiversity, they are highly fragile to any deterioration and environmental impact. In Istanbul, Küçükçekmece Lake, Elmalı Dam, Tuzla Lake have already lost most of their inhabitants due to urban development in their basin and pollution. Other wetlands that supply water for Istanbul are protected better with past experiences. Urbanization should not be allowed it those important ecosystems' basins and residential or industrial pollution should be prevented (IMP, 2009).

1/100.000 Istanbul Environmental Plan defines ecosystems as "Important Plant Land" and suggest comprehensive protection for those areas and surroundings.

As long as urbanization pressure and over consumption of nature exist, it is difficult to protect biodiversity in the city.

4.3.24.3 Vulnerability level of biodiversity

The ecosystem in Istanbul is highly sensitive to any external impact. The urbanization and negative activities of human kind, important ecologic lands have become fragile. Although some protection measures are taken about biodiversity and ecosystem, the comprehensive studies and protection strategies do not exist.

The overall score of the planning area vulnerability level is high as seen at Table 4.42.

Table 4.42 : Vulnerability level of biodiversity.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Low (3)	High (6)

4.3.25 Culture - cultural & historical heritage

The final and eleventh sector that is analised is 'Culture and the planning area of this sector is 'Cultural & Historical Heritage'. Sensitivity analysis and adaptive capacity analysis are conducted respectively and the vulnerability score is determined for the planning area.

4.3.25.1 Sensitivity analysis of cultural & historical heritage

Historical, monumental buildings are directly open to any climate and environmental effect. Because of weather event, facades of historical buildings are damaged, corroded. For example stone buildings get dirty because of air pollution especially on

their road side. Rain water may stick between stones and in cold period it frozen which cause cracks on the wall. Within restoration studies, problems and damages are determined, appropriate solutions are suggested. Repairment only covers registering the building and restoration. There is no climate focused repairment actions (Interview with Tülin Özcan, 29.05.2014).

Zeyrek, Sultanahmet, Süleymaniye, Kara Surları are in the UNESCO's World Heritage List. Therefore those areas and city centers are prior for maintenance. Interventions are implemented according to buildings priority, importance and the need (Interview with Tülin Özcan, 29.05.2014). There are about 20.000 registered buildings in Istanbul. Some of those buildings are in public ownership such as municipality, ministry, universities, foundations, while some of them in private ownership. Institutions usually restoration the monumental buildings in their ownership so there is no serious problem about protecting them. However, privately owned registered buildings' restoration and protection is up to their owners. Since restoration and protection is costly, most land owners do not care about the issue or cannot afford it (Interview with Ahmet Hamdi Bülbül, 29.05.2014).

Some of monumental buildings, palaces are located on the sea side (i.e. Dolmabahce Palace). Climate change may cause increase in sea level rise and all those monuments may be damaged. Although 2m. sea level rise would lead a serious damage for the palace, there is no concern about climate change impacts. Authorities do not expect and detrimental impact from climate change (Interview with Mehmet Ali Çubukçuoğlu). However, for any natural or environmental risk, important accessories from the palace are storage in safe places. There are about 100.000 pieces that storage.

4.3.25.2 Adaptive capacity analysis of cultural & historical heritage

Istanbul is a rich city in terms of cultural and historical heritage. Zeyrek, Sultanahmet, Süleymaniye, Kara Surları are in the UNESCO's world heritage list. Those areas are prior to protect and restoration. 80% of historical structures in historical peninsula have restoration projects and most of them are implementing (Interview with Ahmet Hamdi Bülbül, 29.05.2014).

Ownership patter creates a problem for comprehensive protection strategies. For buildings in private ownership, owner is responsible for restoration, authorities

cannot interfere to any action. They can only be registered as historical building which protect them from destruction. However, buildings in public ownership are maintenance regularly and they are under protection of institutions (Interview with Tülin Özcan, 29.05.2014).

In order to protect historical buildings in private ownership, municipality offers a service for the citizens in Zeyrek and Süleymaniye. Municipality prepares all restoration projects for the buildings which is ready to implement. When owner of the building willing to restoration the structure, those projects are given to the citizens. This technical service reduces the cost for citizens to restoration their buildings however, implementation cost belongs to the owner. Therefore, this service do not work efficiently (Interview with Tülin Özcan, 29.05.2014).

Climate change is not concerned for the restoration projects, however any disruptions on the monumental buildings are observed and repaired. Also, some of climate change impacts like sea level rise are underestimated, not expected. Therefore, there is no preparation for adverse impacts.

4.3.25.3 Vulnerability level of cultural & historical heritage

The historical buildings are open to any climate effect. Adverse impacts of climate events give serious damage on important monumental buildings. Since Istanbul have a rich historical background, protecting those heritage is important and authorities consider the issue. Public institutions work regularly for protecting and restoration. However, old and registered buildings in private ownership cannot be protected sufficiently.

The overall score of vulnerability level of the sector is high as seen at Table 4.43.

Table 4.43 : Vulnerability level of cultural and historical heritage.

Sensitivity Level	Adaptive Capacity Level	Vulnerability Level
High (3)	Medium (2)	High (5)

4.4 Overall Vulnerability Levels of Sectors

In the Table 4.44 the summary of the vulnerability assessment is presented and the all sectors are indicated with their vulnerability scores and levels.

Table 4.44 : Vulnerability levels of all sectors.

Sector	**Planning Area**	**Vulnerability Level (Score)**	**Average Vulnerability Score**
Health	Air Quality	Medium (4)	5
	Heat	High (6)	
Water Resources	Water Quality	High (5)	5
	Water Supply	High (5)	
Energy	Energy Production	High (5)	4.5
	Energy Demand	Medium (4)	
Transportation	Public Transit	High (5)	5
	Road & Bridge Maintenance	Medium (4)	
	Sea Transit	High (6)	
Agriculture	Crop Diversity	Medium (4)	4.5
	Agricultural Land Maintenance	High (5)	
Public Safety	Disaster Response	High (5)	4.6
	Urban Risk Areas	High (6)	
	Fire Safety	Low (3)	
Land Use & Development	Affordable Housing	Medium (4)	4
	Urban Renewal	Low (3)	
	Urban Planning	Medium (4)	
	Social Facilities	High (5)	
Materials	Waste Collection & Recycling	Low (3)	3
Infrastructure	Storm Water Management	High (5)	4
	Sewage System	Low (3)	
Ecology & Biodiversity	Urban Forest Management	Medium (4)	4.6
	Green Spaces	Medium (4)	
	Biodiversity	High (6)	
Culture	Cultural & Historical Heritage	High (5)	5

Vulnerable sectors can be defined as highly exposed to the climate conditions, under stress of climate and non-climate factors and low ability to absorb or adapt to the climate change impacts and new conditions. In Istanbul, The most vulnerable

systems are heat, sea transit, urban risk areas, and biodiversity with the score of 6 in the table. For the improvements of those highly vulnerable areas, local government should make studies especially on urban development and urban structure. The other highly vulnerable system group with score of 5 are; water quality, water supply, energy production, public transit, agricultural land maintenance, disaster response, social facilities, storm water management and cultural and historical heritage. The improvements on some of those systems such as energy production, agricultural land maintenance can be accomplished with a higher level governmental organization and regulations. Those problems are large scale problems and legal encouragement, regulations are needed. However, the others are city level problem and can be improved with local government studies.

The systems that have medium vulnerability are; air quality, energy demand, road and bridge maintenance, crop diversity, affordable housing, urban planning, urban forest management, green spaces.

The systems that have low vulnerability are; fire safety, urban renewal, waste collection and recycling, sewage system. Those system have low vulnerability level because of their existing flexibility or technological improvements or having necessary encouragements or less exposure to the climate conditions.

When vulnerability assessed by sectors considering average score of planning areas, the most vulnerable sectors are; health, water resources, transportation and culture with the highest average score of 5. Those sectors are followed by public safety, ecology and biodiversity with the score of 4.6 and energy, agriculture with the score of 4.5. The sector of land use and development and infrastructure comes after with the score of 4. The least vulnerability sector with the score of 3 is materials.

To conclude, out of 25 planning areas, 4 of them have highest vulnerability score of 6, 9 of them have the high vulnerability level with the score 5, 8 of them have medium vulnerability score 4, 4 of them have low vulnerability score 3.

4.5 Risk Assessment of Sectors in Istanbul

In this section of the thesis, risk assessment is conducted to each sector and each planning area. The assessment is resulted with a risk level for each of them.

4.5.1 Health - air quality

The change in the ratio of air components cause health problems. Also, pollens and microspores cause allergies, asthma, respiratory system diseases. Decrease in air quality cause more ultraviolet light penetrate into the surface which cause skin diseases.

Climate change will lead to more air pollution, decrease in air quality within heat effect and deterioration of atmosphere. Those changes will result as increase in allergies, respiratory diseases, asthma, and skin cancer.

Climate change and decrease in air quality will create extra cost for health expenses. Ecology will also be affected by the decreased air quality. Some species may lost their ability to adapt and extinct. All citizens will be affected but elder, sick people, children and outside workers are risk group which constitute half of the population. For the cultural behavior, slight changes may occur on people's daily life habits and people may spend less time outside.

The probability of the change is high. We can even observe the change in air quality in our daily life. Table 4.45 shows the risk level of the planning area.

Table 4.45 : Risk of air quality.

Consequence	**Probability**	**Risk Level**
High (3)	High (3)	High (6)

4.5.2 Health - heat

The most obvious climate change impact is increase in heat and longer summer periods. Heat may cause increase in deaths and diseases. Also, increase in heat will lead to increase in the number of vectors that carry diseases such as mosquitos. Not only their amount but also the area they spread will increase with heat effect.

Increasing heat with climate change will be costly for citizens in terms of health expending and energy bills. Hotter periods will lead to increase in air conditioner usage, demand for cooling energy which reflects to the bills as extra cost. The ecosystem is directly affected by the heat. While some species are able to adapt new climate conditions, some cannot exist and extinct. All citizens living in the city will be affected. Many of the citizens will be able to continue their daily life. However, especially elder, sick people and outside workers are at risk. Life threatening

conditions may occur for those people. Increasing heat may create slight changes in citizens' daily life and their time spent outside.

We have already observe the increase in the heat especially in summer time. More increase with climate change is highly possible. Table 4.46 shows the risk level of the planning area.

Table 4.46 : Risk of heat.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.3 Water resources - water quality

Water quality is under risk because of unplanned settlements, wrong land use decisions, and uncontrolled urban development. Urbanization not only create pressure on water resources, but also uncontrolled discharge of waste water creates pollution.

Climate change will lead to extreme weather events. As a result, water resources will get polluted due to leakage, storms and erosion. Also sea level rise cause salinization in water resources.

The water quality is important for all citizens. Polluted resources create serious cost to treat and to supply clean water to the city. People living in the city can be affected from water quality and unquality water service creates life threatening risk for citizens. Also, ecologically keeping water resources clean is very important. Ecologic sustainability is up to water quality and reservation of resources.

Climate change has secondary impact on water quality. Water resources are threatened basically by urbanization and uncontrolled discharge system. Climate change effects and extreme weather conditions just make the situation more complex. Therefore probability is medium. Table 4.47 shows the risk level of the planning area.

Table 4.47 : Risk of water quality.

Consequence	**Probability**	**Risk Level**
High (3)	Medium (2)	High (5)

4.5.4 Water resources - water supply

Istanbul does not have adventurous in terms of water resources like streams. Therefore it needs reservoirs for water supply. Currently main water resources for the city are reservoirs, regulators and wells.

Climate change will cause decrease in rain fall and drought. Increasing temperatures will cause evaporation in the water level of reservoirs. Water scarcity is a possible result of climate change. Also, rapid urbanization threats water basins and underground water. Uncontrolled usage of underground water causes consumption of primary water resource for the scarcity.

In order to supply sufficient water for Istanbul, new reservoirs should be constructed. Considering increasing urban population, water demand rapidly increasing. That creates double challenge for water supply with drought. The distance between city and water resources and new reservoirs are increasing. All of those creates great cost for the system. Ecology is also affected by drought and water scarcity. Since water is basic need for human life, all citizens are affected by the drought. The results may lead to epidemics and deaths. That may also affect citizens' cultural habits and daily life.

The temperatures are increasing, water levels in reservoirs are decreasing especially in summer time. Istanbul faces water scarcity risk even now. Therefore, drought probability in the city is high. Table 4.48 shows the risk level of the planning area.

Table 4.48 : Risk of water supply.

Consequence	**Probability**	**Risk Level**
High (3)	High (3)	High (6)

4.5.5 Energy - energy production

Turkey is depend on out resources since it can only produce 40% of its energy. Renewable and clean energy resources are not sufficient. Fossil fuel is still main energy resource.

Climate change will cause the change in demand for energy. Heating need will decrease while cooling need will increase. The city will need more renewable energy because of consumption of fossil fuel. It has potential for the alternative renewable energy resources.

Energy production will be costly with increasing population and increasing demand. Especially for citizens, more energy consumption will bring more cost. Ecology is already affected by fossil fuel. In order to protect ecology alternative, renewable energy is more important. For citizens, it does not create a life threatening situation. People's demand would change and it do not affect their daily habits.

The probability of climate change effect is high since it can obviously be observed. Table 4.49 shows the risk level of the planning area.

Table 4.49 : Risk of energy production.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.6 Energy - energy demand

Istanbul has rapidly grooving population. Increasing population cause increase in energy demand.

Climate change will cause increase in temperatures; long hot summer periods and warmer winter periods. That is expected to change seasonal energy demand; increasing demand for cooling energy in summer time, decreasing demand for heating energy in winter time. Considering population growth, the overall energy demand is supposed to increase.

Increasing demand reflects as energy bills to the citizens. For high, medium income citizens it may not be a problem however, for low income people increasing cost creates a problem. Energy used for transportation is harmful for ecology due to gas emission. It does not create a life threatening situation for citizens. Culturally citizens are not expected to be affected expect their seasonal demand change.

The probability of climate change impacts is high. Table 4.50 shows the risk level of the planning area.

Table 4.50 : Risk of energy demand.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.7 Transportation - public transit

Istanbul suffer from heavy traffic. The amount of automobile on traffic increases day by day. Public transportation has different modes such as metro, metrobus, buses, ferries etc. In extreme weather like heavy rain, snowing transportation becomes a problem for the city, transportation time prolongs.

Climate change needs more sustainable solutions for mitigation and adaptation. Also capacity and comfort for public transportation should be improved. More frequent extreme weather events with climate change will effect transportation. Demand for public transportation will increase.

Investments for public transportation is costly. The city needs more metro lines, alternative modes. The municipality has the budget for new transportation investments. Constructing public transportation lines has already started. Public transportation is also important in terms of protecting environment and ecology. The more traffic problem causes the more deterioration on ecology. Insufficient public transportation decreases comfort level, creates crowded in vehicles and increases transportation time spent in traffic.

The probability of climate change impact such as extreme weather conditions are highly possible for Istanbul. Table 4.51 shows the risk level of the planning area.

Table 4.5 : Risk of public transit.

Consequence	**Probability**	**Risk Level**
Low (1)	High (3)	Medium (4)

4.5.8 Transportation - road & bridge maintenance

Roads and bridges need constant maintenance because of weather events. Heavy rain, snowing, flood events damage roads.

Climate change will lead more extreme and frequent weather events. More damages on the roads and bridges will occur. Increasing population will cause more traffic. Transportation problem may occur more frequent and maintenance may take time.

The maintenance of roads and bridges will be more costly for the municipality. However, precautions and smart systems helps to decrease the cost. Ecology is not

affected by maintenance. All citizens are affected but there will not be a life threatening situation accept traffic accidents.

The expected impacts are highly possible. Table 4.52 shows the risk level of the planning area.

Table 4.52 : Risk of road and bridge maintenance.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.9 Transportation - sea transit

The sea transit is essential for the connection of two sides of Istanbul. However, its ratio in transport system is low (2%). Also, the sea transit is highly affected by climate conditions.

Climate change will lead to more frequent and extreme weather events. That means more cancellation of trips. Also sea level rise cause increase in distance between two sides, which create extra cost.

Climate change effects may create extra cost for operators. There is no risk for ecology. Citizens may be affected by the situations but there are alternative ways for connection of two sides. Culturally there is no risk.

Existing of extreme climate events is highly possible. Table 4.53 shows the risk level of the planning area.

Table 4.53 : Risk of sea transit.

Consequence	**Probability**	**Risk Level**
Low (1)	High (3)	Medium (4)

4.5.10 Agriculture - crop diversity

Climate conditions affect crop diversity. Fertility of each crop may change depending on climate. Drought periods have negative impact on agriculture.

Climate change will lead to less precipitation and more drought periods. Some crops are more resistant to the drought which are able to exist while cannot be cultivated in the new climate conditions. Irrigation system needs more improvements because of potential water scarcity.

Investments on irrigation technology may be costly for both government and farmers. Monitoring systems have already established. The agricultural production in Istanbul is not sufficient for the population. The population is depended to the other cities. The decrease in crop diversity will cause increase in dependence. However this does not create a serious risk for citizens and not a life threatening situation. The crop diversity will decrease. The ecologic pattern will change depending on climate conditions. The farmers should adapt the new conditions and learn about compatible crop pattern.

The climate impacts can be easily observed in agriculture. The impacts and the probability is high. Table 4.54 shows the risk level of the planning area.

Table 4.54 : Risk of crop diversity.

Consequence	**Probability**	**Risk Level**
Medium(2)	High (3)	High (5)

4.5.11 Agriculture - agricultural land maintenance

Agricultural production in Istanbul is low comparing with Turkey. Also, in sectorial employment, agriculture is lowest one in the city. Istanbul is a rapidly growing city which puts agricultural lands in danger of urbanization. Pollution is another factor that creates risk for agricultural land maintenance.

Climate change and longer drought periods will cause decrease in fertility. More pollution will cause decrease in quality of the soil. Immigration to Istanbul is expected to increase which leads to more pressure on agricultural land.

Agricultural land maintenance can be provided with regulations and technology that increase the fertility of the land. The sufficient technology would be costly. There is no life threatening situation for citizens but, decrease in open land will have negative impacts on urban life. Ecologically losing agricultural land is a problem. It may affect ecological balance. The farmers and their cultural life style would be affected.

The probability of the risk is high since the current situation give signals for the future predictions. Table 4.55 shows the risk level of the planning area.

Table 4.55 : Risk of agricultural land maintenance.

Consequence	Probability	Risk Level
Medium (2)	High (3)	High (5)

4.5.12 Public safety - disaster response

Istanbul frequently faces climate based disasters. Flooding, storm, drought are the disasters that can be observed seasonally.

Climate change will create more disasters to be dealt with. Those disasters may give serious damages to the city.

Some studies about disaster response has already conducted. There are early prediction systems and forecasts. Those systems should be updated considering climate change. Ecology may have damage because of disasters. Citizens especially living in risk areas may faces life threatening situations.

The probability of occurrence of climate change effects is high. Table 4.56 shows the risk level of the planning area.

Table 4.56 : Risk of disaster response.

Consequence	Probability	Risk Level
Medium (2)	High (3)	High (5)

4.5.13 Public safety - urban risk areas

Urban risk areas are vulnerable to any climate based disasters. Unplanned and illegal settlements are generally in those risk areas. Therefore, those areas exposes to climate impacts such as flooding. Being unqualified buildings, risk is greater in those settlements.

Climate change will cause more disaster in risk areas. More frequent and severe flooding, storms will be more harmful. Especially low income group settled in risk areas will be affected.

The renewal is a basic tool to decrease the risk in urban risk areas. Another is expropriation to wipe out the settlements especially in flood pains, high risk areas. However, it is not possible to do those precautions to al urban risk areas and it is very costly. People living in those areas are under a great risk. Disasters may result with deaths or severe lost.

The probability of occurrence of the risk is high. Table 4.57 shows the risk level of the planning area.

Table 4.57 : Risk of urban risk areas.

Consequence	**Probability**	**Risk Level**
High (3)	High (3)	High (6)

4.5.14 Public safety - fire safety

Heat, drought cause fires in urban areas and forests. Residential fires are used to be a severe risk in winter because of burning coal in stove, however, natural gas usage decreased that risk. Climate based residential fires have decreased.

Climate change creates more risk especially in summer time because of increasing temperatures and drought.

Fire department is well organized and improving institute. For more effective intervention they need more fire station in the city which is hard to find and costly. Ecology is under risk because of forest fires. Not all citizens are affected in any fire situation. However fires may pose a severe threat for people.

The probability of occurrence of the risk is high. Table 4.58 shows the risk level of the planning area.

Table 4.58 : Risk of urban fire safety.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.15 Land use & development - affordable housing

Istanbul Metropolitan Municipality, District Municipalities and TOKI produce affordable houses for citizens. Those affordable houses are usually used to transfer settlements in risk areas. However, it is not possible to transfer all slum and informal settlements into affordable houses.

Severe weather events by climate change will cause more damage especially in risk areas. The demand for affordable housing is expected to increase. Also, growing population and migration to the city increase the demand for housing.

Producing affordable housing is expensive, however, there are various ways to finance such as housing credits, involvement of private sector or investments. The sprawl of urban area threatens the ecology around the city. Not all citizens will be affected. Low income group and people living in urban risk areas would be affected. Culturally, people's life styles may change depending on the architectural style of houses or neighborhoods.

Affordable houses are continuously produced and climate change impacts on the planning area have some uncertainties. Therefore, the probability of the risk is medium. Table 4.59 shows the risk level of the planning area.

Table 4.59 : Risk of affordable housing.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.16 Land use & development - urban renewal

In Istanbul 25,000 buildings are under transformation(IMM). It is essential to reduce risk and produce more qualified buildings. After the 1999 earthquake which had serious damages on Istanbul, the recognition on the more quality building structures and importance have raised.

Climate change has more severe impacts on unqualified buildings. Those buildings pose great risk for the city.

Economically urban renewal is affordable. Private sector has active role in urban renewal. Ecology is under risk because of urban sprawl and increased density. It does not create a life threatening situation for citizens. However, building based transformation cannot eliminate risk totally. Based on architectural style, citizens' life styles may change.

The impacts of climate change on this planning area is not certain. Therefore, the probability is medium. Table 4.60 shows the risk level of the planning area.

Table 4.60 : Risk of urban renewal.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.17 Land use & development - urban planning

Istanbul is a growing city in terms of both urbanized area and population. The plan revised in 2009, 1/100.000 Istanbul Environmental Plan is in force currently. It determies the strategic future development of Istanbul.

The current climate effects will increase in the future. The plan does not consider climate change and future impacts. However, there are some strategies that contribute to both sustainability and measures to climate change impacts.

The implementation of plan will be made by municipality's budget. Although it is costly the budget plan is ready. The urban development is detrimental for ecology and environment. The urban sprawl creates risk for biodiversity and natural areas. All citizens will be affected by the decisions of the plan. The plan is unsufficient to reduce risk in some settlement area. The development plan may have effect on people cultural life style.

The impacts of climate change on this planning area is certain. Therefore, the probability is high. Table 4.61 shows the risk level of the planning area.

Table 4.61 : Risk of urban planning.

Consequence	**Probability**	**Risk Level**
High (3)	High (3)	High (6)

4.5.18 Land use & development - social facilities

Istanbul is lack of urban facilities in some districts. The amount of green area per person is less than standards. The plans propose new urban facilities for new development areas. In old and unplanned settlements, urban facilities are still a problem.

Being lack of open spaces in dense districts creates risk for the citizens for any emergency situation that climate change would cause. Insufficient urban facility decreases the quality of environment and quality of life.

For old settlements expropriation is an n useful method to create land for urban facilities. However it is costly. Urban renewal is also opportunity to create urban facilities in those areas. The environment needs open space for the quality of air or surface. Being lack of urban facility and open spaces is a problem for environment.

Citizens living in old and dense settlements are under risk. There is no life threatening situation for citizens.

The impacts are not certain, probability of occurrence is medium. Table 4.62 shows the risk level of the planning area.

Table 4.62 : Risk of social facilities.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.19 Materials - waste collection & recycling

Leakage from storage areas to the underground water is a risk for the environment. However, the leakage is prevented with special construction techniques and methane gas is collected by pipes.

Climate change may increase the environmental risk. But necessary controls are done regularly. Technologic improvements are used to protect environment.

Climate change does not generate considerable risk for this sector. Since the consequences are not certain, the probability is medium. Table 4.63 shows the risk level of the planning area.

Table 4.63 : Risk of waste collection and recycling.

Consequence	**Probability**	**Risk Level**
Low (1)	Medium (2)	Low (3)

4.5.20 Infrastructure - storm water management

The storm water system is not sufficient for Istanbul. In any heavy rain event, water over flows from pipelines.

Climate change and extreme weather events make over flows more frequent and more severe.

In order to prevent overflows, pipelines should be changed considering climate change impacts. That action could be costly for the city. Also more penetrable surfaces should be created in the city. Ecologically overflows may be detrimental for ecology. It creates life threatening situation for citizens especially for those living in

risk areas, flood plains, slums. Overflows cause large flooding that leads to deaths and property loss.

The risk can be observed today. Multiplied effects of climate change will make the risk greater. The probability of occurrence of the risk is high. Table 4.64 shows the risk level of the planning area.

Table 4.64 : Risk of storm water management.

Consequence	**Probability**	**Risk Level**
High (3)	High (3)	High (6)

4.5.21 Infrastructure - sewage system

The waste water is collected by sewage system in the city, transferred to the treatment plants and discharged to sea or streams. In some districts of Istanbul waste water is directly discharged to the sea or streams.

Climate change is not expected to have effect on the system. Growing population and density may create problems for the system.

The capacity of the sewage system should be increased because of population density. It could be costly. In order to prevent direct discharge of waste water to the sea, new treatment plants should be constructed and system should be connected to the plants. Investments on the subject have already started. Direct charges are detrimental for ecology and environment. There is no life threatening condition for citizens. However, in some dense and populated districts, comfort level may decrease because of unsufficient sewage system.

The consequences are not certain and any effect has not observed. The probability level is medium. Table 4.65 shows the risk level of the planning area.

Table 4.65 : Risk of sewage system.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.22 Ecology & biodiversity - urban forest management

Urban forest areas in Istanbul are threaten by urban development. Afforestation studies are conducted in Istanbul.

Climate change and extreme weather events may harm trees and green areas. It may have effect on biodiversity.

The urban areas in the city are getting smaller because of urbanization. Afforestation studies have already started and it is not hard to afford. Loss of urban forest areas are harmful for ecology. Also it decreases comfort level, air quality for citizens.

The probability of the risk is medium. Table 4.66 shows the risk level of the planning area.

Table 4.66 : Risk of urban forest management.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.23 Ecology & biodiversity - green spaces

Green areas are maintained by municipality regularly. The sick trees are determined, treated, green areas are irrigated. The compatible plants to the Istanbul climate conditions are chosen.

Climate change impacts may create problems for the green areas. Drought is a problem for irrigation. Extreme storms may turnover of trees. Climate condition may give damage to design of green areas, plants in them and parks.

Climate change will need more and constant maintenance on green areas. That could create extra cost for municipality. Ecology on green areas could be affected by adverse climate conditions. Some plants may not exist with new conditions. Citizens may be affected in term of their comfort and access to the green areas. The habit of people in green areas may change.

The probability of risk is medium. Table 4.67 shows the risk level of the planning area.

Table 4.67 : Risk of green spaces.

Consequence	**Probability**	**Risk Level**
Medium (2)	Medium (2)	Medium (4)

4.5.24 Ecology & biodiversity - biodiversity

In Istanbul, ecologically important areas confront risk of urbanization, over consumption, deterioration by human. They are sensitive to any external impacts.

Climate change is expected to affect biodiversity in negative way. Biodiversity challenges with external impacts and changing climate conditions would accelerate the destruction.

Biodiversity do not create extra cost for the city. For protection of ecology and biodiversity, public investments may be needed which is not expected to be considerably costly. The ecology is under great risk with climate change. It may have impact on the air quality, natural resources which are essential for citizens. Citizens will be affected but it is hard to estimate any life threatening condition.

Biodiversity is already under risk in Istanbul. The probability of impact is high. Table 4.68 shows the risk level of the planning area.

Table 4.68 : Risk of biodiversity.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.5.25 Culture - cultural & historical heritage

The climate conditions directly affect the historical buildings. Traffic pollution cause darkening on facades, rain and snow cause cracks on walls.

Climate change will effect negatively the historical heritage. The damage caused by climate conditions will multiplied with more frequent and extreme weather conditions.

The historical buildings are constantly maintained and restorated. Therefore, climate change will not cause an extra cost. For citizens it does not create life threatened situations. However, for those living in old, historic and registered buildings climate change may create a risk. Those buildings may need restoration and it may be costly for the residents. Those heritages are culturally important. The risk on the historical buildings is a risk for culture of the society.

The consequences of the climate impacts on historical heritage can be observed. Climate change will also have great impact on the sector. Therefore, the probability of the risk is high. Table 4.69 shows the risk level of the planning area.

Table 4.69 : Risk of cultural and historical heritage.

Consequence	**Probability**	**Risk Level**
Medium (2)	High (3)	High (5)

4.6 Overall Risk Levels of Sectors

In the Table 4.70 the summary of the risk assessment is presented and the all sectors are indicated with their risk scores and levels.

Table 4.70 : Risk levels of all sectors.

Sector	**Planning Area**	**Risk Level (Score)**	**Average Risk Score**
Health	Air Quality	High (6)	5.5
	Heat	High (5)	
Water Resources	Water Quality	High (5)	5.5
	Water Supply	High (6)	
Energy	Energy Production	High (5)	5
	Energy Demand	High (5)	
Transportation	Public Transit	Medium (4)	4.3
	Road & Bridge Maintenance	High (5)	
	Sea Transit	Medium (4)	
Agriculture	Crop Diversity	High (5)	5
	Agricultural Land Maintenance	High (5)	
Public Safety	Disaster Response	High (5)	5.3
	Urban Risk Areas	High (6)	
	Fire Safety	High (5)	
Land Use & Development	Affordable Housing	Medium (4)	4.5
	Urban Renewal	Medium (4)	
	Urban Planning	High (6)	
	Social Facilities	Medium (4)	

Table 4.70 (continuation) : Risk levels of all sectors.

Materials	Waste Collection & Recycling	Low (3)	3
Infrastructure	Storm Water Management	High (6)	5
	Sewage System	Medium (4)	
Ecology & Biodiversity	Urban Forest Management	Medium (4)	4.3
	Green Spaces	Medium (4)	
	Biodiversity	High (5)	
Culture	Cultural & Historical Heritage	High (5)	5

The at risk planning areas are determined considering the economic impacts with its cost, ecologic impacts that are detrimental for the nature, impact on citizens, how many people are affected and is there any life threatening situation and if exist, the impact on culture when any climate situation occurs. Also the probability of the climate impacts are included. The most costly, life threatening, ecologically detrimental, causing cultural alteration impacts and high possibility create high risk on planning areas.

According to the results, air quality, water supply, urban risk areas, urban planning, storm water management have the highest risk to climate change. Also, the planning areas of heat, water quality, energy production, energy demand, road and bridge maintenance, crop diversity, agricultural land maintenance, disaster response, fire safety, biodiversity, cultural and historical heritage have high risk. Any impact on those planning areas will affect many people in the city even some create life threatening situation and create high costs for recovery and adaptation also, create ecologically problematic situations and cultural alterations.

The planning areas of public transit, sea transit, affordable housing, urban renewal, social facilities, sewage system, urban forest management, green spaces have lower risk. The lowest risk planning area is materials.

In terms of sectors in the assessment, health and water resources have the highest risk with the score 5.5 followed by public safety with 5.3 and energy, agriculture, infrastructure and culture with the score of 5.

Land use and development sector have medium risk with 4.5 score and transportation, ecology and biodiversity sectors have the score of 4.3. The sector of materials have lowest risk score with 3.

As a result out of 25 planning area, 5 of them have highest risk score 6, 11 of them high risk score 5, 8 of them medium risk score 4, 1 of them have low risk score 3.

4.7 Prioritization Assessment of Sectors in Istanbul

The last step of the study is the prioritization assessment. It is combination of vulnerability assessment results and risk assessment scores. In the Table 4.71 the results and the combined scores of sectors and planning areas are presented.

Table 4.71 : Combined scores of all sectors.

Sector	**Planning Area**	**Vul. Score**	**Risk Score**	**Combined Score**	**Sector Average Combined Score**
Health	Air Quality	4	6	10	10.5
	Heat	6	5	11	
Water Resources	Water Quality	5	5	10	10.5
	Water Supply	5	6	11	
Energy	Energy Production	5	5	10	9.5
	Energy Demand	4	5	9	
Transportation	Public Transit	5	4	9	
	Road & Bridge Maintenance	4	5	9	
	Sea Transit	6	4	10	
Agriculture	Crop Diversity	4	5	9	9.5
	Agricultural Land Maintenance	5	5	10	
Public Safety	Disaster Response	5	5	10	10
	Urban Risk Areas	6	6	12	
	Fire Safety	3	5	8	
Land Use & Development	Affordable Housing	4	4	8	8.5
	Urban Renewal	3	4	7	
	Urban Planning	4	6	10	
	Social Facilities	5	4	9	

Table 4.71 (continuation) : Combined scores of all sectors.

Materials	Waste Collection & Recycling	3	3	6	6
Infrastructure	Storm Water Management	5	6	11	9
	Sewage System	3	4	7	
Ecology & Biodiversity	Urban Forest Management	4	4	8	9
	Green Spaces	4	4	8	
	Biodiversity	6	5	11	
Culture	Cultural & Historical Heritage	5	5	10	10

The prioritization assessment of planning areas is needed to lead decision makers about where should be started for adaptation and resilience strategies. For the assessment, the score system is used and vulnerability assessment and risk factor are combined for each planning areas. The planning areas that have high vulnerability and high risk are the ones that should be given the greatest priority for developing strategies. The planning areas that have low vulnerability and low risk are the lowest priority ones. Table 4.72 is the matrix for the vulnerability scores and risk scores combination and the priority score results.

The vulnerability scores from 3 to 6 and risk scores from 3 to 6 are combined. As final step the rank from 12 to 6 are obtained representing the planning area that have the most priority with combined score of 12 and the least priority with combined score of 6.

Table 4.72 : Prioritization matrix.

	VULNERABILITY SCORE				
RISK SCORE		6	5	4	3
	6	12 - Urban Risk Areas	11 - Water Supply - Storm Water Management	10 - Air Quality - Urban Planning	9
	5	11 - Heat - Biodiversity	10 - Water Quality - Energy Production - Agricultural Land Maintenance - Disaster Response - Cultural & Historical Heritage	9 - Energy Demand - Road &Bridge Maintenance - Crop Diversity	8 - Fire Safety
	4	10 - Sea Transit	9 - Public Transit - Social Facilities	8 - Affordable Housing - Urban Forest Management - Green Spaces	7 - Urban Renewal - Sewage System
	3	9	8	7	6 - Waste Collection & Recycling

According to the results of the assessment, the planning areas that have the most priority are with score 12 and 11; urban risk areas, water supply, storm water management, heat, biodiversity. The other prior planning areas are; sea transit, water quality, energy production, agricultural land maintenance, disaster response, cultural

and historical heritage, air quality, urban planning with the score of 10, having significant vulnerability and risk impacts.

The following has moderate vulnerability and risk impacts. Those are; public transit, social facilities, energy demand, road and bridge maintenance, crop diversity with the score of 9, affordable housing, urban forest management, green spaces, fire safety with the score of 8.

The lowest priority is for the low vulnerability and risk factors. Those planning areas are urban renewal and sewage system with score of 7, waste collection and recycling with the score of 6. Table 4.73 presents the ranking of all sectors according to their prioritization score.

Table 4.73 : Rank of all sectors.

Score	**Planning Areas**
12	Urban Risk Areas
11	Heat, Biodiversity, Water Supply, Storm Water Management
10	Sea Transit, Water Quality, Energy Production, Agricultural Land Maintenance, Disaster Response, Cultural & Historical Management, Air Quality, Urban Planning
9	Public Transit, Social Facilities, Energy Demand, Road & Bridge Maintenance, Crop Diversity
8	Affordable Housing, Urban Forest Management, Green Spaces, Fire Safety
7	Urban Renewal, Sewage System
6	Waste Collection & Recycling

The results reveal that some planning areas have priority considering risk and vulnerability impacts of Istanbul that should be developed strategies. The further studies to design more resilient city have been enlighten with this assessment about where to start. Strategies should be developed with cooperation of different institutions, NGOs, private investors, local and upper level governmental actors, academics. Also, planning areas are in relation with each other. One strategy about climate change impacts may be beneficial for several planning areas. Therefore, the co-benefit strategies also should be considered.

4.8 General Evaluation of Vulnerability and Risk Assessments

Istanbul is a complex system with its sectors and planning areas. Prioritization of planning areas considering vulnerability and risk impacts of climate change is very important as first step of a comprehensive study. In order to develop strategies for more resilient community, the starting point should be determined. This study is a guide for the further studies.

Although results of the assessment categories the priority, cros-sectoral thinking would be more helpful. One strategy about a prior planning area may affect the other planning areas that have less priority. That situation helps to improve the city system and brings more comprehensive approach.

The priory of planning areas can change with additional data or investments. Also, the vulnerability level and risk factors can change over time with climate or non-climate effects. Some implementations may directly or indirectly affect the planning areas. Any disaster may occur that has serious impacts on the city system which decreases the resilience of the city. On the other hand, technological improvements, changing economic circumstances, changing demands are non-climate dynamics that may have impacts on the systems resilience. Therefore, any situation that affects city system should be observed and the assessment should be updated considering those alterations. The advantage of the assessment is new data can easily be adopted to the analysis. Considering those changes, priority levels of the planning areas may change. In time, reassessment is inevitable.

Istanbul suffers from missing data about city system in some sectors or planning areas. The next step should be completing the missing analysis and data for each planning areas. Istanbul government have attempt for climate change adaptation strategies however, they are weak or lack of sanction power. Another step should be strengthen the existing regulations. After that, the strategic plan for more resilient city should be prepared considering the vulnerability and risk factor of the planning areas.

5. CONCLUDING REMARKS

Climate change is the undeniable fact of the planet which can be observed easily in temperature changes, seasonal periods. The climatic events are above the natural level of the natural system and in the future it may be worse than expected (Blakely, 2007). There is no place in the earth that will not be affected by climate change (IPCC, 2007). The cities and metropolitan areas are the most crucial places that will be affected in social, economic, natural terms. Rapid urbanization process, increasing the population in cities - 50% of the world population lives in cities- creates challenge for cities confronting the climate change impacts. Considering the impact of human activities on climate change, the future decisions and activities carry great importance. In that point, how countries' development will be formed is the main question and the resilience is the key answer.

There are various amount of definitions on resilience based on the different disciplinary approaches. The common point of all definitions has two components; the ability to absorb or adapt to the stress and the level of tolerance to the stresses. The main idea of the resilience is the ability of the system to withstand any stress in sustainable way. In that perspective the urban resilience represent the ability the urban system to retain its basic functions in any disturbance or stress.

The enhancing factor of resilience is determining the risk and minimalizing the vulnerabilities. The less vulnerable urban system to the climate change and risks has more resilience. A resilient city is the one that minimized vulnerabilities, reduced risk and well organized (UNISDR, 2012).

The resilience level of a city based on its vulnerabilities and the risks that the city is expected to confront. Therefore, towards a resilient development risk and vulnerability assessment have great importance. The risks should be determined and expected impacts on the city system should be measured. The determination of risks and expected consequences are important to reduce the uncertainty. In addition, the vulnerabilities should be known about the city in any climate based situation. In order to reduce the vulnerabilities and increase the resilience, the vulnerable sectors

the viability of the system, the weakness and sensitivities of the system should be determined.

In the world climate change and resilience concept is an important issue that orient the countries development plans. There are studies in international level to mitigate and adapt the climate change impacts. Also, in the national and local level many important studies and strategies are developed especially in developed countries. The acknowledge of the importance of mitigation to climate change, building resilient communities and being prepared for the future climate change impacts have spread the all over the world.

Turkey is at the early stage of the climate change based studies. The participation into Kyoto Protocol have become the important initiator for the increase in awareness of climate change and related studies. Strategies have already began to develop in national level. Although legal regulations were made on related issues, the enforcement of those regulations are problematic and does not work efficiently. In some cities local climate plans and strategies have already developed. The acknowledge of local studies on climate change adaptation and mitigation is still limited. In other words, the recognition of climate change impacts have already started but the practice, enforcement and related studies are far behind the developed countries. Turkey have significant gaps in local and national level actions on climate change. The absence of local strategy and action plan for metropolitan cities is one of those gaps. In rapidly urbanized structure of the country, metropolitan cities especially Istanbul as the biggest city in terms of economy, culture and population need the development plans in the perspective of climate change and its impacts. Although there are some strategies and investments that contributes to the mitigation and adaptation to climate change impacts, Istanbul is lack of a comprehensive approach to the issue.

In this study, the motivated factor is the necessity of the urban climate change studies in Turkey. Istanbul is selected being the biggest metropolitan city and being lack of comprehensive climate change resilient study. As two main determinant of resilience, this study focused on vulnerability and risk assessment in Istanbul. For more comprehensive approach, the sectors that are important for city development, viability in the future and supplying the main services are selected referring Istanbul's development plan. Also, planning areas that are relevant to the sectors are

determined to be analyzed. In that direction 11 sectors and 26 planning areas are analyzed using the methodology of vulnerability assessment and risk assessment that are defined in literature. The data collected with in-depth interviews, related reports, publication and surveys. This study is aimed to reach the conclusion that which sectors from selected 11 are the most vulnerable and the most at-risk to climate change impacts. In other words, it is aimed to determine the prior sectors to take actions for the climate change adaptation and mitigation to increase resilience.

The results of the study show that the most prior sectors are public safety (urban risk areas), health (heat), water resources (water supply), ecology and biodiversity (biodiversity) and infrastructure (storm water management). The vulnerability and the risk factor of those sectors are highly related to the urban development pattern of Istanbul. Uncontrolled urban development, formal and informal settlements in river basin, earthquake areas that are not suitable for urban development increase the vulnerability of the sector public safety. The dense settlements creating urban heat island effect and being lack of wind corridors, green areas increase the vulnerability of the settlement to the heat. That situation makes the health sector more prior. The increasing population, the sprawl of the city in the peripheral areas, the pressure on the natural resources cause increase in the vulnerability of water resources and ecology and put those resources at risk of extinction. The infrastructure of the city is not sufficient for the population especially in dense and old settlements area. In any adverse weather event, the infrastructure cannot work efficiently because of not balancing the density and capacity of the system in those areas.

The strategies to decrease vulnerability and risk should be developed in a participative platform with all the actors of the city system. One result deduced from interviews is that the actors; public institutions, private institutions, academics and NGOs are not cooperating with each other. In Istanbul national and local governmental authorities are actively produce new projects that contributes to the economic development. However, while doing this ecologic and social sustainability is underestimated. The governmental organizations work as the only decision makers on the city. The interaction with academics and governmental organizations is limited while there is almost no interaction with governmental organizations and NGOs. The transparency is the key word for the development strategies which is not considered in decisions on Istanbul. The power of central government on Istanbul is

undeniable. Central government produces mega projects in Istanbul with the economic development perspective. Those projects may contradict to the local governments' development strategies or sustainable development. However, being lack of transparency, discussion and participation platforms on those projects, create negative impacts for the future of the city and sustainability. 3rd bridge, canal Istanbul, gated communities and satellite settlements in periphery of Istanbul, Eurasia tunnel project are examples of those mega projects.

Private sector's contribution to resilience is mostly in their initiative, no or limited incites from government in some sectors. In order to increase their brand value, they prefer more innovative, creative production in the market. That strategy indirectly contributes to the resilience (example; green buildings). However, the examples of such contributions is limited. In order to include private sector in the resilient development and extend the examples of qualified projects, the governmental incites are essential.

Academic studies have already started on climate change and resilience but, they are still not enough. There are many information that cannot be found, should be researched. Therefore, academics should be more active in both surveys and researches on the climate change resilience and in the development decisions process with their scientific contributions.

NGOs are the most concerned actors about preservation of nature, sustainable development. They try to stand against the decisions that threaten the future and sustainability of Istanbul in both legal stage and with activist operations. However, the government refuses the cooperation with NGOs in important decisions.

The process of development resiliency in Istanbul needs;

- The sustainable approach to the urban development strategies instead of pure economic concerns
- The transparency of the plans and decisions
- Cooperation of public organizations, private institutions, academics, NGOs and the citizens
- Participative approach to the development strategies
- More academic studies on climate change, its impacts
- Enlighten of citizens about climate change and its impacts

- Incites by government to the private sector on the projects contributing the resilience increase
- More powerful enforcement and control on the existing legal regulations about climate change adaptation and mitigation
- Making legislative regulations considering the climate change adaptation and mitigation
- Preparing the emergency action plan for any possible adverse impacts

The city is a complex system with inter-related sectors and services. Therefore, cros-sectoral thinking on developing more resilient communities is essential. Any decision or strategy would affect multiple sectors. The comprehensive approach and interrelation consideration of sectors is more effective on improving the city system resilience. Any additional data or action in the city would change the resilience of all system and the rank of the priorities as well. Therefore this study should be revised periodically and monitoring system should be developed to follow the new information affecting the resilience directly or indirectly. Those new information can be technological improvements, new investments and projects, regulatory regulations, economic circumstances, disasters, etc.

This study stands for the starting point in developing more resilient Istanbul, addressing the pathways for the further studies. It is a comprehensive study considering the vital city system components and actors that are active in development addressing the weaknesses, opportunities and giving clues for the further steps on resilience.

"There is no finish line. Resilience is an ongoing process." Yukimoto Ito

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APPENDICES

APPENDIX A: Tables of sensitivity analysis of all planning areas.
APPENDIX B: Tables of adaptive capacity analysis of all planning areas.
APPENDIX C: A copy of the semi-structured questionnaire
APPENDIX D: List of interviews

APPENDIX A: Tables of sensitivity analysis of all planning areas.

Table A.1: Sensitivity analysis of air quality.

Current and Expected Stresses to Systems	Pollens and microspores cause allergies, asthma, respiratory system diseases. Ultraviolet light cause the increase in the risk of skin cancer, skin diseases. Risk is greater for the children and outside workers.
Known Climate Conditions Relevant to Systems	Temperature, Season Length, Humidity, Airflow, Rain
How Known Climate Conditions Currently Affect Systems	High temperature and sunlight cause photochemical reaction and dilution on atmospheric ozone layer.
How Known Climate Conditions are Projected to Change	Increase in temperatures and length of the hotter summer days, Increase in atmospheric weather events
Projected Impacts of Changes to Systems	Increase in allergies, respiratory diseases, asthma and risk of skin cancer.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.2: Sensitivity analysis of heat.

Current and Expected Stresses to Systems	Long hot periods may cause deaths and diseases. The number of vectors that carry the diseases such as mosquito increases and they spread larger areas. Elder and sick people are at risk.
Known Climate Conditions Relevant to Systems	Temperature, Season Length
How Known Climate Conditions Currently Affect Systems	High temperature and longer hot summer days decrease the comfort level.
How Known Climate Conditions are Projected to Change	İncrease in temperatures and length of the hotter summer days.
Projected Impacts of Changes to Systems	Because of warmer weather in the winter, there may be decrease in winter deaths, however increase in summer death with longer hot summers. Especially elder and sick people are under a severe risk. Here may be increase in the energy usage for cooling.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.3: Sensitivity analysis of water quality.

Current and Expected Stresses to Systems	Unplanned settlements, wrong land use decisions, uncontrolled development cause water resources get polluted. Urbanization pressure on water resources is a serious risk. Water basins are tried to be protected from urbanization and water quality is controlled regularly. Water is distributed after treatment.
Known Climate Conditions Relevant to Systems	Temperature, Rain, Floods, Drought, Humidity, Sea Level Rise.
How Known Climate Conditions Currently Affect Systems	Rain cause the waste water and waste material leakage to the water resources. Salinization because of sea water is a risk for aquifer. Storms and erosion get the pollutants carried into the water resources.
How Known Climate Conditions are Projected to Change	Increase in temperatures and length of the hotter summer days, drought, more frequent and severe storm events, sea level rise.
Projected Impacts of Changes to Systems	Increase in pollution caused by weather events. More salinization because of rising sea level.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.4: Sensitivity analysis of water supply.

Current and Expected Stresses to Systems	Istanbul supplies its water from reservoirs, regulators and wells. İt does not have adventurous in terms of streams. Therefore, building new reservoirs is the strategy for the future water need.
Known Climate Conditions Relevant to Systems	Temperature, Rain, Drought
How Known Climate Conditions Currently Affect Systems	High temperature cause evaporation which cause decrease in the water level of reservoirs. Decrease in rain would result drought and water scarcity. Underground water is not supplied by rain because of sprawled urbanization.
How Known Climate Conditions are Projected to Change	Increase in temperatures, Changes in precipitation, Long arid periods.
Projected Impacts of Changes to Systems	The water level in reservoirs could decrease. Uncontrolled and over usage of underground water could cause consumption of sources. Water basins and underground water supply are under threat because of sprawled urbanization.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.5: Sensitivity analysis of energy production.

Current and Expected Stresses to Systems	Turkey can only produce 40% of its energy demand, it is depended to the other countries. İn order to supply energy; coal, natural gas, hydraulic sources and renewable energy are used.
Known Climate Conditions Relevant to Systems	Temperature
How Known Climate Conditions Currently Affect Systems	The climate affects the need for energy and the amount of usage. İn the winter the energy for heating is used while in the summer the energy for cooling is used. Renewable energies; solar and wind energy is directly affected by the climate conditions and events.
How Known Climate Conditions are Projected to Change	Increase in temperatures, Hotter summer and warmer winter days, Urban Heat Island Effect
Projected Impacts of Changes to Systems	While the need of heating energy is decreasing, the cooling energy is increasing. The population and the number of automobile in the traffic will increase which cause more energy consumption.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.6: Sensitivity analysis of energy demand.

Current and Expected Stresses to Systems	The rapid increase of the population would lead to the increase in energy demand. Studies about energy efficiency for dwellings are maintained. However, it has not carried into action effectively.
Known Climate Conditions Relevant to Systems	Temperature
How Known Climate Conditions Currently Affect Systems	In the winter the energy for heating is demanded while in the summer the energy for cooling is demanded.
How Known Climate Conditions are Projected to Change	Increase in temperatures, Hotter summer and warmer winter days, Urban Heat Island Effect
Projected Impacts of Changes to Systems	While the demand for heating energy is decreasing, demand for the cooling energy is increasing. İncreasing energy demand would lead to an increase in cost which some groups cannot afford.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.7: Sensitivity analysis of public transit.

Current and Expected Stresses to Systems	In Istanbul there are various mode of public transportation such as; metro, metrobus, dolmus, and ferry. Improvements of public transit are prior for the plans.
Known Climate Conditions Relevant to Systems	Temperature, Storm, Flood, Extreme weather events, Icing.
How Known Climate Conditions Currently Affect Systems	Roads cannot be used because of extreme weather events, some public transportation modes cannot be used such as ferries. Traffic jam would occur.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe storms, Increase in number of icy days, More extreme weather events.
Projected Impacts of Changes to Systems	The traffic jam may prolong the travel time. Public transportation may not support the demand of population. When extreme weather events occur, the trips may fail, some trips may cancel. Large population may create crowded in the public transportation station.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.8: Sensitivity analysis of road and bridge maintenance.

Current and Expected Stresses to Systems	Roads and bridges need constant maintenance because of weather events. Roads and bridges are maintained by the municipality regularly. Closing of some roads or icing may occur because of weather conditions.
Known Climate Conditions Relevant to Systems	Temperature, Storm, Flood, Extreme weather events, icing.
How Known Climate Conditions Currently Affect Systems	Roads cannot be used because of extreme weather events. Weather events damages the roads for instance; rain and snow may cause cracks on asphalt, extreme hot weather may cause melting of asphalt, heavy vehicles in the hot weather may cause collapse.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe storms, Increase in number of icy days, More extreme weather events.
Projected Impacts of Changes to Systems	More extreme weather events leads to an increase in the need of maintenance on roads and bridges. More frequent disruptions on the roads may occur. The number of vehicle would increase because of population growth which creates more difficulties.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.9: Sensitivity analysis of sea transit.

Current and Expected Stresses to Systems	Vertical transportation is sustained by various the companies between 2 sides of Istanbul. There are also horizontal transportation parallel to the cost line however it is limited. The Bosporus is also used for freight shipment.
Known Climate Conditions Relevant to Systems	Precipitation, Storm, Fog
How Known Climate Conditions Currently Affect Systems	Southwester and fog cause cancellation of trips. Sea transit is directly affected by weather events in terms of cost, travel time.
How Known Climate Conditions are Projected to Change	More frequent and severe precipitation, storms and fog, Rising of sea level
Projected Impacts of Changes to Systems	More cancellation of the trips may occur and cost would increase. The increase in the sea level would increase the distance which leads to increase in the cost of operation.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.10: Sensitivity analysis of crop diversity.

Current and Expected Stresses to Systems	Crop diversity is affected by climate conditions, drought and fertility changes periodically.
Known Climate Conditions Relevant to Systems	Precipitation
How Known Climate Conditions Currently Affect Systems	The crop diversity is depend on precipitation of the period. The change in precipitation affects the fertility of the crops.
How Known Climate Conditions are Projected to Change	Less precipitation, drought
Projected Impacts of Changes to Systems	Some crop types cannot adapt to the new climate conditions. More drought resistant crops will be chosen to cultivate.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.11: Sensitivity analysis of agricultural land maintenance.

Current and Expected Stresses to Systems	The urbanization creates pressure on agricultural land and they get smaller because of urban development. Pollution is a problem for the quality of the agricultural land. Drought periods create problem for irrigation and fertility of the soil.
Known Climate Conditions Relevant to Systems	Precipitation, Drought, Air quality
How Known Climate Conditions Currently Affect Systems	Drought is major problem. Irrigation technologies should be improved.
How Known Climate Conditions are Projected to Change	Less precipitation, longer drought periods
Projected Impacts of Changes to Systems	The quality of the soil will decrease, fertility of the agriculture will decrease. More pollution will be observed in the soil. Urban pressure will increase with the growth of population.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.12: Sensitivity analysis of disaster response.

Current and Expected Stresses to Systems	The disasters caused by the climate and weather events are not rare. The studies to predict the disaster before it happens are conducted. AKOM is the department that coordinates and stimulates the related departments when any disaster happens.
Known Climate Conditions Relevant to Systems	Temperature, Precipitation, Storm, Flood
How Known Climate Conditions Currently Affect Systems	Flooding, drought, storms are the serious risks for the city. Being prepared for this kind of risk situation is highly important.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms and flooding, Rising number of forest fires
Projected Impacts of Changes to Systems	More frequent and severe weather events would be more harmful and give serious damages to the city. The solution for the situation would be more difficult. Sustaining public safety in a short time would be a critical issue that difficult to handle.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.13: Sensitivity analysis of urban risk areas.

Current and Expected Stresses to Systems	The urban risk areas are usually where illegal and unplanned settlements are located. Generally low income group lives in those areas. Any disaster may cause serious destruction.
Known Climate Conditions Relevant to Systems	Temperature, Precipitation, Storm, Flood
How Known Climate Conditions Currently Affect Systems	The illegal settlement are usually located on stream bed and valley. Therefore those areas are under risk of flooding when heavily rain. Meteorological events have great impacts on those areas.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms and flooding
Projected Impacts of Changes to Systems	More frequent and severe weather events would cause deaths and losses. Flooding would cause more damage. The sufficient living condition could not sustained because of rising temperatures. That situation may cause health problems.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.14: Sensitivity analysis of fire safety.

Current and Expected Stresses to Systems	The fires caused by usage of coal diminished after the expanse of natural gas usage for heating. Forest fires are serious threat for the environment.
Known Climate Conditions Relevant to Systems	Temperature, Drought
How Known Climate Conditions Currently Affect Systems	In the summer, forest fires increase because of unconscious use of urban forests and drought. The number of residential fires decreased after natural gas usage in the winter. Heat and drought cause fires of grass side of motorways in the summer.
How Known Climate Conditions are Projected to Change	Increase in temperatures, Long arid periods
Projected Impacts of Changes to Systems	Increase in the forest fire events in the summer period. Climate change will not have any effect on residential fires.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.15: Sensitivity analysis of affordable housing.

Current and Expected Stresses to Systems	The demand for housing for the low income group is sustained by TOKI and housing department IMM. The produced houses are used for the discharge of risky areas where settlements are developed illegally. Although mass production of houses, it is not possible to transfer all the slums.
Known Climate Conditions Relevant to Systems	Temperature, Floods
How Known Climate Conditions Currently Affect Systems	Unqualified settlements can highly be damaged by storms or floods which may cause deaths and loss of property. Settlements that are not located in the risk areas and more qualified houses are the basic needs of the city.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme climate events
Projected Impacts of Changes to Systems	More damage would occur because of severe weather events. The need for affordable house would increase. The increase in population would lead to increase the demand for affordable housing. Affordable housing would have an important part in production of housing.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.16: Sensitivity analysis of urban renewal.

Current and Expected Stresses to Systems	With the calamity regulation the urban renewal has gained speed in Istanbul. Over 2 million buildings, 25.000 buildings are under transformation.
Known Climate Conditions Relevant to Systems	Temperature, Floods, Storms
How Known Climate Conditions Currently Affect Systems	Settlements in Istanbul are under risk because of unqualified development. The risk could be reduced by urban renewal and the living conditions could be improved.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	Unqualified buildings would be under more severe risk. The living standards would decrease because of the bad conditions. Unqualified houses would lead to more energy consumption.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.17: Sensitivity analysis of urban planning.

Current and Expected Stresses to Systems	The increasing population of the city will make the demand for housing and spatial development increased. The bureau of planning considers new development areas in more sustainable frame. Although it has not yet consider climate change as a priority concern subject, its development strategies contribute to the issue.
Known Climate Conditions Relevant to Systems	Temperature, Floods
How Known Climate Conditions Currently Affect Systems	Although development in flood plains is restricted by the Bureau, illegal and unplanned housing development confronts flooding when heavy rain occurs. Old and dense high rise settlements are lack of open and green spaces which creates urban heat island effect and air pollution. Urban renewal is a tool to solve this problem.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	The current climate effect will increase in the future. There will be longer and hotter summer, increased temperatures. Also flooding will be more frequent and intense. The city will need more climate change mitigation policies such as; public transportation, smart growth, TOD, mixed used development, decentralization. More open space, penetrable surfaces, shading and cooling trees in streets will be needed.
Projected Change in Stresses	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.18: Sensitivity analysis of social facilities.

Current and Expected Stresses to Systems	The old settlement areas are lack of social facilities in Istanbul. The amount of green areas per person is not enough, less than standards or proposed. However, newly developed areas are planned considering their social facility and green area needs.
Known Climate Conditions Relevant to Systems	Temperature, Floods, Storms
How Known Climate Conditions Currently Affect Systems	The absence of the social facilities within walking distance increases the travel demand for long distances. Travels are disrupted because of the great amount of the vehicle on the traffic and adverse weather events. The areas that are lack of green and open spaces confronts the problem of air pollution and extreme heat.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	The lack of the urban facilities decreases the quality of environment and life. Adverse weather conditions multiplies the undesired effects. The increasing population would need more social facilities and it could be a problem to find adequate place to build.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.19: Sensitivity analysis of waste collection and recycling.

Current and Expected Stresses to Systems	Residential waste collection is done by district municipalities and waste are collected in the transfer stations. IMM transfers waste from stations to the storage yards. This system works efficiently.
Known Climate Conditions Relevant to Systems	Temperature, Floods, Storms
How Known Climate Conditions Currently Affect Systems	Because of weather conditions especially in the winter, some problems may occur collecting the waste from districts. Floods, storms or erosion may cause spread of the harmful waste to the around.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	More disruption may occur while collecting waste because of bad weather conditions. The harmful leakage to the underground water or spread of waste to the environment around the yard may happen.
Projected Change in Stresses to Systems	Neutral
Degree of System Sensitivity to Climate Change	Low

Table A.20: Sensitivity analysis of storm water management.

Current and Expected Stresses to Systems	Storm water is collected in a separated system with water pipelines. 95 % of Istanbul has separated infrastructure system.
Known Climate Conditions Relevant to Systems	Floods, Precipitation
How Known Climate Conditions Currently Affect Systems	Heavy rains could lead to over flows because of the inadequate size of the water pipeline or any material that blocks the pipes
How Known Climate Conditions are Projected to Change	More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	More overflows would happen because of the heavy rains.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.21: Sensitivity analysis of sewage system.

Current and Expected Stresses to Systems	The waste water is collected and treated by ISKI. The waste water is directly discharged to the sea or streams in some districts of Istanbul. In order to prevent this new waste water treatment plants are constructed.
Known Climate Conditions Relevant to Systems	Floods, Precipitation
How Known Climate Conditions Currently Affect Systems	The climate conditions do not affect the sewage system.
How Known Climate Conditions are Projected to Change	More frequent and severe precipitation, storms, and flood, More extreme events
Projected Impacts of Changes to Systems	The growing population is the problem for infrastructure. İncreasing densities cause the problem of insufficient sewage system.
Projected Change in Stresses to Systems	Neutral
Degree of System Sensitivity to Climate Change	Low

Table A.22: Sensitivity analysis of urban forest management.

Current and Expected Stresses to Systems	The urban forests around or in the city are generally natural protection areas. Forest areas are getting smaller because of the urban development.
Known Climate Conditions Relevant to Systems	Temperatures, Floods, Droughts
How Known Climate Conditions Currently Affect Systems	Hot and drought seasons are harmful for trees' health, the bad weather conditions weakens the trees.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events, Long arid periods.
Projected Impacts of Changes to Systems	Urban forests are lost because of urban development. The stress on the forests would increase because of the adverse effects of climate.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.23: Sensitivity analysis of green spaces.

Current and Expected Stresses to Systems	The design and forestation of green areas within city are in the charge of IMM. The natural plants which could live in Istanbul's climate are chosen for the green areas.
Known Climate Conditions Relevant to Systems	Temperatures, Floods, Droughts
How Known Climate Conditions Currently Affect Systems	Hot and drought seasons are harmful for trees' health, the bad weather conditions weakens the trees. Irrigation is important for the green areas sustainability. Severe storms and flooding may damage the landscape, park equipment.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe precipitation, storms, and flood, More extreme events, Long arid periods.
Projected Impacts of Changes to Systems	The more storm and flooding damage on greenspace would have a negative effect on IMM budget. The habits of citizen use would change. Drought would create problems for irrigation and maintenance of the plants.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	Medium

Table A.24: Sensitivity analysis of biodiversity.

Current and Expected Stresses to Systems	Istanbul has rich biodiversity in its ecosystem. Biodiversity is threaten by urbanization, hunting, over consumption of resources, pollution.
Known Climate Conditions Relevant to Systems	Ecosystems have a certain climate condition to exist. Any change in climate conditions would affect the biodiversity and environment.
How Known Climate Conditions Currently Affect Systems	There are no study on ecosystem and climate impact on biodiversity in that ecosystem. Therefore, the certain impact of climate cannot be acknowledged.
How Known Climate Conditions are Projected to Change	Increase in temperatures, more frequent and more extreme weather events, change in seasons and climate conditions.
Projected Impacts of Changes to Systems	Since ecosystems are fragile, any change in climate condition will negatively affect the biodiversity. Decrease in biodiversity and extinction of some species may happen.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

Table A.25: Sensitivity analysis of cultural and historical heritage.

Current and Expected Stresses to Systems	The historical buildings are directly affected by climate. Also there are many important historical structures, palaces on the cost which is under the threat of sea level rise.
Known Climate Conditions Relevant to Systems	Temperature, Precipitation, Sea Level Rise
How Known Climate Conditions Currently Affect Systems	In the winter the snow or frozen rain causes cracks on the buildings walls. The buildings are open to climate destruction. The traffic pollution causes darkening on facades.
How Known Climate Conditions are Projected to Change	Increase in temperatures, More frequent and severe storms, flooding and precipitation, Rising of sea level
Projected Impacts of Changes to Systems	More cracks on the buildings walls and more destruction would happen because of weather conditions. Some important structures, palaces are under risk of sea level rise and flooding.
Projected Change in Stresses to Systems	Negative
Degree of System Sensitivity to Climate Change	High

APPENDIX B: Tables of adaptive capacity analysis of all planning areas.

Table B.1: Adaptive capacity analysis of air quality.

Current and Expected Stresses to Systems in This Planning Area	Pollens and microspores cause allergies, asthma, respiratory system diseases. Ultraviolet light cause the increase in the risk of skin cancer, skin diseases. Risk is greater for the children and outside workers.
Projected Impacts of Changes to Systems in This Planning Area	Increase in allergies, respiratory diseases, asthma and risk of skin cancer.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The air pollution is observed using pollution observation stations. Increasing the air quality is concerned and some measures are taken in order to decrease air pollutant. As the major air pollutant, the car traffic is tried to be solved.
Barriers and Facilitators to Improving Resiliency	The spread of land development as a result of population growth, urban heat island effect will increase. İn order to increase air quality, some measures for both transportation and urban development should be taken. The system is lack of the studies that tries to inform and coordinate people.
Adaptive Capacity of This Planning Area	Medium

Table B.2: Adaptive capacity analysis of heat.

Current and Expected Stresses to Systems in This Planning Area	Long hot periods may cause deaths and diseases. The number of vectors that carry the diseases such as mosquito increases and they spread larger areas. Elder and sick people are at risk.
Projected Impacts of Changes to Systems in This Planning Area	Because of warmer weather in the winter, there may be decrease in winter deaths, however increase in summer death with longer hot summers. Especially elder and sick people are under a severe risk. Here may be increase in the energy usage for cooling.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The land use development should be compatible with climate factors. Natural cooling methods should be used and need for cooling energy should be decreased. Wind corridors, forestation could be useful.
Barriers and Facilitators to Improving Resiliency	Istanbul is a growing city with its rapidly growing population. The unplanned development in the city center creates difficulties for creating green areas. Existing green areas are threatened because of more development. As a cooling method conditioner usage may cause high utility bills for the residents.
Adaptive Capacity of This Planning Area	Low

Table B.3: Adaptive capacity analysis of water quality.

Current and Expected Stresses to Systems in This Planning Area	Unplanned settlements, wrong land use decisions, uncontrolled development cause water resources get polluted. Urbanization pressure on water resources is a serious risk. Water basins are tried to be protected from urbanization and water quality is controlled regularly. Water is distributed after treatment.
Projected Impacts of Changes to Systems in This Planning Area	Increase in pollution caused by weather events. More salinization because of rising sea level.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	Rapid urbanization could put water resources in danger. ISKI and DSI control the quality of water regularly. New water treatment plants are constructed.
Barriers and Facilitators to Improving Resiliency	The water coming from reservoirs are refined before distribution and more investments for the water treatment are made. Some precautions are taken to protect water basins. However preventing the illegal settlements in the basin and clean out those is costly. Also preventing waste water discharge directly to the water resources is costly.
Adaptive Capacity of This Planning Area	Medium

Table B.4: Adaptive capacity analysis of water supply.

Current and Expected Stresses to Systems in This Planning Area	Istanbul supplies its water from reservoirs, regulators and wells. İt does not have adventurous in terms of streams. Therefore, building new reservoirs is the strategy for the future water need.
Projected Impacts of Changes to Systems in This Planning Area	The water level in reservoirs could decrease. Uncontrolled and over usage of underground water could cause consumption of sources. Water basins and underground water supply are under threat because of sprawled urbanization.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	There are 13 drinking water reservoirs in Istanbul. İncreasing population and increasing need for water is planned to be supplied by construction of new reservoirs around and outside of the city. There are enough water resources for water demand in the arid period.
Barriers and Facilitators to Improving Resiliency	The urbanization threaten the water resources would create problems for water supply. There is no investment on collecting rain and reuse of it. While demand for water increases the distance of the supply source will increase which cause increasing cost.
Adaptive Capacity of This Planning Area	Medium

Table B.5: Adaptive capacity analysis of energy production.

Current and Expected Stresses to Systems in This Planning Area	Turkey can only produce 40% of its energy demand, it is depended to the other countries. İn order to supply energy; coal, natural gas, hydraulic sources and renewable energy are used.
Projected Impacts of Changes to Systems in This Planning Area	While the need of heating energy is decreasing, the cooling energy is increasing. The population and the number of automobile in the traffic will increase which cause more energy consumption.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The investment to renewable energy, especially to the wind is increasing. There are some alternative methods to produce energy. In the waste collection areas the methane is used to produce energy. For the public transportation buses natural gas is used for being more natural friendly than oil.
Barriers and Facilitators to Improving Resiliency	Energy supply is depended to other countries and fossil fuel is the main production source. There is no encouragement for the renewal energy by the government. Government do not give importance to energy investments. Wind energy has reached its limits that the energy production and distribution system could carry. Solar energy needs more improvements.
Adaptive Capacity of This Planning Area	Low

Table B.6: Adaptive capacity analysis of energy demand.

Current and Expected Stresses to Systems in This Planning Area	The rapid increase of the population would lead to the increase in energy demand. Studies about energy efficiency for dwellings are maintained. However, it has not carried into action effectively.
Projected Impacts of Changes to Systems in This Planning Area	While the demand for heating energy is decreasing, demand for the cooling energy is increasing. İncreasing energy demand would lead to an increase in cost which some groups cannot afford.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The increasing energy cost may not be problem for the high-medium income group. However, low income group may not afford the energy cost. Investments for the energy efficiency should be encouraged. In order to sustain efficiency for the dwellings isolation and central heating systems are used. However it is not enough.
Barriers and Facilitators to Improving Resiliency	Since building the energy efficient building or green building, smart building is costly, they are used only for luxury buildings. The regulation for the energy efficiency is not carried into action which underestimate the importance of the issue.
Adaptive Capacity of This Planning Area	Medium

Table B.7: Adaptive capacity analysis of public transit.

Current and Expected Stresses to Systems in This Planning Area	In Istanbul there are various mode of public transportation such as; metro, metrobus, dolmus, and ferry. Improvements of public transit are prior for the plans.
Projected Impacts of Changes to Systems in This Planning Area	The traffic jam may prolong the travel time. Public transportation may not support the demand of population. When extreme weather events occur, the trips may fail, some trips may cancel. Large population may create crowded in the public transportation station.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	Different transportation roads and alternatives of each of them prevent the failure of the system in the extreme weather days. It generates the solution. However the number of public transit vehicles and the frequency of run should be increased for a more comfortable trip. Sustainability in the transportation system is concerned by policy makers and strategies are developed such as; spreading rail system across the city and usage of natural gas for the buses
Barriers and Facilitators to Improving Resiliency	The transportation department is the biggest budget in the Municipality. Transportation master plan developed by Istanbul Metropolitan Municipality, focused on public transportation. New rail systems are under construction. In order to integrate different transportation modes, smart systems, transfer centers are developed.
Adaptive Capacity of This Planning Area	Medium

Table B.8: Adaptive capacity analysis of road and bridge maintenance.

Current and Expected Stresses to Systems in This Planning Area	Roads and bridges need constant maintenance because of weather events. Roads and bridges are maintained by the municipality regularly. Closing of some roads or icing may occur because of weather conditions.
Projected Impacts of Changes to Systems in This Planning Area	More extreme weather events leads to an increase in the need of maintenance on roads and bridges. More frequent disruptions on the roads may occur. The number of vehicle would increase because of population growth which creates more difficulties.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	New systems are developed to observe meteorological conditions and predict the possible effects. That system helps to be prepared for the problem before it occurs. Action teams are always ready for any problem. Also roads and bridges are regularly controlled.
Barriers and Facilitators to Improving Resiliency	Although the problem or disaster could be predicted before it happens, there is no emergency action plan. Interventions are formed instantly. Roads and bridges are controlled regularly and any hazard is repaired. Smart systems are used to warn citizens. The number of vehicle would increase because of population growth which creates more difficulties.
Adaptive Capacity of This Planning Area	High

Table B.9: Adaptive capacity analysis of sea transit.

Current and Expected Stresses to Systems in This Planning Area	Vertical transportation is sustained by various the companies between 2 sides of Istanbul. There are also horizontal transportation parallel to the cost line however it is limited. The Bosporus is also used for freight shipment.
Projected Impacts of Changes to Systems in This Planning Area	More cancellation of the trips may occur and cost would increase. The increase in the sea level would increase the distance which leads to increase in the cost of operation.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	There are limited actions to do because of the direct effect of the weather condition on the sector.
Barriers and Facilitators to Improving Resiliency	The ferries could be modified into smaller, faster and practical form to improve sea transport conditions however it is costly. Vertical transits are impossible on the bad weather conditions because of the shipment through the Bosporus.
Adaptive Capacity of This Planning Area	Low

Table B.10: Adaptive capacity analysis of crop diversity.

Current and Expected Stresses to Systems in This Planning Area	Crop diversity is affected by climate conditions, drought and fertility changes periodically.
Projected Impacts of Changes to Systems in This Planning Area	Some crop types cannot adapt to the new climate conditions. More drought resistant crops will be chosen to cultivate.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The action plan for drought has already prepared and crop diversity that is compatible with new climate condition is determined. Remote sensing systems, monitoring and modelling systems are used to predict the fertility and inform, oriented farmers about the issue.
Barriers and Facilitators to Improving Resiliency	Istanbul is not an agriculture city and agricultural lands are getting smaller. The measures are on strategic level not in action yet.
Adaptive Capacity of This Planning Area	Medium

Table B.11: Adaptive capacity analysis of agricultural land maintenance.

Current and Expected Stresses to Systems in This Planning Area	The urbanization creates pressure on agricultural land and they get smaller because of urban development. Pollution is a problem for the quality of the agricultural land. Drought periods create problem for irrigation and fertility of the soil.
Projected Impacts of Changes to Systems in This Planning Area	The quality of the soil will decrease, fertility of the agriculture will decrease. More pollution will be observed in the soil. Urban pressure will increase with the growth of population.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The regulation on maintenance of agricultural land is in process. The Agriculture Ministry has already prepared “Struggle Strategy and Action Plan for Agricultural Drought". Studies on educating farmers about the issue is conducted.
Barriers and Facilitators to Improving Resiliency	Pollution creates irreversible impacts on agricultural land. Urbanization threatens the agricultural land. Growing population will create more problem for the maintenance of the agricultural land.
Adaptive Capacity of This Planning Area	Medium

Table B.12: Adaptive capacity analysis of disaster response.

Current and Expected Stresses to Systems in This Planning Area	The disasters caused by the climate and weather events are not rare. The studies to predict the disaster before it happens are conducted. AKOM is the department that coordinates and stimulates the related departments when any disaster happens.
Projected Impacts of Changes to Systems in This Planning Area	More frequent and severe weather events would be more harmful and give serious damages to the city. The solution for the situation would be more difficult. Sustaining public safety in a short time would be a critical issue that difficult to handle.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	Serious deaths and loss would occur. The prediction system is an important tool to intervene before the disaster happens.
Barriers and Facilitators to Improving Resiliency	The intervention strategies and disaster prediction is prepared for today's climate conditions. There is no plan for future considering climate change. The studies conducting today may not be sufficient for the future.
Adaptive Capacity of This Planning Area	Medium

Table B.13: Adaptive capacity analysis of urban risk areas.

Current and Expected Stresses to Systems in This Planning Area	The urban risk areas are usually where illegal and unplanned settlements are located. Generally low income group lives in those areas. Any disaster may cause serious destruction.
Projected Impacts of Changes to Systems in This Planning Area	More frequent and severe weather events would cause deaths and losses. Flooding would cause more damage. The sufficient living condition could not sustained because of rising temperatures. That situation may cause health problems.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The urban renewal could be an advantage for controlling the development around risk areas and diminishing the risk. ISKI determines the flooding areas and plans the stream reclamation.
Barriers and Facilitators to Improving Resiliency	The expropriation is one of the important parts of reclamation plan. However the expropriation is costly. The sustainability of the urban renewal is possible because of the private companies investing on construction.
Adaptive Capacity of This Planning Area	Low

Table B.14: Adaptive capacity analysis of fire safety.

Current and Expected Stresses to Systems in This Planning Area	The fires caused by usage of coal diminished after the expanse of natural gas usage for heating. Forest fires are serious threat for the environment.
Projected Impacts of Changes to Systems in This Planning Area	Increase in the forest fire events in the summer period. Climate change will not have any effect on residential fires.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The fire department of the IMM is highly qualified. The technology is used to improve their intervention methods. The team can reach everywhere in Istanbul in 6 minutes. There are plans and sufficient equipment for any severe situations.
Barriers and Facilitators to Improving Resiliency	More fire department stations would be more effective and support faster intervention. However, finding an appropriate place to locate is a problem. The intervention techniques are improving continuously using latest technological advancement.
Adaptive Capacity of This Planning Area	High

Table B.15: Adaptive capacity analysis of affordable housing.

Current and Expected Stresses to Systems in This Planning Area	The demand for housing for the low income group is sustained by TOKI and housing department IMM. The produced houses are used for the discharge of risky areas where settlements are developed illegally. Although mass production of houses, it is not possible to transfer all the slums.
Projected Impacts of Changes to Systems in This Planning Area	More damage would occur because of severe weather events. The need for affordable house would increase. The increase in population would increase the demand for affordable housing. Affordable housing would have an important part in production of housing.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The mass production of houses by TOKI is quick. TOKI contributes to production of affordable housing very much.
Barriers and Facilitators to Improving Resiliency	It is not possible to use smart systems, energy efficiency systems for residential, green structure for the affordable housing since it is high costly. Here are many slums that settled on the risky areas. Therefore it is not possible to transfer all the slums to the affordable houses.
Adaptive Capacity of This Planning Area	Medium

Table B.16: Adaptive capacity analysis of urban renewal.

Current and Expected Stresses to Systems in This Planning Area	With the calamity regulation the urban renewal has gained speed in Istanbul. Over 2 million buildings, 25.000 buildings are under transformation.
Projected Impacts of Changes to Systems in This Planning Area	Unqualified buildings would be under more severe risk. The living standards would decrease because of the bad conditions. Unqualified houses would lead to more energy consumption.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The not endurable buildings to any disaster is determined and transformation starts quickly. There are legal encouragements for the renewal which spread the transformation all over the city.
Barriers and Facilitators to Improving Resiliency	The transformation does not consider the whole area, it just transforms the building that could be endurable for the disasters. It does not contribute to a better environment. The smart systems and energy efficiency systems are only used for luxury houses since it is costly. Also the decision is depend on the investor or builder. New problems may occur because of the more floor built and more density of population.
Adaptive Capacity of This Planning Area	High

Table B.17: Adaptive capacity analysis of urban planning.

Current and Expected Stresses to Systems in This Planning Area	The increasing population of the city will make the demand for housing and spatial development increased. The bureau of planning considers new development areas in more sustainable frame. Although it has not yet consider climate change as a priority concern subject, its development strategies contribute to the issue.
Projected Impacts of Changes to Systems in This Planning Area	The current climate effect will increase in the future. There will be longer and hotter summer, increased temperatures. Also flooding will be more frequent and intense. The city will need more climate change mitigation policies such as public transportation, smart growth, TOD, mixed used development, decentralization. Moreover, more open space, penetrable surfaces, shading and cooling trees in streets will be needed.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The master plan contributes to a sustainable development. Construction of new rail systems across the city, increasing the green areas, urban renewal are the projects the bureau has conducted. Old central and unplanned dense settlements pose the biggest problem which is tried to be solved by urban renewal.
Barriers and Facilitators to Improving Resiliency	The plan is proposed for a sustainable development however its implementation has some problems because of the value of the land. Climate change has not prior for the planning of Bureau. The necessary information and surveys about it do not exist.
Adaptive Capacity of This Planning Area	Medium

Table B.18: Adaptive capacity analysis of social facilities.

Current and Expected Stresses to Systems in This Planning Area	The old settlement areas are lack of social facilities in Istanbul. The amount of green areas per person is not enough, less than standards or proposed. However, newly developed areas are planned considering their social facility and green area needs.
Projected Impacts of Changes to Systems in This Planning Area	The lack of the urban facilities decreases the quality of environment and life. Adverse weather conditions multiplies the undesired effects. The increasing population would need more social facilities and it could be a problem to find adequate place to build.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	In the old and unplanned settlement areas it is difficult to solve the inadequate social facility problems. For the new development areas, plans consider the social facility necessity.
Barriers and Facilitators to Improving Resiliency	Although urban renewal could be used for creating new social facility areas, it is used for rebuilding of buildings which cannot change the settlement pattern and generate new open spaces. Expropriation by the local government could be a solution for those areas however it is costly.
Adaptive Capacity of This Planning Area	Low

Table B.19: Adaptive capacity analysis of waste collection and recycling.

Current and Expected Stresses to Systems in This Planning Area	Residential waste collection is done by district municipalities and waste are collected in the transfer stations. IMM transfers waste from stations to the storage yards. This system works efficiently.
Projected Impacts of Changes to Systems in This Planning Area	More disruption may occur while collecting waste because of bad weather conditions. The harmful leakage to the underground water or spread of waste to the environment around the yard may happen.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	There are improvements about collection and storage using the technology. The possible harm to the environment is tried to be prevented. In case of any harm, it is controlled regularly.
Barriers and Facilitators to Improving Resiliency	While choosing the location of storage yards, environmental aspects are taken into consideration not to harm environment. Infrastructure is designed to prevent any leakage and to collect the harmful methane gas. The technology enables to better protection of environment
Adaptive Capacity of This Planning Area	Medium

Table B.20: Adaptive capacity analysis of storm water management.

Current and Expected Stresses to Systems in This Planning Area	Storm water is collected in a separated system with water pipelines. 95 % of Istanbul has separated infrastructure system.
Projected Impacts of Changes to Systems in This Planning Area	More overflows would happen because of the heavy rains.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	Having separated infrastructure is an advantage but the size of the pipelines should have determined according to the future precipitation projections. The increasing amount of impenetrable surfaces prevents the surface to absorb the water.
Barriers and Facilitators to Improving Resiliency	The size of the water pipelines is not adequate for the heavy rain. Flood events occur more frequently although the separated infrastructure. The size of the pipelines could be larger and it could be cleaned regularly but, it is costly. The storm water collected with water pipes is discharged to the stream which cause flood event around the stream basin. Illegal settlements are under risk of flooding. The reuse of the storm water is possible but costly.
Adaptive Capacity of This Planning Area	Medium

Table B.21: Adaptive capacity analysis of sewage system.

Current and Expected Stresses to Systems in This Planning Area	The waste water is collected and treated by ISKI. The waste water is directly discharged to the sea or streams in some districts of Istanbul. In order to prevent this new waste water treatment plants are constructed.
Projected Impacts of Changes to Systems in This Planning Area	The growing population is the problem for infrastructure. İncreasing densities cause the problem of insufficient sewage system.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The size of the pipelines are determined considering maximum standards that needed for the certain population. There are investments for new waste water treatment plants.
Barriers and Facilitators to Improving Resiliency	The population grows rapidly in Istanbul. Existing infrastructure would not be sufficient for more density and more population. The sewage system should be changed according to population growth regularly which is costly.
Adaptive Capacity of This Planning Area	Medium

Table B.22: Adaptive capacity analysis of urban forest management.

Current and Expected Stresses to Systems in This Planning Area	The urban forests around or in the city are generally natural protection areas. Forest areas are getting smaller because of the urban development.
Projected Impacts of Changes to Systems in This Planning Area	Urban forests are lost because of urban development. The stress on the forests would increase because of the adverse effects of climate.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	The natural protection area border determines the development conditions in that area according to its protection level. However the protection levels are questionable and changeable. Afforestation is implemented in some regions.
Barriers and Facilitators to Improving Resiliency	The weaken stability of trees because of weather events are under risk of urban development. There is no strategy to strengthen the trees. The afforestation areas are away from existing forest areas and they are not efficiently organized.
Adaptive Capacity of This Planning Area	Low

Table B.23: Adaptive capacity analysis of green spaces.

Current and Expected Stresses to Systems in This Planning Area	The design and forestation of green areas within city are in the charge of IMM. The natural plants which could live in Istanbul's climate are chosen for the green areas.
Projected Impacts of Changes to Systems in This Planning Area	The more storm and flooding damage would have a negative effect on IMM budget. The habits of citizen use would change. Drought would create problems for irrigation and maintenance of the plants.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	IMM works regularly on determination of sick, deteriorated trees. The equipment and the personal is ready for any adverse event about green areas.
Barriers and Facilitators to Improving Resiliency	All the precautions are for today's conditions. There is no preparation or strategies for future climate. However, slow climate change can be manageable.
Adaptive Capacity of This Planning Area	Medium

Table B.24: Adaptive capacity analysis of biodiversity.

Current and Expected Stresses to Systems in This Planning Area	Istanbul has rich biodiversity in its ecosystem. Biodiversity is threaten by urbanization, hunting, over consumption of resources, pollution.
Projected Impacts of Changes to Systems in This Planning Area	Since ecosystems are fragile, any change in climate condition will negatively affect the biodiversity. Decrease in biodiversity and extinction of some species may happen.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	In Istanbul Environmental Plan, ecology and biodiversity are taken into consideration, the important ecological lands are determined and protection for those areas is suggested.
Barriers and Facilitators to Improving Resiliency	Ecologically important habitats are already under pressure of urbanization. The resources are over consumed and those areas cannot be properly protected from external impacts. There is no study about biodiversity, endangered species and protection strategies.
Adaptive Capacity of This Planning Area	Low

Table B.25: Adaptive capacity analysis of cultural and historical heritage.

Current and Expected Stresses to Systems in This Planning Area	The historical buildings are directly affected by climate. Also there are many important historical structures, palaces on the cost which is under the threat of sea level rise.
Projected Impacts of Changes to Systems in This Planning Area	More cracks on the buildings walls and more destruction would happen because of weather conditions. Some important structures, palaces are under risk of sea level rise and flooding.
Ability of the Systems in This Planning Area to Accommodate Projected Impacts with Minimum Disruption or Cost	There are 20.000 historical structure that is under protection in Istanbul Fatih district. The municipality, foundation, ministry or the citizens have the ownership of those structures. The public institutions work regularly for restoration of important buildings and maintenance of structures.
Barriers and Facilitators to Improving Resiliency	The historical buildings that in the private ownerships cannot be protected by local government and there is limited thing to do. There is no encouragement to protect buildings in private ownership. There are too many buildings to be protected so the budget may not be sufficient.
Adaptive Capacity of This Planning Area	Medium

APPENDIX C : A copy of the semi-structured questionnaire

GENEL BİLGİLER/*GENARAL INFORMATION*
KURUM/*INSTITUTION*:

DAİRE/*DEPARTMENT*:

AD - SOYAD/*NAME-SURNAME*:

ÜNVAN/*TITLE*:

İLGİLİ SEKTÖR/*RELATED SECTOR*:

a) SAĞLIK (Hava Kalitesi, Sıcaklık)

HEALTH (Air Quality, Heat)

b) SU KAYNAKLARI (Su Kalitesi, Su Kaynağı)

WATER RESOURCES (Water Quality, Water Supply)

c) ENERJİ (Enerji Üretimi, Enerji Talebi)

ENERGY (Energy Production, Energy Demand)

d) ULAŞIM (Toplu Taşıma, Yol ve Köprülerin Bakımı, Deniz Ulaşımı)

TRANSPORTATION (Public Transit, Road and Bridge Maintenance, Sea Transit)

e)TARIM (Mahsül Çeşitliliği, Tarımsal Arazilerin Bakımı ve Korunması)

AGRICULTURE (Crop Diversity, Agricultural Land Maintenance)

f) HALK/KAMU GÜVENLİĞİ (Afet Müdahale, Kentsel Risk Alanları, Yangın Güvenliği)

PUBLIC SAFETY (Disaster Response, Urban Risk Areas, Fire Safety)

g)ARAZİ KULLANIMI VE GELİŞİMİ (Uygun Fiyatlı Konut, Kentsel Yenileme/Dönüşüm, Kentsel Planlama, Sosyal Altyapı)

LAND USE AND DEVELOPMENT (Affordable Housing, Urban Renewal, Urban Planning, Social Facilities)

h) ATIK MADDELER (Atık Toplama, Geri Dönüşüm)

MATERIALS (Waste Collection & Recycling)

i) ALTYAPI (Yağmur Suyu Yönetimi, Kanalizasyon Sistemi)

INFRASTRUCTURE (Storm Water Management, Sewage System)

j) EKOLOJİ VE BİYOLOJİK ÇEŞİTLİLİK (Kent Ormanları Yönetimi, Yeşil alanlar, Biyolojik Çeşitlilik)

ECOLOGY & BIODIVERSITY (Urban Forest Management, Green Spaces, Biodiversity

k) KÜLTÜR (Tarihi ve Kültürel Miras)

CULTURE (Cultural & Historical Heritage)

İKLİM DEĞİŞİKLİĞİ VE SİSTEMİN HASSASİYETİ/*CLIMATE CHANGE AND SYSTEM SENSITIVITY*

1) Bu sektördeki sistemlerin bugün karşılaştığı iklim kaynaklı sorunlar/stresler nelerdir?

What are the climate based stresses the systems in that sector currently confrontes?

2) Var olan iklim koşulları bu sektördeki sistemleri nasıl etkilemektedir?

How the current climate conditions affect the systems in that sector?

3) İklim koşullarının gelecekte nasıl değişmesi öngörülmektedir?

How the climate conditions are projected to change?

4) Bu sektördeki sistemlerin gelecekte karşılaşacağı öngörülen iklim kaynaklı sorunlar/stresler nelerdir?

What are the expected climate based future stresses the system will confront?

5) Sistemin doğal veya yapılaşmış elemanlarının iklim değişikliklerine karşı hassasiyeti ne ölçüdedir?

How is the sensitivity of the system's natural or structural components to climate change?

6) İklim değişikliğinin sistemdeki doğal ve yapılaşmış elemanları nasıl etkilemesi beklenmektedir? Beklenen etkiler arasında en çok önem arz eden hangisidir, neden?

How is the climate change expected to affect the system's natural and structural components? Which one of the expected impacts is the most important, why?

7) Sistem bu haliyle iklim değişikliğine hazır mıdır?

Is the system's current situation ready for the climate change?

İKLİM DEĞİŞİKLİĞİ VE ADAPTASYON/*CLIMATE CHANGE AND ADAPTATION*

8) Varolan planlar, politikalar, düzenlemeler iklim değişikliği etkilerini ne ölçüde dikkate almaktadır? Lütfen örneklerle açıklayınız.

To what extend do the current plans, policies or regulations consider the climate change impacts? Explain with examples.

9) Var olan planlar, politikalar, düzenlemeler iklim etkileriyle mücadele konusunda ne kadar yeterlidir? (iyi, orta, kötü) Birden fazla plan, politika veya düzenleme varsa lütfen her biri için cevaplayınız.

To what extend are the current plans, policies or regulations sufficient for climate change impacts? (good, medium, bad) If more than one, explain for each.

10) İklim değişikliği etkileriyle mücadele edebilmek için ne gibi ek müdahaleler, politikalar veya düzenlemelere ihtiyaç vardır?

In order to struggle with climate change impacts what kind of additional interventions, policies or regulations are needed?

11) Bu sektördeki sistemler için iklim değişikliğinin etkilerini hedef gösteren çalışmalara başlandı mı?

Do the studies addressing climate change impacts start for the systems in that sector?

12) Sistemin iklim değişikliğine adapte olabilmesi ve iklim değişikliğinin etkilerinin üstesinden gelebilmesi açısından önünde herhangi bir bariyer var mıdır?

Is there any barrier to the adaptationto climate change or struggle with it for the sector?

13) Sistemin iklim değişikliğine adapte olabilmesi ve iklim değişikliğinin etkilerinin üstesinden gelebilmesi açısından avantajları nelerdir?

What are the opportunities of the sector to adaptation to climate change and struggle with it?

14) Diğer sektörlerde gerçekleştirilen iklim değişikliği adaptasyon çalışmaları sizin kaynaklarınızı ve çalışmalarınızı ne ölçüde etkilemektedir?

To what extend do the studies on other sectors about climate change adaptation affect your studies and sources?

İKLİM DEĞİŞİKLİĞİ VE RİSK/*CLIMATE CHANGE AND RISK*

15) Sektörün karşılaştığı iklim kaynaklı riskler nelerdir?

What are the climate based risks the sector confronts?

16) Beklenen risklerin sonuçları sistemi nasıl etkileyebilmektedir?

How the consequences of the expected risks affect the system?

17) Bu risklerin gerçekleşme olasılıkları nelerdir?

What is the probability of occurance of those risks?

18) Riskler halk için hayati tehlike oluşturuyor mu?

Is there any life-threatening situation for the citizens?

19) Riskler ekolojik dengeyi tehdit ediyor mu?

Is there any threat for the ecological balance?

20) Riskler kültürel açıdan bir tehdit oluşturuyor mu?

Is there any threat for the culture?

21) Riskleri önlemek için yapılacak olan müdahalaler ne kadar maliyetlidir?

How costly are the actions to prevent the risks?

22) Meydana gelen bir afetten sonra sistemin onarılması ne kadar maliyetlidir?

How costly is the recovery after any disaster happen?

APPENDIX D: List of Interviews

1. Cihat Özdemir IBB Planlama Müdürlüğü (28.04.2014)
2. Selçuk Alkan IBB Planlama Müdürlüğü (28.04.2014)
3. Andaç Erdem Çakır IBB Kentsel Dönüşüm Müdürlüğü (05.05.2014)
4. Mehmet Öç TOKI (08.05.2014)
5. Hakan Ilçın TOKI (08.05.2014)
6. Rasim Bulut IBB Mesken Müdürlüğü (12.05.2014)
7. Berna Çalışkan IBB Ulaşım Planlama Müdürlüğü (20.05.2014)
8. Halime Tekin IBB Ulaşım Koordinasyon (20.05.2014)
9. Nesim Karaca IBB Ulaşım Koordinasyon (20.05.2014)
10. Zeynep Çakır IBB Ulaşım Koordinasyon (20.05.2014)
11. Kürşat Sensoy IBB Trafik Müdürlüğü (20.05.2014)
12. Ali Ünal IBB Trafik Müdürlüğü (20.05.2014)
13. Abdulkadir Akpınar IBB Strateji Geliştirme Müdürlüğü (20.05.2014)
14. Hasan Yalçın Çamcı IBB Strateji Geliştirme Müdürlüğü (20.05.2014)
15. Ahmet Köse AKOM (21.05.2014)
16. Hamdi Çinal AKOM (21.05.2014)
17. Tunay Çarpar ISKI (21.05.2014)
18. Burcu Saraç ISKI (21.05.2014)
19. Burçin Kapucu ISKI (21.05.2014)
20. Nizamettin Mangir IBB Çevre Koruma Müdürlüğü (23.05.2014)
21. Mikdat Kadıoğlu ITU Meteoroloji Mühendisliği (23.05.2014)
22. Yasemin Bayer IBB Atik Yönetim Müdürlüğü (26.05.2014)
23. Sibel Gültekin IBB Atik Yönetim Müdürlüğü (26.05.2014)
24. Volkan Erç ISTAC (26.05.2014)
25. Zekai Sen ITU, İnşaat Fakültesi (26.05.2014)
26. Murat Çetin IBB Avrupa Yakası Yol Bakim Onarım Müdürlüğü (27.05.2014)
27. Ali Can Ari IBB Avrupa Yakası Yol Bakim Onarım Müdürlüğü (27.05.2014)
28. Ali Çağlar Aydin IBB Avrupa Yakası Yol Bakim Onarım Müdürlüğü (27.05.2014)
29. Musa Yazıcı IBB Toplu Ulaşım Hizmetleri Müdürlüğü (27.05.2014)
30. Münir Küçük Deniz Ulaşım (27.05.2014)
31. İrfan Onat IBB Park ve Bahçeler Müdürlüğü (27.05.2014)

32. Nilgün Özdingiş Tarakçı IBB Park ve Bahçeler Müdürlüğü (27.05.2014)
33. Mustafa Torun IBB Yeşil Alanlar Müdürlüğü (27.05.2014)
34. Mesut Tandoğan Orman Bölge Müdürlüğü (28.05.2014)
35. Ercan Özyürek Orman Bölge Müdürlüğü (28.05.2014)
36. Mustafa Özsert IBB İtfaiye Daire Başkanlığı (28.05.2014)
37. Sezgin Yazıcı İstanbul Enerji AS (28.05.2014)
38. Turgay Aygun ISTAC (28.05.2014)
39. Hüseyin Sen Çevre ve Şehircilik İl Müdürlüğü, Tabiat Varlıkları (29.05.2014)
40. Hilal Yaman Çevre ve Şehircilik İl Müdürlüğü, Çevre Yönetimi (29.05.2014)
41. Funda Ercan Çevre ve Şehircilik İl Müdürlüğü, Çevre Yönetimi (29.05.2014)
42. Mehmet Ali Çubukçuoğlu Milli Saraylar ve Vakıflar Müdürlüğü (29.05.2014)
43. Tülin Özcan IBB Tarihi Çevre Koruma Müdürlüğü (29.05.2014)
44. Ahmet Hamdi Bülbül Kültür Turizm Bakanlığı İstanbul 4 Numaralı Kültür ve Tabiat Varlıklarını Koruma Bölge Kurulu Müdürlüğü (29.05.2014)
45. İbrahim Keskin Atik Yönetim Müdürlüğü (02.06.2014)
46. Yurdanur Ünal ITU Avrasya Bilimleri (02.06.2014)
47. Levent Saylan ITU Meteoroloji Mühendisliği (02.06.2014)
48. Hakan Eminoglu DSI Bölge Müdürlüğü (03.06.2014)
49. Nadir Simsek İl Gıda Tarım ve Hayvancılık Müdürlüğü (03.06.2014)
50. Fahrettin Doğan İl Gıda Tarım ve Hayvancılık Müdürlüğü (03.06.2014)
51. İrem Yılmaz ITO (05.11.2014)
52. Metin Varlıbaş Varyap Yönetim Kurulu Üyesi (27.11.2014)
53. Çare Olgun Çalışkan SPO İstanbul şubesi yönetim kurulu üyesi/Kuzey ormanları savunması (05.12.14)
54. Önder Karaduman Enerji Üreticileri Derneği (29.12.2014)

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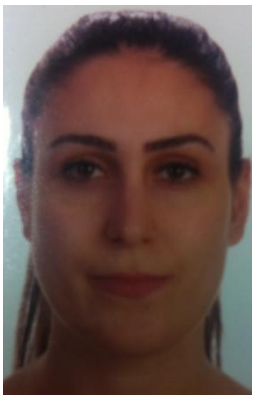

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