24th AESOP Annual Conference, Finland, 7–10 July 2010
Track 13: Resource Management, Energy and Planning
Special session on "Sustainable urban land-use policies for resilient cities"

"Resilience Thinking" for urban analysis and planning: An exploratory research on Istanbul

AYDA ERAYDIN[1]

Abstract

This paper attempts to decipher the concept of resilience in urban analysis and planning, first by working on the terms used in order to explain "resilience", second to define a framework that defines the basic principles of building resilience cities and third to discuss these principles in the Istanbul context in order to investigate the critical issues for planning this city region, which became increasingly vulnerable in recent years.

In order to reach this aim the paper proposes a framework to understand and analyze the changes and processes with the use of attributes of resilience under the headings below; disturbances, vulnerability of the urban ecosystems, adaptive capacities and outcomes of disturbances on urban sub-systems as self-organization, adaptation or transformation.

Using the exploratory questions and indicators that define the adaptive capacity, the research on Istanbul has been designed to identify the critical issues in urban analysis and planning principles to be followed in Istanbul under the resilience perspective. The paper presents the findings and discusses how general principles as well as principles based on local issues and priorities can be defined in planning practice.

[1] Middle East Technical University Department of City and Regional Planning 06531 Ankara Turkey

I. Introduction

Recently the question "how might urban systems accommodate future "shocks," "crises," "disasters," and "emergencies" in whatever (un)expected forms they might take?" became very crucial, due to increasing vulnerability of urban systems following repeated global economic crises as well as expected global ecological problems and catastrophes.

This question raises the need for "resilience thinking" in planning, which is rather underestimated in the planning literature up to the recent years, since the recent attempts on planning theory have concentrated on more on processes and methods, but less on principles. The increasing importance of resilience is due to first increasing interconnections between different places as the outcome of globalization and deregulation, which enables the diffusion of economic forces immediately to different spatial units and making them prone to large-scale shocks. Secondly, increasing use of natural resources and their negative outcomes are becoming major global threats such as climate change. Third, the urban areas becoming are precarious, since sprawling natural/ecological and human/social systems grow intricately intertwined. This trend requires a resilient system that is able to absorb unforeseen shocks, continually adapting and evolving so as to resist collapse, by providing a framework to define the interplay between deterministic forces and random events, structural factors and human agency, linear paths and contingency (Critical Planning Journal, 2009).

Resilience thinking necessitates adaptive capacity that aim explicitly equipping urban systems to deal effectively with change, surprises and risks. As Baud and Hordijk (2009) state its application so far has been limited to the field of disaster management, but can be the core of a new paradigm for planning practices. The difficulty is the adaptive capacity should cover responses to multidimensional issues that vary from ongoing environmental /ecological concerns, the changing urban built environment, movements of people, evolving socioeconomic regimes and the interplay of political ideologies and collective imaginaries. The wide variety of issues makes to settle planning principles planning practice quite complicated. The existing urban resilience literature, unfortunately concentrates on one dimension of change by ignoring the others. However, there are increasing numbers of studies in this field, which try to add other dimensions and to adapt the concept derived from ecology to urban analysis and planning. The composition and context of projects of URBAN-NET program of EU (URBAN-NET, 2009) are good indicators of this attempts, which try to depict the different aspects of resilience of urban systems.

This paper attempts to decipher the concept of resilience with respect to urban analysis and planning, first by working on the terms used in order to explain "resilience", second to define a framework that explores the basic principles of building resilience cities and third to discuss them in the Istanbul context. The main objective is to investigate the critical issues for enhancing the resilience of this city region, which became increasingly vulnerable in recent years. This is, however, an exploratory essay, which aims to show how starting points, core issues and priorities can change in urban analysis and planning if the resilience thinking is adopted.

II. The concept of resilience and its main attributes

A resilient system is defined by its two main features: ability to absorb change and disturbance together with the persistence of systems while retaining its basic function and structure (Walker and Salt, 2006). According to Adger (2000: 349) resilience is the buffer capacity or the ability of a system to absorb perturbations, or the magnitude of disturbance that can be absorbed before a system transforming its structure by changing the variables and processes that control behaviour. In many studies, resilience is used as a loose antonym of vulnerability. When a social or ecological system looses its resilience, they become vulnerable to change that previously could be absorbed. Therefore, most of the discussions on resilience are focused on and agree upon the importance of change/disturbance that can makes the system to loose its resilience (Ludwig, Walker and Holling, 1997) and the different phases of adaptation to disturbances as defined in the "adaptive cycle theory"[1] (Holling, 2001).

Some authors add the ability to anticipate their occurrence within the definition of resilience. For instance, Aguirre (2006) includes the 'ability to anticipate crises and to enact, through planning and recovery, changes in the system that will mitigate their effects. Similarly, Baud and Hordijk (2009: 5) state that it incorporates not only the ability to respond, but also the preventive measures, which can be incorporated at different scale levels into local urban planning, management, design and community inclusion processes.

Therefore, the concept of resilience shifts policies from those that aspire to control change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to, and shape change. Folke on behalf of The Environmental Advisory Council to the Swedish Government (2002) claims that in a resilient system change has the potential to create

opportunity for development, novelty and innovation. Managing for resilience enhances the likelihood of sustaining development in changing environments where the future is unpredictable and surprise is likely. These discussions obviously facilitate the use of the concept of resilience as a new focal point in the planning literature.

III. Planning for resilience: Sustaining development in changing environments where the future is unpredictable and surprise is likely

The urban resilience approach assumes *cities as complex adaptive social-ecological systems.* Developing ways of assessing urban vulnerability and adaptation capacity of urban systems under the disturbance and identifying principles and opportunities for building resilience in urban systems are the keys for a new planning paradigm. "Urban Resilience" Research Prospectus (2007) claims that "the attributes – of *self-organisation*, of *adaptation* and *demise*, and of dynamics playing out on *multiple spatial and temporal scales* – lead us to conclude that studies of sustainable urbanisation can get benefit from the employment of a resilience approach.

The Prospectus suggests that in order to understand the resilience of urban systems which recognizes the role of *metabolic flows* in sustaining urban functions, human well-being and quality of life; *governance networks* and the ability of society to learn, adapt and reorganize to meet urban challenges; and the *social dynamics* of people as citizens, members of communities, and their relationship with the *built environment* which defines the physical patterns of urban form and their spatial relations and interconnections are important. This report and several studies on resilience (Adger, 2000; Berkes and Folke, 1998; Folke and Carpenter, 2000; Abel, Cummings, Anderies, 2006) use concept of resilience not only in ecological sense. They introduce the terms of economic and social resilience, since economic, social and ecological systems are themselves linked with synergistic and co-evolutionary relationships.

These issues and principles covered under the four headings are not new. What is new about them is how they should be investigated; their contribution is on the analysis of changes. Abel, Cummings, Anderies (2006) propose to understand and analyze the changes and processes, there is need to define of attributes of resilience by defining disturbances/threats and the nature of the urban system. Within this framework, it is necessary to describe how far the urban system is

vulnerable and whether urban the system has adaptive capacity. This framework provides clues to find out how disturbances modify the urban system and to develop scenarios in order to estimate the impacts of disturbance on the urban system.

This above framework necessitates clarifying the several notions beginning from the definition of disturbance. Resilience is defined with reference to a disturbance, which takes place either suddenly or in relatively short periods. However, cities could be subject to effects, which span over some period of time and cause problems in the efficiency of functioning of activities that are located in these cities. The resilience concept defines how well the system that is subject to the disturbance recovers from the disturbances. Cities that have the capacity to overcome negative effects of disturbances, either through the market mechanism or by implementing certain policies and plans, as it is emphasised in this paper.

The threads/disturbances have certain affects on the urban areas, which can be studied at the sub-systems levels. The impact of the disturbances is related to the vulnerability of a system. The term vulnerability refers to the propensity of social and ecological system to suffer harm from exposure to external stresses and shocks (Dalziell, and McManus, 2004; Folke and Carpenter, 2000). Research on vulnerability can; for example, assess how the disturbances will affect people and ecosystems and how sensitive they will be to such changes.

The concept of the adaptive capacity of the social and ecological systems, consists the core of the debates on resilience, and especially important in planning decisions. Adaptive capacity is defined as the capacity to adapt to and shape change and as a vector of resources and assets, which enable urban systems to adapt to changing conditions. Enhancement of adaptive capacity is a necessary condition to reduce vulnerability, particularly for the most vulnerable regions, nations or socio-economic groups. Enhancement of adaptive capacity presents a practical way of coping with changes and uncertainties and necessitates both availability of and entitlement to resources are (Folke and Carpenter, 2000; Vincent, 2007).

The adaptive capacity enables the chance of self-organisation, which is a process of attraction and repulsion in which the internal organization of a system without being guided or managed by an outside source (Heylighen, 2002; Holling, 1992). Self-organisation of ecological systems establishes the arena for evolutionary change. However, the self-organisation is not always possible and the systems had to be changed thoroughly. Transformation, in such cases is

inevitable, which is defined as the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable (Walker, Holling, Carpenter and Kinzig, 2004). Planning may play a vital role within this process. Obviously, if the things change very rapidly the system may collapse which necessitates to a new regime characterized by changes in scale, state variables, and feedbacks.

Following the arguments above the role planning in this way of resilience thinking can be focused on identifying disturbances and the possible vulnerabilities in the urban systems, defining the adaptive capacity of the urban system and whether the impacts lead to self-organisation, transformation or insufficient to sustain the existing conditions and quality. We argue that pinpointing the critical issues for enhancement of adaptive capacity and if the adaptive capacity is limited, indicating the necessary transformation in order to prevent the collapse of the system should be the major concerns of contemporary resilience based planning.

IV. The exploratory research on Istanbul

In this paper, I try to introduce the framework, which aims to focus on enhancement of adaptive capacity and building a resilient metropolitan region. The paper presents the preliminary findings of the study that followed the framework above. The main aim is to discuss the way to introduce resilience thinking and to define the critical points, which the planning process should focus on in order to support the resilience of the Istanbul Metropolitan Region. This type of approach is very crucial to analyze Istanbul, which is one of the largest urban concentrations exposed to different pressures and disturbances. This huge metropolitan area with more than 12,573 million populations in year 2007, covering 540 thousand hectares has become the playfield of different pressures, which has negatively affected its resilience. The recent planning attempts showed the necessity for a new approach for planning of this very complex urban system, which is open to external demands and pressures, since not only its ecological systems, but also economic and social systems have become increasingly vulnerable

4.1 Methodology

The aims of the research presented in this paper can be defined under four headings: to define the major threads that induce ecological, economic and social change, to evaluate how far the system

is vulnerable with the help of indicators of resilience, to discuss adaptive capacity of the urban system and to pinpoint critical issues of planning and policy instruments in enhancement of the resilience of Istanbul metropolitan area. The research is designed in three stages:

Stage 1 consists of the review of recent studies on Istanbul, including planning and other published documents, reports and newspapers in order to frame the study and to define the lists of threads and disturbances. In Stage 2 of the research, the discussions on the major problems of the metropolitan regions are carried out with the local authorities, especially members of the Planning Bureau of Greater City Municipality in order to identify the urban subsystems that necessitate a special focus. After collecting background knowledge, the issues that are important in defining the resilience of the metropolitan region are used to frame Stage 3.

Stage 3 is composed of 5 steps to analyze the resilience of the metropolitan region. The steps followed in the analyses and the context of these steps is as follows (see Table 1). First, the major disturbances/threats are identified for Istanbul Metropolitan Region; changes in population and the demand for urban land strongly affected by the changes in the global markets, besides the increasing ecological risks accelerated by the rapid expansion of this metropolitan region. Second, the main territorial issues at stake are listed. The urban sub- systems where the exogenous impacts are important are identified using the information collected by earlier studies and meetings organised by the different stakeholders. The subsystems and issues that necessitate further attention are defined as; freshwater ecosystem, forests, agro-ecosystem, areas with natural hazard risks, ecologically sensitive areas and air quality. Third, the impacts of disturbances on urban sub- systems are designated with the help of indicators (see Table 1). Fourth, the adaptive capacity of the system is evaluated with the help of four attributes of resilience: adaptability, flexibility, recovery and transformability. Fifth, critical appraisal of the adaptive capacity and setting the critical issues for planning is the last step that provides the main inputs for the planning.

4.2 Disturbances/threats

The existing documents and discussions at the meetings organised together with the different stakeholders indicated the volatile demand on urban space due to increasing attractivity of Istanbul for domestic and foreign migrants and for global activities became major disturbances together with newly emerging several ecological problems. While the economic changes and repeated crisis made

the system more vulnerable, the risks of disasters have been accelerated due to increasing residential and other activities on areas with risks of ecological hazards.

Population growth is the source of major threads in Istanbul that decreases the resilience of this rapidly expanding urban system. The high rates of population increase, without any doubt, led to pressures on urban ecological systems as well as social economic systems on Istanbul metropolitan region. Increasing population means increasing urban land demand, increasing use of energy, ecological services and resources as well as increasing pollution, which intensified the pressure on ecological systems. It has also important impacts on socio-economic structure due to increase in job opportunities in services, etc.(see Table 1).

In Istanbul, the high rates of population increase have been one of the major problems of this city for a long period. It has become a major thread for the ecological resilience of the city in recent decades. The population of Istanbul that was 4.7 million in 1980 has reached 12.7 million in year 2008. From 1980 to 1990 period, the increasing population was 2.5 million, which was followed by 2.8 million population increase between 1990 and 2000. In the last 9 years, on the other hand, 2.7 million people were added to Istanbul. These figures indicate that in the last thirty years, in each decade Istanbul grew more than 2.5 millions, most of which is due to domestic and international migration. The increasing numbers of people living in Istanbul means increasing demand for ecological and other types of services, which is difficult to be supplied both in terms of quantity and quality. While the immigrants expected to find better employment opportunities in Istanbul, obviously in the periods of crisis having a job became quite difficult. Increasing unemployment and decreasing income levels have been the source of socio-economic problems but also they have strong repercussions on built environment.

Changes in the economic structure

Since the 1980s onwards, major metropolitan areas in the world experienced the important restructuring in their economies in order to adapt and compete in the newly emerging conditions and risks in the global economy. While the deregulation with respect to the flow of goods, capital and people decreases the level of protection of local economies to external affects, volatility of the global economy intensified the vulnerability of them. In order to define how well the local economy adapts to conditions imposed by the external and internal conditions, two indicators are

identified; the change in income per capita levels and the change in the in the composition of working population.

Istanbul has experienced considerable rates of economic growth and has been successful in creating new employment opportunities. In fact, from 1980 to 2000 more 1 million 900 thousand new jobs were created in Istanbul Metropolitan Area. The number of jobs in the scientific and technical sectors increased substantially. In 1980, only 8 percent of the country's working population were employed in technical and scientific jobs, but this figure reached 11.3 percent in 2000. People with scientific and technical backgrounds, besides those working in the banking and insurance sector, constituted the most attractive target for companies engaged in global economic activities. The figures on the changing composition of workforce (Table 2) show that in the recent twenty years or more, finance and banking sector including insurance activities experienced a substantial rise. The share of finance and banking in the total working population has increased from 6,4 per cent in 1980 up to 8.2 per cent in 2000 in Istanbul, which means more than 200 thousand additional jobs have been created in these activities. There is also increase in the other types of services, such as public services, transportation communication and infrastructure services; the figures in year 2000 is more than the double in almost all of these service activities.

Table 2: The composition of workforce 1980 to 2000

	Manufacturing	Infrastructure services	Construction	Trade	Transport & communication	Finance & banking	Public services	Others	Total
1980	526490	6177	111690	279699	104929	82715	333587	416302	1.563.939
	34,28	0,21	6,56	18,47	6,52	6,44	20,51	26,95	100
1990	834888	10728	224126	486177	167467	179558	456245	635803	2.539.963
	32,87	0,43	8,83	19,14	6,6	7,07	17,96	25,03	100
2000	1097051	14968	215925	650295	221298	283404	696033	979437	3.471.400
	31,6	0,43	6,22	18,73	6,38	8,16	20,05	28,21	100

While the share of different types od services rose substantially, the share of manufacturing employees in total declined between 1980 to 2000. However, still the share of manufacturing employment constitutes 31,6 per cent of the total population. The rapid population growth had a very significant impact on shaping the economic structure especially the manufacturing employment. The increasing numbers of migrants, mostly unskilled, helped to keep wage levels low, enabling Istanbul to sustain its competitive advantage in some of the traditional mature industries. Although there were attempts to increase the competitiveness of Istanbul in certain

knowledge-based production sectors, sustained competitiveness in the traditional sectors became a negative motivation for industrial growth in high tech capital intensive production sectors.

In fact, the increasing jobs opportunities and integration into the global markets did not improve the welfare of the people living in Istanbul relative to the rest of the country, since the relative income increase per capita stayed below than the national average while the cost of living rose more than in other cities of Turkey (Eraydin, 2006). The ratio of income per capita of Istanbul to the national average fell from 1.74 in 1987 to 1.43 in 2001, indicating a slow growth of average income per capita due to the high rates of migration from different regions, as well as from abroad.

As explained in the above paragraphs although the growth of income per capita is not very high due to massive migration, the increasing numbers of different kinds of activities and the population created a huge demand for urban land. **Increasing demand for urban land for global functions** is the main of pressure that has been affecting economic and socio-spatial restructuring of this huge metropolitan area. Recently, there has been substantial increase in the importance of the global enterprises in Istanbul, since it became an important international node (Beaverstock, et al., 1999 and 2000; Taylor and Walker, 2001; Taylor, 2001 and 2003). These new functions reflected in the increasing role of financial services in the Istanbul economy besides other producer services.

The number of people work for foreign capital firms increased substantially in the last two decades. The findings of a sample survey[2] of 405 foreign capital firms in different production and service activities in year 2005 indicated that the large Turkish market has been important in their location decisions, although 30 percent of them defined their markets as European countries, 20 percent Middle East and less than 10 percent Eastern Europe and Central Asia. These findings indicate that the attractivity of Istanbul is due to not only its large domestic market but also other factors that make Istanbul competitive among the other major cities in the region (Eraydin, et al., 2009a).

Urban sprawl increasing risks of ecological hazards

The impact of population growth and the global functions led the transformation of the socio-spatial organisation of Istanbul, which can be defined with two countervailing trends; *"urban sprawl together with increasing densities in the urban core"*. The increasing population as well

as increasing production and global service activities obviously created new demand for land both for the urban land in the core of the city as well as in the periphery of the existing built up areas. The shortage of developable land under the conditions of rapid population growth led to the rise in land and building prices. This situation created favourable conditions to carry out renewal, regeneration and transformation projects, as well as new housing and industrial estates, at the outskirts of the built up areas. The urban sprawl and the increasing projects far from the core of the metropolitan area has become one of the major trends of spatial development in Istanbul.

While the population living in already built up areas within Istanbul Greatercity Municipality (former boundaries-before 2004 enlargement), rose from 6753929 in 1990 to 9085599 in 2000 and 11174257 in 2007, the population in the smaller settlements around the built up core rose from 268271 in 1990 to 747182 in 2000 (Figure 1). More important than this trend the smaller settlements (less than 5000 population) attracted immigrants, especially the ones nearby the southern and northern coasts in the European part and nearby Bosphorous in the Anatolian side (Figure 2). Their total population rose from 286690 to 652397 in 2000. The expansion of the small settlements located in the forests, which became attractive for residential and other purposes have become a major threat to water resources and forests.

Figure 1: Population change in the settlements nearby the IMA

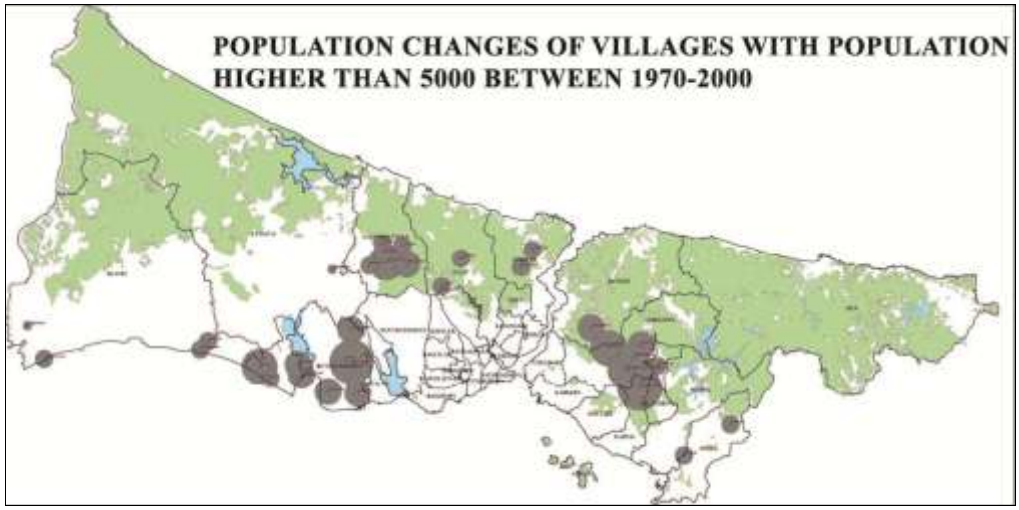
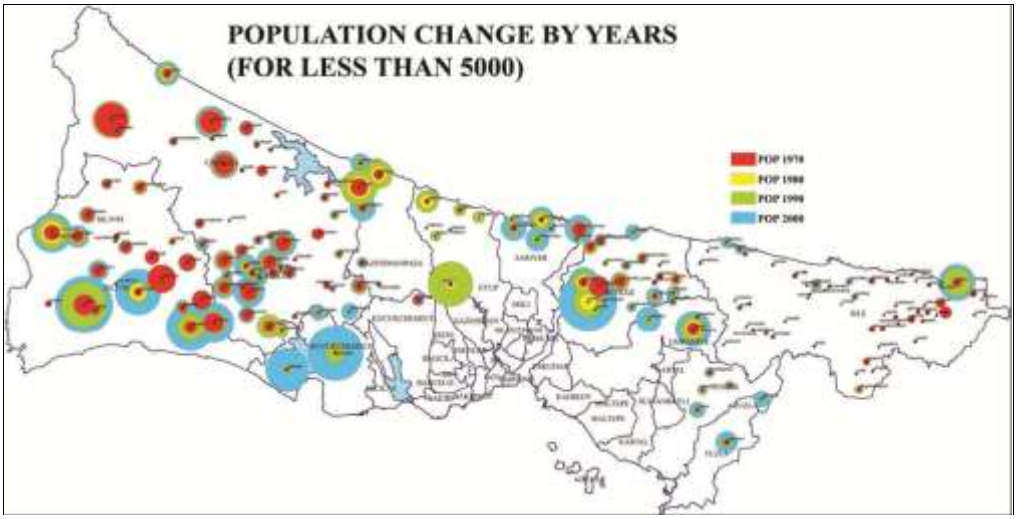


Figure 2: population change in smaller settlements in the outer periphery of the IMA (boundaries before 2004)



The increasing demand for land also increased the risks and hazardous affects of disasters. While the areas with flood risks are occupied with both illegally developed housing units (squatter houses) and even many unauthorised business firms located in these river beds with very high risks. In fact, the flood in September 2009 resulted in the loss of 24 people in Istanbul and many buildings show the negative affects of such trends. There is a more important threat on Istanbul; earthquake. In Istanbul, there are high numbers of buildings constructed on the areas with a high risk of earthquake and most of these building do not satisfy the technical standards for the buildings with earthquake risk.

4.3. The vulnerable ecosystems and the impacts of designated threads on these ecosystems

In Istanbul, the increasing disturbance due to increasing rates of expansion in built up areas and volatility in the rates of growth of global functions have important impacts on the different ecosystems and urban assets, which are briefly summarised under five headings.

4.3.1. The impacts on freshwater ecosystems/water resources

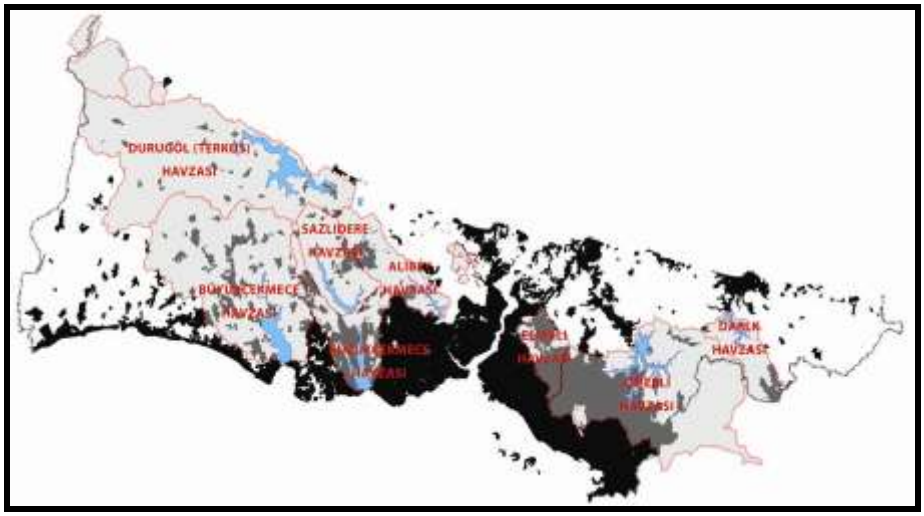
Water resources are the most sensitive ecological resource in Istanbul, due the massive increase in demand, where the supply and the potential resources are limited. Water to meet the needs of

metropolitan Istanbul comes from the Marmara and Melen basins, whose combined water potential amounts to about 3.34 billion m3. Groundwater resources are limited; their annual potential is around 0.175 billion m3. In 2007, the amount of water resources in use was 1.42 billion m3. This means 40% of the water potential is being exploited, on average.

According to recent figures by Istanbul Water Authority (ISKI, 2009) total amount of drinking water demand is 2,004 million m3/day (172 litres per head), which is slightly lower than the the existing total water supply (2,182 million m3/day). Due to geographic and seasonal disparities in the distribution of water resources, coupled in recent years with severe drought, have necessitated interbasin water transfer projects to provide more water where needed in Istanbul. For example, the Melen Project Phase I, which became operational in December 2007, supplies an additional 0.27 billion m3 of water per year. In coming years new water resources need to be developed in order to meet the increasing demand and the loss of water storage capacities in coming decades due to climate change.

These figures show the importance of protecting all of the existing water resources, which are endangered by the increasing urban sprawl in water basins. However, as the study by Küçükmehmetoğlu and Geymen (2009) illustrated (see Table 3) there is substantial increase in built up areas in the water basins, namely 3800 additional hectares of built up area from 1995 to 2005 (Figure 3). There are 9 watershed areas in Istanbul with different water capacities, which all are vital for Istanbul as indicated above. However, some of them have a high risk of being polluted. Among these major water resources one of them is Kücükçekmece Lake, which can not be used as a source of drinking water due to increasing pollution. The other two of the existing water resources are under the threat of urban growth and they have been increasingly polluted in recent years. The first water resource is Elmali Dam, which has relatively low capacity (20,7 million m3/day). The water quality of this source has been seriously damaged and can not be used for drinking water in coming years. The other one is Omerli dam, the water resource with the largest capacity (867,4 million m3/day) and the increasing built up areas in the watershed areas are very important, creating a big threat of on this source. Unfortunately, if it can not be used for drinking water purposes there is no such source to compensate its loss.

Figure 3: Built-up areas within water basins



Increasing population living in watershed areas is one of the major indicators of the sprawl of the urban settlements even in the water basins. According to ISKI (2005) the total population living in the short and medium distance protection zones of the water resources reached 890 thousand, 247 bin living in Elmalı Dam basin and 386 thousand in Omerli Dam Basin (see Table 3). Parallel to the population increase, it is possible to see the increasing numbers of industrial firms in the water basins. According to the Environment Report (2005) prepared for Istanbul Metropolitan Planning Bureau (IMP) the number of industrial firms reached 1663 in total, 533 in Omerli basin and 553 in Alibeyköy and 257 manufacturing firms in Büyükçekmece basin. Although the existing data do not provide the pollutant types and levels of these manufacturing firms, the pollution levels of the existing water resources (ISKI, 2005) indicate clearly the negative impacts of these types of activities.

Table 3: Population built up areas and industrial frms located in water basins

	Population (2000)	Built-up areas 1995		Built-up areas 2005		The change in built-up areas 1995-2005	The number of industrial firms
		ha	% of basin	ha	% of basin		
TERKOS	22562	340	0.5	365	0.5	25	17
BÜYÜKÇEKMECE	120269	1149	1.8	1639	2.6	490	257
SAZLIDERE	29113	518	3.1	622	3.7	104	143
ALİBEYKÖY	83359	851	5.4	1051	6.6	200	553
KÜÇÜKÇEKMECE		3507	19.6	4270	26.4	1213	
ELMALI	247062	2444	29.3	3233	38.8	789	160
ÖMERLİ	386569	5076	12.4	6053	14.5	977	533
DARLIK	0	0	0	0	0	0	0
TOTAL	888934	13885	5.3	17683	6.7	3798	1663

Sources: Küçükmehmetoğlu and Geymen (2009)
IMP (2005) Çevre Durum Raporu (Environment Report)

Adaptive capacity of the freshwater ecosystem

The adaptive capacity of the ecosystem is evaluated by the analysis that depends on two main indicators. Firstly, the capacity of water resources to meet the increasing demand is identified. The analytical studies during this research shows that if sprawl of residential and commercial activities in the water basins of Elmalı and Ömerli Dams will not be controlled efficiently, the existing water resources will decline substantially (888,4 billion m3/year), which will be very difficult to compensate with the help of additional water resources. Another adaptive capacity indicator is the level of pollution in different watershed areas. The classification of major water resources with respect to "The Decree on Control of Pollution on Water Resources"shows that one of the water resources (Darlik Dam) have relatively acceptable quality, whereas almost all resources have very low quality in terms of physical and inorganic chemical parameters.

4.3.2. Earthquake as the major risk

The second important threat for the sustainable development of the city is earthquake. The 17 August 1999 (Mw=7.4) Kocaeli earthquake killed 18,000 people, destroyed 17,000 buildings, and

caused $25 billion in damage. Approximately 1000 people in the İstanbul were killed and damage of buildings was rather serious, though the epicenter of the 1999 earthquake on NAFZ was more than 110 km away.

According to the earthquake studies on Istanbul there are about 1,200,000 buildings in Istanbul as of 2006, an important portion of them is prone to earthquake risk. JICA study (2002) in coordination with Istanbul Metropolitan Municipality (IMM) estimated that a major earthquake of Mw=7.4 near to Istanbul might cost more then 50,000 lives and cause economic losses of more than $ 60-70 billions. Moreover, the expected number of injuries requiring hospitalization will be around 150,000. In Istanbul 30% of hospitals (in total of 635) are located in risky areas of southwest part of the city.

The high levels of hazardous risks are due to two characteristics of built-up areas; the construction of building with earthquake high-risk areas and the low quality of buildings (not only the unregistered buildings but also the registered ones).

4.3.2. The impacts on urban sprawl on forests and their ecosystem services

Forests are vital for sustainability of urban systems, since they are important for supporting water resources, controlling air pollution and for sustained quality of life. Today, they are even more important due to the climate change and their negative affects on water resources. In order to find out the threads on the forests, in this study two indicators are defined: the net loss of forests in the last thirty years and the decrease in the carbon uptake capacity of forests, which means their decreasing contribution to limit the greenhouse effect, which has important contribution to global warming.

Using the Satellite images and aerial photographs for different years and the GIS data provided by the Ministry of Environment and Forestry, the total loss of forests in the last 30 years is identified during the third stage of the research. The comparison of areas covered by forests in 1980 and 2007, shows that the importance of decrease in the size of the areas covered by forests. The figures show that almost one third of the forests are converted to different types of land uses; 42 thousand hectares of forests to residential areas and about 60 thousand hectares to different activities such as, agriculture, mining and infrastructure facilities (Table 4). Knowing that

Istanbul forests are very important for freshwater ecosystems and biosphere, the amount of loss is alarming.

Table 4: The changes in the size of land covered by forests 1980 to 2007

	(ha)
Total	540000
Forests (before 1980)	356652
Existing Forests	261290
The Loss in Forests	102360
The illegal use of forest areas, converted to squatter houses or other activities	16267
Built-up areas within forests	26740
Forest converted to different land use, mainly for agricultural use	59533

Source: Areas calculated by the GIS data provided by Ministry of Environment and Forestry (2007)

The loss of forest areas affects air pollution. To examine the effects of the declining size of the forest areas on air pollution, the carbon storage uptake by vegetation of forest areas and the impact of the loss of forest areas on increasing levels of air pollution are calculated. In order to make this comparison possible, first the above-ground biomass of dominant species of the two main types of trees (broad leaf and conifers) are calculated using the data based on the most recent inventory study provided by the Ministry of Agriculture and Forestry (2007). In finding out the total biomass, we have used the method and the ratios[3] developed by Asan, Yesil and Ozdemir (1995).

According to detailed calculations, the total wealth of Istanbul forests is 48565400 m3 and annual increase in constant weight as 2575310 m3. These figures indicates 3246111 tons of annual increase in biomass and 2307985 tons of annual carbon storage capacity, which is equal to 8,477 million tons CO_2 , avoided emissions (Table 5).

Table 5: The Carbon uptake capacity of forest by the increase of annual constant weight (2006-2007)

Increase in constant	Biomass (tons)				Carbon storage (tons)		
	Above	Below	Soils as dead	Total	In total	In forest	Total forest

weight (m3)	ground	ground	organic matter		biomass	soil	ecosystem
2575310	2100987	307663	927460	3246111	1460750	847235	2307985

In order to find out the impact of the loss of one third of the existing forests in the last three decades on air pollution, the annual carbon storage capacity and its equal to CO_2 is compared to the existing carbon dioxide emissions. According to studies held by Can (2006) Istanbul has the highest CO2 emission level among all cities in Turkey, 30 million m3 in 2003 CO_2. These figures indicate the carbon uptake level of forests constitutes less than 28 % (8.4 million m3 of CO_2 uptake/30 million m3 CO_2 emission) of total CO_2 emission in Istanbul. This percentage shows the importance of the loss of nearly 30% of its forests in last 30 years in terms of air pollution. Since it became more difficult to reduce the emissions in this rapidly growing metropolitan area, protecting forests has become very important in recent years.

4.3.4. Urban sprawl towards the ecologically sensitive areas: An important thread on the biodiversity

Forests and agro-ecological subsystems are also important for the biodiversity, which is an integral parts of ecological resilience. Therefore, one of the key principles should be to enhance biological diversity in order to sustain the capacity of ecosystem after disturbance.

In Istanbul there are 11 areas designated as the areas with special importance of biodiversity by Doğa Derneği (Association of Nature). This voluntary organisation made an inventory study on the most important environmental areas, namely "Türkiye'nin Önemli Doğa Alanları" (Eken, et al., 2006). The study shows that among the 11 areas of biodiversity in Istanbul; six of them have an official status, some of which are Natural Heritage Sites while the others are Preservation Areas of Wild Life covering 133417 hectares. The remaining 5 sites do not have an official status, although they are very important due to their richness in different species of flora and fauna. They cover 74414 hectares in total[4].

In the meetings organised in collaboration with the experts from Doğa Derneği and UNDP, it became evident that these areas, which are very important for protecting natural habitat in Istanbul face important threads. The major threads are open mining, manufacturing industries and new residential areas as well as new large-scale projects such as Formula 1 Racing Site, Nuclear Energy Center, industrial estates besides many others. Obviously, how to protect these resources should be the important concerns of the planning practices

4.3.5. Urban sprawl, increasing travel distance and reliance on private

Urban sprawl is not a threat on natural resources, it also creates important problems related to transportation as it increases the travel distance and time well as traffic congestion. It is difficult to develop the public transport systems for the urban areas that experience urban sprawl with low density residential areas; as exemplified by the American cities, which highly depend upon private car ownership. Although the density of the urban field in the periphery is higher in Istanbul compared to American cities, still the share of public transport in total trips is low in Istanbul. Unfortunately, the efficiency of the existing transportation system is low and it mainly depends upon on roads. In Istanbul 92,8 percent of the transportation depends on highways, while the share of rail transport including subway system is 5,7 % and share of ship transport in total daily trips reaches only 2,5 per cent of the total (see Table 6).

Table 6: The importance of different modes of transportation 2006

Mode of transportation	No of vehicles	Average daily trips	Share %
Public bus	2587	1500000	14,8
Private bus	1229	800000	7,9
Car	1628367	3100000	30,7
Minibus	5860	2000000	19,8
Dolmuş	590	70000	0,7
Taxi	17416	750000	7,4
Service buses	32000	1050000	10,5
Road Transport	**1688049**	**9.270.000**	**91,8**
Rail transport	**243**	**574.000**	**5,7**
Ship Transport	**391**	**251.000**	**2,5**
TOTAL	**1688767**	**10.095.000**	**100**

In road transport, private car dependency still constitutes a high percentage (30 % in 2006). It fact the number of cars in 1980 was only 211 thousand and the car ownership ratio was 45,1 per thousand people, while it reached 1486 thousand with 110,1 cars per thousand population in 2006. The increasing car ownership and the lack of an efficient public transportation system obviously created several problems. In fact, according to the research focused on the foreign firms located in Istanbul, the firms define the traffic congestion as the most important problem (Eraydin et al, 2009).

Together with traffic congestion, the emissions generated by transportation are important. In Istanbul, the emissions generated by vehicles have important share (%40) in air pollution. Moreover, the share of traffic in different types of pollutants are rather high; %70-90 in CO, %40-70 in NO and %50 in hydrocarbon and %100 in PB (IMP, 2006).

The increasing urban sprawl without efficient transportation systems means both increasing volume of traffic, travel distance and pollution. Obviously, the efforts to solve the existing problems need a systematic approach. The transportation system of Istanbul is one of the issues defined as the most important in Istanbul. The layout of this huge metropolitan area, in the two sides of the Bosphorous makes the solutions more difficult. There are now two bridges on Bosphorous and recently the route of the third one is declared by the Ministry of Transportation. All of them are for vehicles. There is also a tunnel project under the Bosphorous, which will be completed in coming years.

Experts are sceptical about its contribution of a new bridge to reduce traffic congestion and criticise this decision due its expected negative effects on the water catchment areas. Improving public transportation especially railways, however, is expected to reduce the emissions due to transportation, although the new projects should be supported by the public transportation system within the whole city.

4.5 The social resilience of Istanbul under the waves of global economic change and population growth

The sprawl of this huge metropolitan area has been accelerated by the rapid population growth and the increasing number of new enterprises, which caused a sudden rise in land demand. The urban land and market mechanisms and the existing planning instruments, however, supported this process and led to increasing socio-spatial segmentation of the different groups. This trend has been evaluated as negative since it decreased the social resilience of this metropolitan area, which is as important as ecological resilience.

Several studies indicate the importance of socio-spatial segmentation of population in Istanbul. Analytical studies (Güvenç et al., 2005) point to the importance of segregation among neighbourhoods in terms of the different levels of education and the types of occupation, both in 1990 and in 2000. In 1990, there was a clear distinction among the neighbourhoods: where people with higher levels and lower levels of education, and people with white collar and blue collar jobs lived. The general picture was not much different in 2000, but the indices point to a decrease in the segregation between the social groups with different levels of education and occupation This tendency shows that some inclusionary processes peculiar to Istanbul have played an important role. The reasons for these inclusionary processes are grouped into two (Eraydin, 2008); the increasing level of education of the city dwellers including the increasing number of migrants with better education and the transformation of squatter areas into planned residential areas. While increasing level of education and accordingly the changes in occupational profiles of households increased the mobility of people, high amounts of squatter housing areas transformed to middle class housing units have created new mixed zones.

This trend, however, do not imply decrease in income disparities. The opportunities in both production and service activities that were clearly differentiated based on skills neglected to take into account income distribution; and Istanbul experienced this worsening income distribution, which can be clearly seen in its Gini coefficients[5] (Boratav, Yeldan and Kose, 2000). A major outcome of worsening income distribution is the increasing poverty groups (Dumanli, 1996). Although there are no specific statistics related to poverty in the Istanbul city region, the figures for the region in which Istanbul is situated (Marmara Region) show that the share of people in absolute poverty reached 21.3 percent in 1987, while the share of the people in the relative poverty group based on consumption patterns[6] was 57.8 percent in the same year (Dansuk, 1997). Although socio-spatial segmentation did not increase from 1990 to 2000 the increasing numbers of very large luxurious projects, is expected to increase segmentation between different social groups (Kurtuluş,2005)

5. Conclusive remarks: Assessment of the recent plans and policy instruments with respect to the attributes of resilience

The short summary of the new forms of urban developments triggered by the globalisation show the increasing vulnerability and declining adaptive capacity of the urban system in Istanbul. Each of the issues indicated in the former sections, received a wide attention and debated within academic circles and among the other stakeholders.

These concerns reflected themselves on plan documents, projects as well as on recent legislation. However, there is no systematic evaluation of these issues that affects negatively the resilience of the ecological, social and economic resilience of Istanbul. There are some positive attempts to bring coordination in the decision making mechanism and planning process. These attempts, however, are not sufficient to improve the downgrading adaptive capacity of the urban system.

Firstly, the administrative organisation has changed by extending the area of jurisdiction of the metropolitan municipality. The "Metropolitan Municipality" was set up in 1984 with the jurisdiction of a smaller area than the province, and it was enlarged by the new legislation in 2004 from 1,869.64 km/sq to 5,434.04 km/sq. It now covers the whole province. The expansion of its territory enabled smaller settlements around the earlier metropolitan area to become a part of the new administrative structure.

Second, the recent expansion of the Metropolitan Area boundary supported the transfer of rights to prepare plans at higher levels to Istanbul Metropolitan Municipality, such as drawing and monitoring the regional plan which was previously under the responsibility of the State Planning Organisation, Environmental Management and Land Use Plan (at 1/100 000 scale) that was prepared and approved for most of the other provinces by Ministry of Public Works or Ministry of Environment and Forestry, and the Metropolitan Master Plan (at 1/50000 scale), which was approved by the Ministry of Public Works and Settlement.

Using their new rights in 2006 the Planning Bureau (IMP) of the Greatercity Municipality prepared the Environmental Management and Land Use Plan at 1/100.000 scale, which was approved by the Council of Istanbul Greater City Municipality. This plan was amended in the following years and approved again in February 2009. This plan indicated that Istanbul could accommodate a maximum of 16 million inhabitants due to preservation zones, water catchment

areas and forest land, although the population projections showed a higher population (22 million for the year 2020). It also emphasized the need for transformation of large amounts of already built up poor quality housing areas, some of which are under the risk of earthquake and defined special project areas that aimed environmental sustainability, economic development and social sustainability.

While the Environmental Management and Land Use Plan tried to bring major principles and projects for sustainability, the planning and policy instruments defined by the new legislation do not support this broader aims, since they bring a rather fragmented nature on planning practice.

In the last decade, the amendments of planning legislation are passed in order to accelerate redevelopment, renewal and reuse of urban areas by the help of / under the competence and power of central government organisations and the new policies and action plans to redefine the role of Istanbul. The new amendments on the existing legislation denoted certain areas, some of which are very critical for the metropolitan area and shifted the planning and development rights on these sites/areas to different institutions of the central government. The planning authority provided by The Planning Act to metropolitan and district municipalities transferred to different central government institutions . This leads to *piecemeal planning process and fragmentation and ovelapping of planning decisions and rights in the development and implement of projects*. The plans prepared by different authorities not only created *inconsistencies* between plans, but also conflicts between different authorities and the Metropolitan Municipality frequently arise. In fact, beginning from the 2000s onwards Istanbul became a playfield of different authories and actors that have different interests. In particular, Istanbul became an area field of power struggles between central and local governments. Different ministries wanted to use their legal rights and to intervene in a number of policy areas, especially in infrastructure investment and land development, sometimes contrary to the interests of the Metropolitan Municipality.

The evaluation of the adaptive capacity of the urban system and the emerging problems due to loss of the resilience of the urban systems, indicates the need for a new approach that necessitates to analyse the existing and possible impacts of the disturbances and to bring a different planning system, not only able to deal with the expected impacts but also unexpected future crises and emergencies. The increasing vulnerability of the urban system in Istanbul requires measures that enhances on adaptability and flexibility of the metropolitan region as well as immediate measures for recovery of certain critical assets and transform some others.

REFERENCES

ABEL, N. D. CUMMING, H.M. and ANDERIES. J. M. (2006) Collapse and reorganization in social-ecological systems: questions, some ideas, and policy implications. *Ecology and Society* **11**(1): 17. [online] URL: http://www.ecologyandsociety.org/vol11/iss1/art17/

ADGER, W. N. (200) "Social and ecological resilience: are they related?", Progress in human geography; 24; 347

AGUIRRE, B.E., (2006) Preliminary Paper 356: On the Concept of Resilience. Disaster Research Centre, University of Delaware

ASAN, U., YESIL, A AND OZDEMIR, I (1995). Ormanlarda Karbon Birikimi Ve Yıllık Değigimin Belirlenmesinde Basvurulan Temel Yaklasımlar

BAUD, I.S.A and HORDJICK, M.A (2009) Dealing with risks in urban governance: what we can learn from resilience thinking, The 4th International Conference of the International Forum on Urbanism (IFoU) 2009 Amsterdam/Delft The New Urban Question – Urbanism beyond Neo-Liberalism

BEAVERSTOCK, J.V., TAYLOR, P.J., AND SMITH, R.G. (1999) A Roster of World Cities, **Cities**, 16, pp. 445 – 458.

BERKES, F. and FOLKE, C., eds. (1998), Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge, UK: Cambridge Univ. Press.

BERKES, F., J. COLDING, AND C. FOLKE, Navigating social-ecological systems: building resilience for complexity and change. 2003: Cambridge University Press.

BORATAV, K., YELDAN, A. E. and KOSE, A.H. (2000) Globalization, Distribution and Social Policy: Turkey, 1980-1998, *CEPA Working Paper Series I: Globalization, Labor Markets, and Social Policy*

CAN, A. (2006) .Investigation of Tturkey's carbon dioxide problem by numerical modeling, METU: Ankara

CRITICAL PLANNING JOURNAL (2009) Call for papers, http://www.sppsr.ucla.edu/critplan/call.htm

DALZIELL, E.P. and McMANUS, S.T. (2004), Resilience, Vulnerability, and Adaptive Capacity: Implications for System Performance. Stoos, Switzerland: 1st International Forum for Engineering Decision Making (IFED), 5-8: 17.

DANSUK, E. (1997) *Türkiye'de Yoksulluğun Ölçülmesi ve Sosyo-Ekonomik Yapılarla Ölçülmesi*, DPT Uzmanlık Tezi, DPT:Ankara

DUMANLI, R. (1996) *Yoksulluk ve Türkiye'deki Boyutları*, DPT: Ankara

EKEN, G., BOZDOGAN, M. ISFENDIYAROGLU,S., KILIC, D.T and LISE, Y. (2006) Türkiye'nin Önemli Doğa Alanları, Doga Denegi: Ankara

ERAYDIN, A. (2006) İstanbul'da yaşanan değişimlere toplu bakış: tüm gelişim ve dönüşümler İstanbul'un geleceği için ne anlama geliyor? Paper presented to the Symposium on Urban Transformation, November 2006, Istanbul.

ERAYDIN, A. (2008) The impact of globalisation on different social groups: Competitiveness, social cohesion and spatial segregation in Istanbul, *Urban Studies***,** 45 (8) 1663-1691

ERAYDIN, A., GEDIKLI, B, BABALIK, E and TUREL, A (2009a) Yabancı sermaye ve Istanbul: Istanbul'daki yabancı sermayeli firmalarve bu firmaların kentle ilgili değerlendirmeleri (The foreign investment in Istanbul and their assessments on Istanbul city (co-authors) *Gecekondu, Dönüşüm, Kent* (Eds) Kayasü, S., Işık, O, Uzun, N, ve Kamacı, E., ODTÜMF, 353-378

ERAYDIN, A., TUREL, A. AND ALTAY, D. (2009b), Managing urban change-a systematic survey of current policies and instruments, Paper presented URBAN_NET Project "Sustainable Land Use Policies for Resilient Cities, 16-17 November 2009 Stockholm

FOLKE, C. and CARPENTER, S., eds (2000), Resilience and sustainable development: building adaptive capacity in a world of transformations, Stockholm, Edita Norstedts Tryckeri AB.

FOLKE, C., (2002) Resilience and Sustainable Development: Building adaptive capacity in a world of transformations, in Scientific Background Paper on Resilience for the process of The World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government, Environmental Advisory Council - Ministry of Environment: Stockholm.

FOLKE, C., (2006) Resilience: The emergence of a perspective for social–ecological systems analyses. Global Environmental Change, 2006. **16**(3): p. 253-267.

HEYLIGHEN, F. (2002), The science of selforganization and adaptivity, center "leo apostel", Free University of Brussels, Belgium.

HOLLING, C.S. 1992. Cross-scale morphology, geometry and dynamics of ecosystems. *Ecological Monographs*. 62(4): 447-502.

HOLLING, C.S., (2001) *Understanding the Complexity of Economic, Ecological, and Social Systems.* Ecosystems, 4, 390-405.

HOLLING, C.S., SCHINDLER, D.W., WALKER, B.W. AND ROUGHGARDEN, J. (1995) Biodiversity in the functioning of ecosystems: an ecological synthesis, in Perrings, C., Mäler, K.G., Folke, C., Holling, C.S. and Jansson, B.O., (Eds) *Biodiversity loss: economic and ecological issues*, Cambridge: Cambridge University Press, 44–83.

IMP (2006) Istanbul Metropolitan Alan Planlamasında Marmara Bölgesi Bağlantılı Değerlendirmeler, Istanbul: Istanbul Büyükşehir Belediyesi

ISKI (2005) Çevre Durum Raporu (Environment Report) ISKI: Istanbul

KURTULUŞ, H. (2005*) İstanbul'da Kentsel Ayrışma*, Bağlam: Istanbul

KÜÇÜKMEHMETOĞLU, M., GEYMEN, A. (2009) Urban Sprawl Factors in the Surface Water Resource Basins of Istanbul, *Land Use Policy*, 26, 569-579

LUDWIG, D., B. WALKER, AND C. S. HOLLING. (1997) Sustainability, stability, and resilience. Conservation Ecology [online]**1**(1): 7. Available from the Internet. URL: http://www.consecol.org/vol1/iss1/art7/

MANYENA, S.B., The concept of resilience revisited. Disasters, 2006. 30(4): p. 434-450.

RESILIENCE ALLIANCE (2007) Urban Resilience" Research Prospectus, CSIRO, Australia — Arizona State University, USA — Stockholm University, Sweden

TAYLOR, P.J. (2001) West Asian/North African Cities in The World City Network: A Global Analysis of Dependence, Integration and Autonomy. *GAWC Research Bulletin* 58.

TAYLOR, P.J. (2003) European Cities in the World City Network. *GAWC Research Bulletin* 105.

TAYLOR, P.J. and WALKER, D.R.F. (2001) World Cities: A First Multivariate Analysis of Their Service Complexes, *Urban Studies* 38, pp. 23 – 47.

TUREL, A. ERAYDIN, A., BABALIK-SUTCLIFFE, E and GEDIKLI, B. (2005) *İstanbul'un Eylem Planlamasına Yönelik Mekansal Gelişme Stratejileri Araştırma ve Model Geliştirme Çalışması*, Ankara: ODTÜ

TÜRKIYE UOEPRF ORMAN ENVANTERI, 2007.

VINCENT, K. (2007), Uncertainty in adaptive capacity and the importance of scale. Global Environmental Change, 17: 12-24.

WALKER, B., D. SALT, AND W. REID, (2006) *Resilience thinking: sustaining ecosystems and people in a changing world*: Island Pr.

WALKER, B., HOLLING, C. S., CARPENTER, S. R. and KINZIG A. (2004), Resilience, adaptability and transformability in social–ecological systems, *Ecology and Society* 9(2): 5. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5/.

Step1: Disturbances	**Stage 2**	**Step 3-1: The impacts on subsystems**	**Step 3-2: The indicators of vulnerability**	**Step 4: Adaptive capacity indicators**	**Step 5-1: Adaptive Capacity**	**Step 5-2: Critical issues for Planning**
Water resources are under the threat by • High rates of population growth • The urban sprawl • The increasing built up areas in water basins	Freshwater ecosystem/water resources	• Increasing demand for water resources by population increase and new activities • The increasing built up areas in protection zones of water basins, which leads to loss of these water resources for drinking water • Increasing levels of pollution in certain drinking water resources	• The increase in demand for water, available and maximum capacity of water resources • The increasing percentage of built up areas in protection zones of water basins • Population living in water basins • The number of industrial firms • The level of pollution in different watershed areas The capacities of water treatment plans	• The potential to increase supply of water in order to meet the demand The pollution levels • The water treatment capacity	The rate of increase in demand is more than supply, which limits the adaptive capacity of the system. Even all potential water resources to be used, in 2025 the demand for water will exceed the supply of water Some of the water resources are under the risk of not being used for drinking water, since they are getting polluted	Protection and management of water resources is one of the most significant prerequisites for resilience of Istanbul.
Natural hazard risks * Earthquakes Floods	Areas with natural hazard risks	• Most of the already built up areas take place on the earthquake risk areas • Increasing demand for urban land causes the construction (most of which are not registered) in river beds	* Percentage of areas with earthquake risk * The ratio of heavily damaged buildings *The share of built up areas with erosion risk	The number of buildings strenghtened for mitigation for earthquakes.	Limited adaptive capacity, due to need for financial resources for strengthening existing buildings The ratio of heavily damaged buildings in 1999 earthquake reach up to 17000.	
*Increasing demand for urban land due to rapid population growth *The sprawl of the new housing areas due to uncontrolled housing estates and housing areas serving for new life	Forests and agro-ecosystems	• Increasing rate of loss of forest areas • Increasing percentage of built up areas on agricultural land • Increasing urban sprawl and increasing population growth in environmentally sensitive areas	*The loss forests in the last 30 years *The forest areas converted to built up areas without planning permission *The loss of carbon uptake capacity of forests in the last thirty years * The contribution of forests to water regime regulation	The carbon uptake capacity of forests as a percentage of total CO_2 emissions	The forests in Istanbul are important for; -water regime and carbon use. The loss of the existing forests will negatively affect the carbon budget of the city and the existing water resources.	Protection of forests and agricultural land is important in terms of reducing air pollution reduction, water regime regulation and biodiversity.
Urban sprawl * Increasing travel distance and density * Increasing demand for land in CBD areas	Air quality	*Increasing air pollution, that exceed the carbon uptake levels of forests and green that are increasingly invaded by the newly built areas * Increasing density in central locations that brings traffic congestion	*The sprawl of the metropolitan area; - The increase in the population in the periphery of the metropolitan area - The main areas of population concentration areas in the last thirty years. *Increasing volume of traffic, especially by private modes of transportation, leading to increasing emissions by the traffic *The increase in carbon emissions in the last decade	The increase in the ratio of trips by public tarnsport system	The increasing sprawl of the city cause the loss of agricultural land as well as forests The loss of the existing green areas (especially forests) will negatively affect the carbon budget of the city while the emissions are increasing rapidly.	The increasing urban sprawl especially in the last three decades decreased the resilience of the Istanbul metropolitan area.
Globalisation necessitating new types of skills	Social structure	* Increasing income disparities * The socio-spatial segmentation * The increase of human capital, but still with a low percentage in the total labor force	*The changing levels of education of working population *The residential segregation of groups with different education and with different occupation	Upward mobility The share of mix zones		Creating a competitive economy that constantly specializes in new economic sectors is mandatory for a resilient economy.

Table 1: The steps of the exploratory resilience research on Istanbul Metropolitan Area

ENDNOTES

[1] Adaptive cycle theory defines dynamics of resilience of ecological and social ecological systems and defines four phase adaptive cycles;
* growth or "exploitation" (the *r* phase): resources readily available
- conservation or consolidation (the *K* phase): things change slowly; resources locked up
- collapse or release (Ω); things change very rapidly; locked up resources suddenly released
- reorganization (α); system boundaries tenuous innovations are possible

[2] The distribution of 405 firms interviewed are as follows: 140 firms are in manufacturing, 4 in mining, 6 in agriculture, 42 communication-transportation, 21 in tourism, 14 energy and the remaining in different service activities.

[3] These ratios are; conversion ratio of constant weight to oven-dried weight at 65°C to for two main types of species of Istanbul forests, the ratio of below-ground biomass to above ground constant weight for the species that represent conifers and broad leafed tree in Istanbul forests and the ratio the constant weight of shrubs (with less than 8 cm diameter) to biomass.

[4] **Important Environmental Areas in İstanbul**

	ÖDA ADI	Size	Status	Threats
1	**TERKOS LAKE BASIN**	60.351 ha	Natural heritage site,	*Second homes nearby the lake *The drinking water project in order to use rivers of the Istranca rmountain
2	**BÜYÜK-ÇEKMECE LAKE**	5.128 ha	No special status, but important for certain animal species	•Industry- a new organised industrial estate *Urban expansion
3	**WEST ISTANBUL MERALARI**	9.612 ha	No special status, but important for certain animal and plant species	* High density residential areas * Transforming the meadows to farms
4	**KÜÇÜK-ÇEKMECE BASIN**	11.715 ha	Natural heritage site	•Pollutants by Nuclear Energy Research Center • Expansion of new housing sites
5	**AĞAÇLI KUMULLARI**	1.347 ha	No special status, but important for certain animal and plant species	* Mining sites, especially lignite * New tourism activities
6	**KILYOS KUMULLARI**	903 ha	Natural heritage site	* Mining * Unplanned urban development
7	**BOSPHOROUS**	55.631 ha	Natural Habitat Protection Site, Natural Park	• Unplanned urban development *Third Bosporous Bridge
8	**ISTANBUL ISLANDS**	9.458 ha	Natural and urban heritage site	No threats
9	**ÖMERLI BASIN**	58.237 ha	No special status, but important for certain animal and plant species	• Increasing demand for building *Squatter houses * Formula 1 Race Area
10	**IĞLE COAST**	4.817 ha	Natural Heritage Site	• Motocross racing *Mining *Unplanned development
11	**PENDIK VALLEY**	2.852 ha	No special status, but important for certain animal and plant species	•Increasing built-up areas and transportation infrastructure *Organised industrial district and a new technology park * A new university campus

[5] According to Keyder (2005) there is a change from a Gini coefficient of 0.43 in 1984 to 0.58 in 1994, and this is arguably higher now.

[6] The share of population that have less consumption than average.