

## Resilient cities and adaptation to climate change: Chicago metropolitan area as a case study

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### **Abstract:**

Since cities formed, either men or nature has destroyed them through out history. However, they were always rebuilt and rebounded. After about 1800, such resilience became a nearly universal fact of urban settlement around world. Urban disaster takes many forms and can be categorized in many ways, like scale of destruction, human troll, natural disasters and etc. Because of these kinds of disasters, the cities need to be resilient and need to adapt upcoming conditions. Although there are many different forms of disasters, this study is more concerned about the ones that are caused by humans and that can be prevented or at least with the ones which something still can be done about. In other words, this study is about importance of resilient cities and adapting existing cities to the future. This research is about energy efficient buildings, clean and renewable energy resources, improved transportation options, reduced waste and industrial pollution and adapting to new conditions so that cities can be sustainable and their residents can continue their urban life without extreme shocks and stresses.

While studying resilience and adaptation, Chicago Metropolitan Area will be the case study. Chicago's main struggle begins with the Great Fire in 1871, and continues with Great Depression in 1930. The World War II effects and still continues with problems that are caused by people's modern lifestyle, like heat islands or greenhouse gas emissions. For more than fifteen years, Chicago has been promoting the transformation into an environmentally friendly city. From green roofs to recycling, Chicago continues to take steps toward resiliency against climate change. Currently, not only the local government but also the business community and residents at large have engaged in a multitude of key partnerships and efforts to support the city's goal. Scientists, businesses and governments around the world agree: climate change is one of the most serious issues facing the Earth today. In the last 50 years, levels of carbon dioxide in the atmosphere have risen 25 percent; levels of methane, an even more potent greenhouse gas, have more than doubled. Because of these increases in heat-trapping gases, under a high-emissions scenario, recent predictions show that by the end of the century, annual average temperature could increase up to four degrees Celsius, and every single part of the Earth will be affected with climate change. Developed countries started to take action against climate change. They are developing strategies that can be applied by even developing countries, such as Turkey, and surely these strategies can be used as a road map to strength Turkish cities against incoming climate change.

**Keywords:** *Resilient cities, adaptation, climatechange, Chicago.*

## **1. Introduction**

Even though when the term resilience is searched through Internet or written literature, the results gotten for cities that have been destroyed by terror attacks, natural disasters or fire catastrophes. If the search is extended a little more, it will be found about resilient cities and adaptation that concerns about subjects like climate change or oil peak. Actually, these are the disasters that are happening gradually and will not be effecting just for now but also they will be affecting the future of human life in the long term. Especially, climate change is one of the biggest problems of Earth. Since the human beings are the reason of this problem with greenhouse gasses, fossil fuels and improved modern lifestyles; the world should be prevented to fall into pieces.

As time passes more people have started to see the results of human actions, and have begun to search for a solution. Since, these problems are not just caused by individuals, the solution also cannot be only found by individual acts. Governments, businesses, and residents of cities need to work together. This is the reason for choosing Chicago as case study, with Chicago Municipality's Climate Action plan, which also includes businesses and residents; they are trying to make Chicago a green, resilient city, which will, also able to adapt changing conditions.

## **2. Climate change and its impacts**

Climate change is a worldwide environmental, social and economic challenge. It effects on aspects of air pollution, land use, toxic waste, transportation, industry, energy, government policies, development strategies, and individual freedoms and responsibilities.

The researches prove that major tipping points, that are leading to irreversible changes in ecosystems and the climate system, may have already been reached or passed. Ecosystems as distinct as the Amazon rainforest and the Arctic tundra may be approaching thresholds of dramatic change through warming and drying. Mountain glaciers are in alarming retreat and the downstream effects of reduced water supply in the driest months will have repercussions that transcend generations. Climate feedback systems and environmental cumulative effects are building across Earth systems demonstrating behaviors that cannot be anticipated.

The most dangerous climate changes may still be avoided if hydrocarbon based energy systems are converted and if theological and sufficiently financed adaptation programs are initiated to foresee disasters and migrations at unprecedented scales. The tools are available, but they must be applied immediately and aggressively.

According to the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, the overall global temperature rise since 1900 is 0.7 °C. An important question is whether global warming is already having any noticeable effects, despite the thus far small amount of warming 0.7 °C.

In media there are reports about trees blossoming or birds arriving at unseasonal times, about strange sorts of fish turning up at coasts where they don't belong, or about polar bears drowning. The IPCC concludes that both terrestrial and marine species are now being strongly affected by observed recent warming. On the land, the changes involve flora and fauna

moving to higher latitudes. Tree lines have widely moved up. The growing season is lengthening. Spring arrive earlier by two to five days each decade.

While many of these changes may seem positive, some species nevertheless are unable to adapt and thus decline in population, vanish from a particular region or even go extinct. An important problem is the destruction of habitats due to human land use, which makes it difficult or impossible to move to a different area when the climate changes. Another problem is the speed of change, which overstresses the ability of species and ecosystems to adapt.

Ecosystems have shown some resilience during past, natural climate changes in Earth's history. On the other hand, there have also been extinctions of many plant and animal species in the past, many of which have been caused by climatic changes. A few important things are different now compared to the natural changes over the past two million years or so, the time during which many of the present species and ecosystems evolved.

The first difference is the speed of changes. The rate of global warming at the end of ice ages was typically just 0.1 °C per century. Now, the rate of global warming is seven times faster during the twentieth century and up to fifty times faster during the twenty-first. The second difference is the absolute temperature that will be reached. The past two million years have been dominated by a much colder climate than now, so it is not surprising that many plants and animals have evolved for cold conditions. They tide over the warm interglacial near the frigid poles or high up in the mountains. Now it's being added 2 to 7 °C on top of an already warm interglacial, taking the planet outside the range that most plants and animals have evolved in for millions of years. The third difference is that humans have completely transformed a large fraction of the land surface for own use as farmland, managed forests, roads, or cities. Undisturbed nature is often relegated to remnant-fragmented pockets. This means that a gradual migration to different latitudes as the climate shifts is impossible in many cases. The fourth difference is that humans are now causing unprecedented changes to the chemistry of the ocean waters that cover over two-thirds of planet Earth and host over half of the biological productivity on Earth. According to the IPCC report, by the year 2100 the acidity of ocean waters will very likely be greater than at any time during at least the past 20 million years (IPCC, 2007).

These four reasons make climatologists expect a large impact of future global warming on the biosphere. Hundreds of specific scientific studies have examined the likely response of species and ecosystems to warming, based on knowledge about their individual climatic resilience, vulnerability to extremes and geographic conditions. The IPCC report says that; during the course of this century, the resilience of ecosystems is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances. The meaning of "resilience of ecosystems is exceeded" is very likely characterized by threshold-type responses, many irreversible on time-scales relevant to human society, such as biodiversity loss through extinction, disruption of species' ecological interactions, and major changes in ecosystem structure and disturbance regimes.

Climate change is already contributing today to the burden of disease and premature deaths, and it is expected to have far more serious health impacts in the future. Some impacts are positive, like reduced deaths from cold

spells, but more will be negative. Many millions of people will suffer from an impairment of their health and well being. A relatively well-studied issue is malaria. Although in some parts of Africa malaria transmission is likely to decline, the disease will spread into other areas not previously affected, such as highlands. Warming is expected to increase the population at risk by 220 to 400 million people overall (IPCC, 2007). The drought problems and other agricultural impacts discussed above will lead to malnutrition for many people, impairing the healthy development of children. Extreme weather events will cause deaths, injuries, and disease outbreaks.

A hotter climate is also bad for air quality. Summer smog from low-level ozone in cities is expected to increase strongly, worsening respiratory diseases and heart problems. A score of infectious diseases will spread their range in response to global warming, like diarrhea, food poisoning, and the Lyme disease etc.

If the response of human society to climate change is discussed, two fundamental options are usually distinguished: adaptation and mitigation. Mitigation refers to efforts to reduce the rate and magnitude climate change by reducing the emissions of greenhouse gases. Adaptation describes efforts to cope better with the consequences of a given climate change. Adaptation and mitigation are not alternatives; rather, there is a wide consensus amongst experts that both are essential. Climate is already changing and will continue to change for several decades at least, so it is inevitable that it is needed to adapt to these changes.

Politically, there is a fundamental difference between mitigation and adaptation. A ton of carbon dioxide emitted anywhere in the world will be mixed throughout the atmosphere and remain there for decades. Mitigation therefore requires a level of global cooperation.

Adaptation, on the other hand, is something that everyone can do for his or her own benefit. Adaptation also needs international collaboration, since many poor countries have insufficient resources for proper adaptation measures. By the way, it should not to be forgotten that those countries are usually only responsible for a very small portion of greenhouse gas emissions.

### **3. Resilient cities**

In literal meaning, resilience is the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress. It is an ability to recover from or adjust easily to misfortune or change. The origin of resilience is resilient and the meaning of this word is being capable of withstanding shock without permanent deformation or rupture; tending to recover from or adjust easily to misfortune or change (URL-3, n.d.).

Therefore, resilience in general meaning is about surviving, lasting, making through crises. Resilience can also be applied to cities. Cities have been destroyed throughout history. They have, in almost every case, risen again. After about 1800's, resilience became a nearly universal fact of urban settlement around world. On the other hand, cities such as Baghdad, Moscow, Mexico City and Budapest lost between 60 and 90 percent of their population due to wars, yet they were rebuilt and eventually rebounded. A recent example from Turkey can also be mentioned. In 1999, Gölcük

Earthquake caused 17.480 deaths, 23.781 injuries, 505 people's injuries resulted with disabilities. 285.211 resident buildings and 42.902 commercial buildings had been destroyed, according to official reports. Unofficial numbers are a little bit different. About 50.000 deaths and 100.000 injuries have been mentioned. In addition, 133.683 collapsed buildings left 600.000 people homeless (URL-5, n.d.). Almost sixteen million people have been affected because of this earthquake in different levels. Nevertheless, cities that have been destroyed with Gölçük earthquake have also risen again.

Subjected to everything from earthquakes to smart bombs, cities are among humanity's most durable artifacts. Whether they are reconstructed to accommodate and restore ongoing urban life or rebuilt to serve as sites for visitation and commemoration, it has become exceptionally rare for a major city to be truly or permanently lost.

Cities need to last, to respond to crises and adapt in a way that may cause them to change and grow differently. The near or total collapse of many cities has been rooted in fear; and perhaps the biggest fear today in many cities is terrorism. A danger that few think about with such immediacy is the threat of the collapse of the metropolitan regions in the face of resource reduction – specifically, the reduction in availability of oil and the necessary reduction in all fossil fuel use to reduce human impact on climate change. Understanding the implications of human actions and finding right steps can take us to create resilient cities in the face of peak oil and climate change.

Cities have grown rapidly in the age of cheap oil and now consume 75 percent of the world's energy and emit 80 percent of the world's greenhouse gases (Ash *et al*, 2008). Cities are presently growing globally at 2 percent per year (over 3 percent in less developed regions and 0.7 percent in more developed regions), while rural areas have leveled out and are in many places declining (URL-1, n.d.). For the first time, half of humanity lives in cities, and it is estimated that by 2030 the number of city dwellers will reach five billion, or 60 percent, of the world's population (WWI, 2007).

Buildings produce 43 percent of the world's carbon dioxide emissions and consume 48 percent of the energy produced. It is projected that by shifting 60 percent of new growth to compact patterns in the United States will save 85 million metric tons of carbon dioxide annually by 2030 (Mazria, 2007). Nations can do a lot to help or hinder these efforts, but the important initiatives have to begin at the city level because there is great variation in how cities cope with issues within any nation.

Since the devastation of many Gulf Coast cities from Hurricane Katrina in 2005, the Indian Ocean tsunami of 2004 that impacted eleven countries, and the Burmese cyclone of 2008, resilient cities have most often been discussed in relation to the city's ability to respond to a natural disaster. There is a debate about the link between climate change and natural disasters, which has been renewed as scientists try to understand the increasing incidence of devastating natural disasters, such as the super cyclones that devastated New Orleans and Myanmar (AFP, 2008).

Resilient cities have built-in systems that can adapt to change, such as diversity of transport and land-use systems and multiple sources of renewable power that will allow a city to survive shortages in fossil fuel supplies.

In a resilient city every step of development and redevelopment of the city will make it more sustainable: it will reduce its ecological footprint while simultaneously improving its quality of life (environment, health, housing, employment, community) so that it can better fit within the capacities of local, regional, and global ecosystems. Resilience needs to be applied to all the natural resources on which city trust.

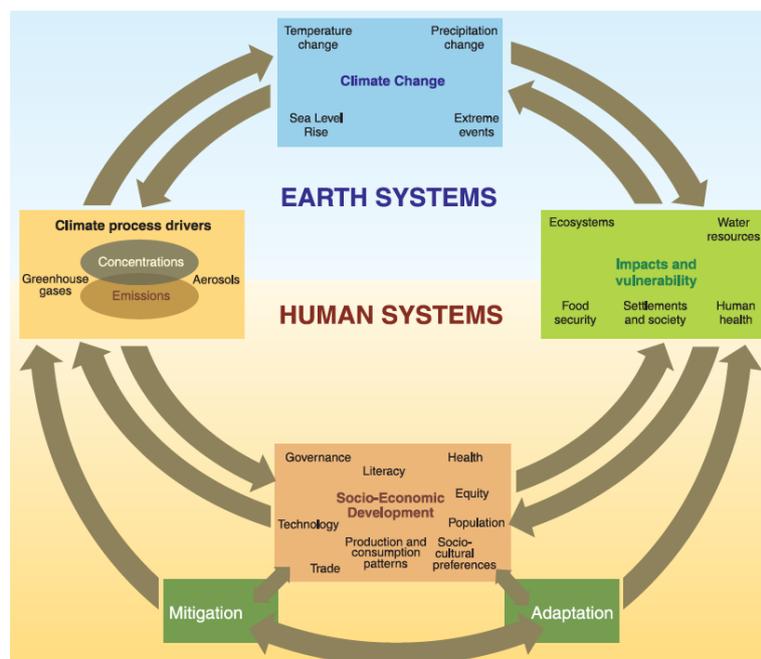
In resilience thinking the more sustainable a city the more it will be able to cope with reductions in the resources that are used to make the city work. Sustainability recognizes there are limits in the local, regional, and global systems within which cities fit, and that when those limits are breached the city can rapidly decline. The more a city can minimize its dependence on resources such as fossil fuels in a period when there are global constraints on supply and global demand is increasing, the more resilient it will be. Atlanta needs 782 gallons of gasoline per person each year for its urban system to work, but in Barcelona it is just 64 gallons. With oil supply cuts and carbon taxes the decline in availability of oil will seriously confront Atlanta, yet Barcelona is likely to cope with ease. Both cities will still need to have plans in place that help their citizenry cope with such a disturbance (Kenworthy *et al*, 1999; Newman & Kenworthy, 2007; Ewing, 2007).

#### 4. Adaptation

Adaptation is not a new concept. Over time, human beings and ecosystems have adapted to different environments and conditions. The current challenge lies in keeping up with the rapidly increasing need for adaptation measures as a consequence of climate change, ensuring that adaptation is considered in political and economic decision-making and is translated into action.

Some degree of future climate change will occur regardless of future's hopefully reduced greenhouse gas emissions. Adapting to or coping with climate change will therefore becomes necessary in certain regions and for certain socio-economic and environmental systems. Growing populations in areas vulnerable to extreme events may increase the need for adaptation.

The IPCC defines mitigation as “anthropogenic (human) intervention to reduce the sources or enhance the sinks of greenhouse gases”; and adaptation as “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm and exploits beneficial



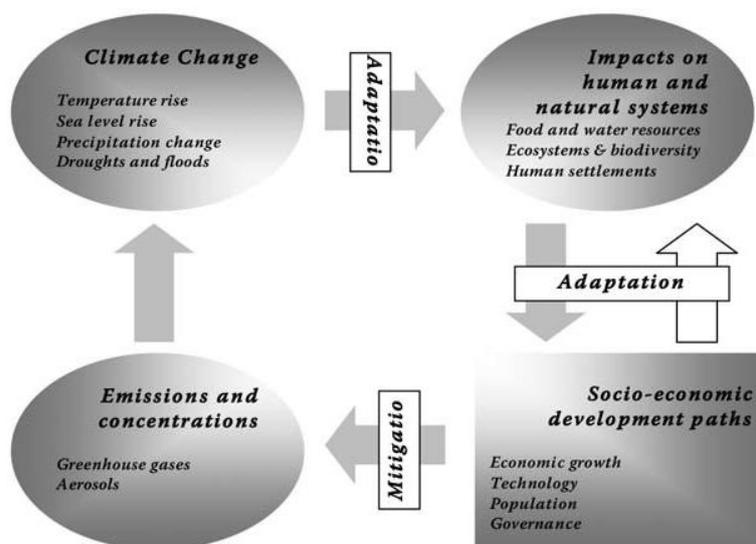
**Figure 1.** Schematic framework representing anthropogenic drivers, impacts of and responses to climate change, and their linkages (IPCC, 2007).

opportunities” (IPCC, 2007). While mitigation measures aim to adverse impacts of climate change in the long term, adaptation measures are designed to reduce unavoidable impacts of climate change in the short and medium terms. This is because even if the concentrations of greenhouse gases could be fixed at 2005 levels, the world could be committed to a long-term eventual warming of 2.4 °C. Therefore, strategies need to be in place for adaptation to temperature increases of at least 2 °C (CNT, 2008; Gürevin, 2012). Figure1 shows a schematic framework of earth and human systems interactions.

As an integral part of sustainable development, mitigation of, an adaptation to, climate change are closely linked and both have the same purpose: reducing undesirable consequences of climate change. Mitigation was given priority partly because climate change itself was conceived as an environmental problem similar to, for example, ozone depletion or acid rain, which could be handled by setting targets and timetables (Munasinghe & Swart, 2004). Larger uncertainties about adaptation measures also played a part in initially paying limited attention to adaptation. It is now acknowledged that climate change is unavoidable and both natural ecosystems and human societies will be affected by its unmitigated impacts.

An integrated view of climate change, as adopted by the IPCC, considers the dynamics of nonlinear cause and effect relationships across all sectors, as depicted in Figure below. The solid arrows show the cycle of cause and effect among the four quadrants and the blank arrow indicated societal responses to the impacts of climate change. The spatial configuration of cities and towns and the ways in which land is used and developed have significant implications for both adaptation to the adverse impacts of climate change and reduction of the emissions that are causing the change.

Responding to climate change involves a risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity and attitudes to risk (IPCC, 2007). While there are strong interactions between mitigation and adaptation objectives, they each call for different or complementary planning tools.



Adaptation is a necessary strategy at all scales to complement climate change mitigation efforts because it could not be sure that all climate change can be mitigated. In the long term, more warming is unavoidable, given the high level of greenhouse gases in the atmosphere, and the delay between emissions and impact.

Adaptation often appears to be conceived as effectively responding to a relatively well defined set of climate-driven changes that complex

**Figure 2.** Climate change – an integrated framework (IPCC, 2007).

climatology models indicate can be expected in a given region. Changes in air temperature, water temperature, sea level, precipitation patterns, agricultural productivity, disease vectors, storm frequency and intensity – ‘All of these predicted changes have immediate consequences for urban environmental management and the building of ecological cities. The changes will clearly make the task much more difficult’ (White, 2002).

Even under the most favorable warming scenarios and in rich countries best able to respond, adaptation efforts will sometimes encounter negative limits in society’s ability to respond effectively to ecological regime shifts and other climate impacts (IPCC, 2007). If the acceleration due to escalating net emissions continues, climate change almost inevitably will push biological and geophysical systems past critical thresholds, or tipping points, in their complex and not well-understood dynamics.

IPCC notes that ‘the options for successful adaptation diminish and the associated costs increase with increasing climate change’ (IPCC, 2007). Further, ‘unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt’ (IPCC, 2007).

Mitigation at the local level constitutes a necessary foundation for global mitigation, which, in turn, provides the only reasonable prospect for a stabilized global climate and hence a firm basis for adaptation at the community level.

The idea that less mitigation means greater climatic change and consequently requiring more adaptation is the basis for the urgency surrounding reductions in greenhouse gases. Climate mitigation and adaptation should not be seen as alternatives to each other, as they are not discrete activities but rather a combined set of actions in an overall strategy to reduce greenhouse gas emissions.

## **5. Chicago as a resilient city**

Chicago’s main struggle has begun with the Great Chicago Fire in 1871, and followed with Great Depression in 1930 and World War II effects. The struggles continue with problems that are caused by people’s modern lifestyle like heat islands and greenhouse gas emissions. Today, Chicago is the third largest city in United States with a population of almost three million. Chicago’s economy is based on manufacture and transportation of goods but recently tourism is also setting its place. Other than being the financial, industrial and cultural capital of the Midwest region, Chicago is also responsible for 34.6 million metric tons of greenhouse gases. If its counties are added to city area, the number rises to about 103 million metric tons (City of Chicago, 2009a). Even though Chicago urban area is responsible for the half of the greenhouse gas emissions in the Illinois State area, Chicago has the most detailed and strategic climate action plan to become a resilient city against upcoming climate change impacts in the United States.

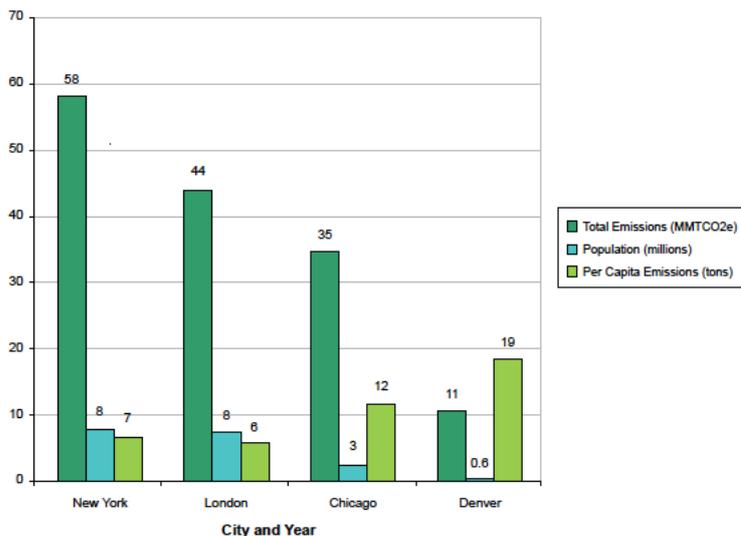
For more than fifteen years, Chicago has been encouraging the transformation into an environmentally friendly city. From green roofs to recycling, Chicago keeps on taking steps toward resiliency against climate change. Presently, not only the local government but also the majority of business communities and residents are taking action to accomplish city’s efforts to be a resilient city with mitigation and adaptation strategies against climate change.

A resilient city should make its every project for becoming more sustainable, so that it will reduce its ecological footprint while improving its quality of life for its residents. Reducing dependence on fossil fuels, reduction greenhouse gas emissions, becoming sustainable and being able to adapt future conditions are the most important steps to be a resilient city.

The scientific and economic analysis showed that if Chicago continues with its current carbon dioxide gas emissions, the City's emission percentage would increase by 35 percent by the year 2050. In addition to that, if the world keeps on using fossil fuel and not taking precautions about climate change not only Chicago but also a major part of the earth will be experiencing extreme heat, heavier rainstorms, floods, stresses. As a result, public health, economy and environment will be affected. Chicago's climate has already started to change, since 1980 the temperatures have risen by 1.4°C; winters are getting warmer, winter ice coverage on Lake Michigan decreases, growing season for plants has extended, water cycle and plant hardiness zone are shifting.

Since global climate models cannot help individual cities, to fight with climate change, Chicago's Mayor shaped a multi-stakeholder task force to produce a climate action plan. Chicago task force has made a research about possible future greenhouse gas emission levels. If dependence on current levels on coal, gas and oil continues, Chicago's summers would feel like Mobile, Alabama in this century. By the end of the century, the number of days which is over 38°C could increase from two days per year to 31 days per year. On the other hand, extremely cold days would be less but the heavy rains and snowstorms would increase. An emission scenario that has cut 60 percent below of greenhouse gas emissions from 1990 level by 2050, the outcome would be less intense but that would still not avoid concerning impacts. As a result Chicago needs to accomplish a 80 percent reduction below its 1990 greenhouse gas emissions level by the year 2050 in order to prevent the worst global impacts of climate change. In order to achieve that desired reduction, Chicago needs an initial goal, which is a 25 percent reduction by 2020.

A research team analyzed Chicago's building stock, transportation systems and



**Figure 3.** Greenhouse gas emissions of four cities (City of Chicago, 2009b).

energy infrastructure to find what can be done for reducing emissions. The city of Chicago now has results on climate impacts, greenhouse gas emissions, and mitigation and adaptation strategies with the work of the task force and many other participants.

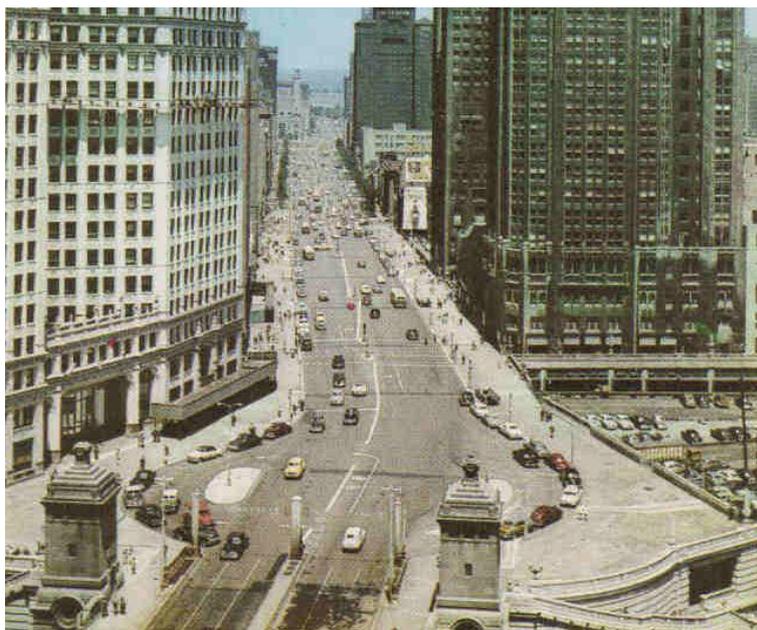
Because of researches, city of Chicago has prepared a plan that has five main strategies. Each of these strategies assessed and selected with their reduction potential, cost, effectiveness, benefits, regional impact and rapid deployment criteria.

First of the strategies are about buildings, which account for nearly 70 percent of all city emissions. Second, one is about transportation, which is reason for 21 percent of Chicago's greenhouse gas emissions. The other three strategies are about clean and renewable energy resources, waste and industrial pollution and adaptation. Adaptation is exceptionally important because Chicago needs to manage the changes that will come because of the level of greenhouse gases that is already in the atmosphere.

Chicago's population continues to increase, because of this energy, performance of the city's buildings is needed to increase and that is the prime target of Chicago Climate Action Plan. Retrofitting commercial, industrial and residential buildings is the first step for energy efficient buildings in Chicago. Conserving water and updating the City's energy code are also other two strategies that city has developed for climate change action plan. For making building energy, efficient task force also advises to establish new guidelines for renovations, and cooling structures with trees and green roofs. Since 2001, Chicago has retrofitted a number of municipal buildings, constructed 36 green roofs on public buildings, and has retrofitted traffic lights with light emitting diodes (LEDs), provided compact fluorescent light bulbs and weatherization materials to residents. In addition to these actions, all new municipal buildings are designed and constructed to the Leadership in Energy and Environmental Design (LEED) Silver standard, including seven libraries. Distributing water to households and businesses needs a major power, improving energy efficiency and using water wisely would help reducing greenhouse gas emissions. To address climate change, improving efficiency of



**Figure 4.** Rooftop Haven for urban agriculture, Gary Comer Youth Center, Chicago, IL.



**Figure 5.** Michigan Avenue, 1960 (URL-2, n.d.).

existing energy sources and move to cleaner power sources is a necessity. Upgrading or repowering the twenty-one coal plants in the state of Illinois, including two in Chicago, could generate substantial reductions. While new power plants replace the old ones, it is important to build them with improved standards for energy efficiency. Shifting to renewable energy resources like solar and wind power also will reduce 3 million metric tons of carbon dioxide equivalent emissions. New technologies provide improved, small on-site power plants and these solutions are more energy efficient than central power plants. Chicago has installed solar photo voltaic and solar thermal panels on municipal buildings and schools. Since 2007 more than 20 percent of the electricity used in City buildings and 30 percent of used in Chicago Park District facilities was purchased from green power.

To lower the greenhouse gas emissions that are caused by transportation, high quality transportation systems that encourage residents to abandon their private cars are important. Public transit, bicycling, walking, car sharing, energy efficient vehicles and the development of transit-oriented neighborhoods would help



**Figure 6.** Michigan Avenue, 2011.

dropping greenhouse gas emissions. For the residents of Chicago public transportation is a smart alternative instead of being stuck in traffic. If residents of Chicago use more public transportation and walk and ride bicycles more, they will drive less, and achieve more significant long-term emission reductions. Metra trains and bike lanes play major roles for city's commuters. Metra trains provide about 300,000 rides everyday. Today Chicago has 18 miles bike lane that serves both commuters and recreational cyclists and the City is planning to increase that number a 500-mile bikeway network by 2015. To encourage biking Chicago is adding more bike-park areas and enabling riding in public transport with bicycles.



**Figure 7.** Mercy Housing Lakefront wind turbines (City of Chicago, 2009b).

Reducing waste and industrial pollution is also important for Chicago's goal of becoming a resilient city. The City has come up with a "Three R" initiative for this goal; reduce – reuse – recycle. To achieve this goal both residents and businesses need to involve. The Chicago Climate Action Report informs that if consumers can recycle packaging material and learn about home composting, the

reduction in waste that is placed in landfills will be 90 percent by year 2020. Managing storm water and using green infrastructures like rain gardens, swales, permeable pavement also help reducing greenhouse gas emissions. To give an example for recycling, in 2007, Chicago has diverted 14000 tons of solid waste from landfills and resulted in new innovative products such as recycled glass countertops.

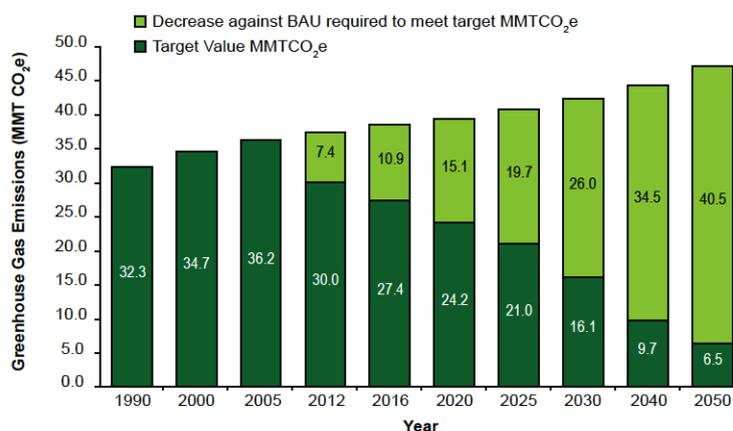
The final and most important step of becoming resilient is being able to adapt into upcoming conditions. Chicago's adaptation tactics include; managing heat, pursuing innovative cooling, protecting air quality, managing storm water, implementing green urban design, preserving plants and trees, planning for the future, engaging public and businesses. Even if greenhouse gas emissions are reduced with the most optimist scenario, still there will be consequences of the greenhouse gases that are already in the atmosphere. Installing permeable pavements through alleys, installing residential and commercial rooftop gardens to reduce overflow, reducing flooding through rain barrels and rain gardens, planting foliage and trees that can adapt in warmer conditions, increasing the size of the urban forest covering to provide cooling shades and installing reflective roofs which cool homes and the city are few of the actions that Chicago has taken to adapt the climate change.

To be ready for more frequent heat waves, municipality, hospitals and community organizations need to work together to update Chicago's emergency response plan and identify the key populations that are most at risk. More research about urban heat islands could help to identify these hot spots. Chicago is coming up with solutions for cooling the city. In the last two decades, Chicago has planted more than 500,000 trees. In addition to these, since Chicago Energy Conservation Code accepted in 2001, new private buildings are required to have reflective roof standards. Many of the adaptation strategies also help reducing greenhouse gas emissions.

Chicago has been working for making the city sustainable, greener, and resilient for years now. They encourage people and projects that will help with their goal. Chicago sets an example for many of the cities around to world to be able to adapt climate



**Figure 8.** Millennium Park bike rent area.



**Figure 9.** Chicago business as usual greenhouse gas emissions and reduction targets (City of Chicago, 2009a)

change, protect city's residents, economies, structures and environment, with foreseeing the impending climate change impacts, researching about its results and making plans that involves today and future.

## **6. Conclusion**

The climate is changing, but these changes appear to be due to more than just natural variability. An increasing body of evidence indicates that the climate changes occurring here are related to the changes occurring in the climate system throughout the world as the result of the human-induced build up of heat-trapping gases in the atmosphere. From the range of projections analyzed here, it is clear that a much greater degree of change can be expected over the coming century (particularly under a higher-emissions future) than has already been experienced to date. It is also clear that past emissions have committed the region and the world to a certain unavoidable level of global warming over the next several decades. Adaptation to climate change will be necessary. At the same time, the worst of the projected changes do not need to occur if prompt action is taken to reduce emissions of heat-trapping gases.

Resilient cities can be created out of the challenge of peak oil and climate change. Cities need peak oil and climate change resilience strategies to guide them through the necessary changes. Most advanced countries have developed highly complex scenarios for dealing with terrorism in the past decade. There are also some such scenarios for dealing with oil and carbon vulnerability. The scenario, that is envisioned, is some cities will respond against climate change and oil peak in time and will adapt to avoid collapse. This will be facilitated by sustainable transport modes, walk able, mixed-used communities, together with new technologies for buildings including renewable energy, which will also be integrated into vehicles.

The first step is to create a clear plan, to determine what can be done in short, medium, and long-term periods. The sooner a start is made, the easier it will be to accommodate adaptation. Climate change is a slow-onset disaster that offers communities and nations time to adapt. But this gradual happening might mistake some people like it is not happening at all.

Low and middle-income nations also have to start to pay attention to climate change, since they could be the ones that will be affected the worst. A large number of urban dwellers are at the risk from the impacts of climate change. It is important to get more attention to avoiding extreme weather disasters. Becoming resilient and being able to adapt needs to be driven by local and national governments, with new policies they can make new developments suitable for mitigation and adaptation. Community based organizations are also a key factor in this process. Local governments and community-based organizations need to interact with each other, and acquaint residents and businesses about climate change. It would be much easier to adapt with an informed community about climate change.

Adaptation is not possible without knowledge, accountability, better resourced and technically competent local authorities that are willing to work well with groups most at risk. Well governed towns and cities have populations and economies that are resilient to a broader range of shocks and stresses, including the extreme weather and other events that can bring disasters that should have been avoided. Well-governed urban centers should be able to protect their inhabitants from floods and storms and

ensure a high quality of life through the provision of infrastructure, services, and public space, a planning framework and accountability. Planning, land-use management, and building and land-use standards should ensure residents that they are safe and protected.

In discussions on climate change during the 1990s, the priority was given to mitigation and the lack of attention to adaptation was justified by the hope that mitigation would mean that dangerous impacts would be avoided. The limited progress on getting the necessary global agreements to reduce greenhouse gas emissions over the last two decades suggests that even under the most optimistic assumptions there will be a considerable time lag between what is needed and what is achieved. As a result, mitigation and adaptation strategies can be listed as below:

- Strategies for energy efficiency
  - Adjust and adapt buildings with new sustainable technologies and energy sources
  - Maintain water
  - Change city's energy policies
  - Inaugurate guidelines for reformations
  - Use nature as a cooling tool (trees and green roofs)
- Strategies for clean and renewable energy resources
  - Upgrade power plants
  - Improve power plant efficiency
  - Encourage residential renewable, sustainable power
  - Build renewable electricity
- Improved transportation options
  - Invest more in public transportation
  - Expand transportation routes
  - Improve facilities for pedestrians and cyclists
  - Provide linkages to existing bike lines
  - Add parking for cyclists and bike-to-transit options
  - Switch to permeable and low solar indexed materials on sidewalks and roads
  - Improve access to public transportation
  - Promote transit-oriented development
  - Switch to clear fuels in transportation
- Reduced waste and pollution
  - Encourage reuse and recycle
  - Manage stormwater
- Adaptation
  - Manage heat
  - Use landscape in every space possible
  - Protect and improve air quality
  - Implement green urban design
  - Protect existing nature
  - Engage and inform public, businesses

Since Turkey is a developing country, there are many opportunities that can be used to become resilient. After 1999 earthquake number of new policies has been taken into action and a new construction era has began.

Many of the resiliency strategies of Chicago can also be applied in every city. It is very clear that; becoming resilient, green and sustainable will not only secure future but it will also save money, improve value and esthetics.

Many of climate change impacts will be, and in some cases already have been felt at the local community levels. Local governments have a major responsibility to protect the people, property, and resources. Since the long-term economies, subsistence, safety and character of their communities at risk, cities are required to use policy tools to increase resilience as they prepare for the future.

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### **Dirençli kentler ve iklim değişimine adaptasyon: Şikago örneği**

Antik bir yerleşimin kent olarak kabul edilip edilmeyeceği konusunda farklı görüşler olsa da, kentlerin geçmişi oldukça eskiye dayanmaktadır. Kentler oluşmaya başladıklarından beri gerek doğa tarafından gerekse insanlar tarafından tahrip edilmişler ama sonunda yeniden inşa edilerek devamlılıklarını korumuşlardır. 1800'ü yılların sonundan itibaren ise, kötü koşullara karşı esneklik ve direnç, kentsel yerleşimin dünya genelinde kabul edilen bir gerçeği haline gelmiştir.

Kentsel afetler birçok farklı şekilde gerçekleşebilir. Yıkımın boyutu, insanlar üzerindeki etkisi ya da doğal nedenlerden kaynaklanmış olmaları gibi başlıklar altında farklı kategorilere ayrılabilir, ya dakentlerdeki yıkımlara neden olan afetler birçok farklı nedene dayanabilir. Ancak bu çalışma daha çok insanların neden olduğu, önlenemeyecek ya da en azından etkisi azaltılabilecek olan tehlikeler üzerine odaklanmıştır. Başka bir şekilde ifade etmek gerekirse, bu çalışmanın ana konusu dirençli ve gelecekteki koşullara uyum sağlayabilecek kentler üzerinedir. Kentler, bu tip yıkımlara karşı güçlü, esnek ve gelişen yeni koşullara uyum sağlayabilecek durumda olmalıdır. Yapılar, açık alanlar, altyapılar ve hatta kentlerin tamamı iklim ve diğer çevresel değişikliklere karşı dirençli duruma gelebilirler. Mevcut sistemleri sürdürülebilir sistemlere çevirmek ve birden fazla işlev yüklemek, geçmiş hatalardan dersler çıkarıp geleceğe uyum sağlamak için çalışmalar yapmak iyi bir başlangıç noktası olmaktadır.

Kentlerin iklim değişikliğine karşı dirençli olması ve oluşacak yeni koşullara uyum sağlamaya odaklanması oldukça önemlidir. Dirençli kentler, öngörülü hareket edip gelecek için kendilerini hazırlayabilirler. Bir kentin gelecekte oluşacak koşullara uygun duruma getirilmesinde bazı hususlar ön plana çıkmaktadır. Bunlar, iklim değişiminin üstesinden gelebilmek, fosil yakıtlarına olan bağıllığı düşürmek ve kentlerin adaptasyon kapasitesini yükseltmektir. Sürdürülebilir çevresel tasarımı teşvik etmek, yerel ve ulusal yetkililer ile birlikte hareket etmeyi geliştirmek, farklı meslek disiplinlerinin çevresel, sosyal ve ekonomik sorunlara karşı ortak çalışması için uygun bir ortam hazırlamak dirençli olma yolunda önemli adımlardır.

Kendini yenileyebilen ve yeni koşullara uyum sağlayabilen kentler ile ilgili araştırmada örnek inceleme alanı olarak Şikago kenti seçilmiştir. Şikago, 1871 yılında büyük bir yangın ile neredeyse tamamen yok olmuş, sonrasında da 1930'lu yıllardaki büyük depresyon ve onu izleyen 2. Dünya Savaşı ile sarsılmıştır.

Günümüzde ise, birçok kent gibi, modern yaşam koşullarının beraberinde getirdiği ısı adaları, sera gazı emisyonu gibi büyük sorunlar ile karşı karşıyadır. Bu araştırma ile enerji tasarruflu binalar, temiz ve yenilenebilir enerji kaynakları, gelişmiş ulaşım seçenekleri ve azaltılmış atık ve sanayi kirliliğinin kent üzerindeki etkisi incelenmiştir. Buna ek olarak, bu araştırma ile kentlerin sürdürülebilir olması ve kentlerde yaşayan insanların büyük şoklar ve stresler karşısında büyük farklılıklar ile karşılaşmadan hayatlarına devam etmeleri için gereken yeni koşullara uyum sağlama yolları ele alınmıştır.

Onbeş yıldan uzun bir süredir, Şikago çevreye duyarlı bir kent olma yolunda bir dönüşümü desteklemektedir. Çatı bahçelerinden geri dönüşüme, Şikago iklim değişimine karşı dayanıklı bir kent olmak için adımlar atmaya devam etmektedir. Şu an geldikleri noktada, sadece yerel yönetim değil, ticari kurumlar ve halkın da büyük bir kısmı kentin bu amacına destek vermektedir.

Dünya genelinde bilim insanları, ticari işletmeler ve idari birimler artık ortak bir noktaya vardılar. Dünya'nın bugün karşı karşıya olduğu en büyük sorunlardan birisini iklim değişimidir. Sera gazı emisyonu hem doğal nedenlerden, hem de insanlardan kaynaklanmaktadır. Son elli yıl içinde, atmosferdeki karbondioksit oranı yüzde 25 artış göstermiş; metan ve diğer sera gazlarının oranı da ikiye katlanmıştır. Isıyı hapseden bu gazların artması sonucunda, geliştirilen farklı bilimsel senaryolardan en kötüsü, sera gazı emisyonunun bu değerlerde devam etmesi durumunda, 21. yüzyılın sonuna kadar yıllık sıcaklıkların dört dereceye kadar artış gösterebileceğidir.

Eğer bir yapının veya çevre düzenlemesinin gelecekteki 30 yıl süresince ayakta kalması isteniyorsa, bu tasarımlar sadece bugünün ihtiyaçlarına bağlı kalarak oluşturulamaz. Kentler altyapılarını oluştururken veya yenilerken, yeni kentsel planlar oluştururken, bu yapıların uzun bir süre boyunca hizmet edeceğini göz önünde bulundurmak gerekir. Bu nedenden dolayı, yeni planlamalar yapılırken gelecekte oluşacak koşullar ve ihtiyaçlar dikkate alınmalıdır. Eğer kentler ve toplumlar dirençli ve geleceğe uyum sağlayacak hale gelmezler ise, sonuçta kaybedilecek tek değer sadece ekonomik olmayacak; doğal çevre ve insan hayatları da tehlikeye atılmış olacaktır.

Gelişmiş ülkeler geçen yıllar boyunca terör ile başa çıkabilmek için çok yönlü ve detaylı projeler geliştirmişlerdir. Şimdi ise, bu ülkeler fosil enerji kaynaklarına karşı alternatif ve sürdürülebilir enerji kaynaklarını araştırmakta, geliştirmekte ve kullanıma geçirmektedir. Bu şekilde tükenmekte olan ve ekonomik olmayan fosil yakıtlarının doğaya ve iklime verdiği zararların da önüne geçmek istenilmektedir. Fosil yakıtlara bağımlılığın devam etmesi ve iklim değişimine karşı önlem alınarak, uyum sağlamama ile ilgili senaryolar gösteriyorki, sonuç tam bir çöküş olabilir. Sürdürülebilir ulaşım modelleri geliştirmek, yürünebilir, karma kullanım alanlarına sahip yerleşim alanları, yenilenebilir enerji kullanan yapılar ve yeni teknolojiler ile bu durumun önüne geçilebilir.

Bu noktada ilk adım açık bir plan oluşturmak ile başlıyor, bunun ile birlikte kısa zamanda, orta ve uzun zaman dilimlerinde neler yapılabileceği belirlenebilir. Bu duruma karşı ne kadar kısa zamanda harekete geçilirse, uyum sağlama süreci toplumlar ve kentler için o kadar kolay olacaktır. İklim değişiminin yavaş hızda ilerleyen bir sorun olması yapılabilecekler için zaman kazandırırken, bazı kesimler yavaşlığından dolayı bu durumu hiç bir zaman gerçek bir sorun olarak görmeme hatasına düşmektedir.

Düşük ve orta gelirli toplumlar da, gelişmiş toplumlar gibi iklim değişimine karşı önlemler almaya başlamak zorundadır. Aksi takdirde bu durumdan en kötü etkilenecek kısım onlar olacaklardır. Dirençli ve uyum sağlayabilir hale gelmek için en büyük rol, yerel ve ulusal yönetimlere düşmektedir. Yönetimler iklim değişiminin olumsuz etkilerini azaltmak ve uyum sağlamak ile ilgili uygun kanunlar ve yetkisel güçler geliştirmelidirler. Başarılı bir adaptasyon, bilgi ve sorumluluk ile birlikte, iyi kaynaklara ve teknik yeterliliğe sahip yerel yönetimlere de ihtiyaç duymaktadır. Ayrıca yerel yönetimler birçok farklı disiplinden olan meslek grupları ile birlikte, risk anında birlikte çalışmayı yürüterek, liderlik edebilmelidir. İyi yönetilen kentler,

halkın ve ekonomisini ileride karşılaşılabilecekleri şok ve streslerden, bunlar iklim kaynaklı olsalar bile, koruyabilecek kentlerdir.

Türkiye de gelişmekte olan ülkeler arasında yer almaktadır. Bu da iklim değişikliğine dirençli hale gelebilmek için birçok fırsata sahip olduğunu göstermektedir. Şikago'da uygulanan iklim değişikimine karşı dirençli hale gelebilme çalışmaları örnek alınarak, Türkiye için de uygun çözümlerin bulunması mümkündür. Bu çalışma kapsamında iklim değişikiminin nedenleri ve geçmişten bugüne kadar olan etkileri araştırılmıştır. İklim değişikimine karşı kentleri koruyabilmek için neler yapılabileceği, dirençli kentlerin nasıl oluşturulacağı, sera gazı salınımını düşürmek için alınabilecek önlemler ve önüne geçilemeyecek olan iklim değişikimine karşı nasıl uyum sağlanabileceği incelenmiştir. Bu inceleme her ne kadar Şikago kenti üzerinden gerçekleştirilmiş olsa da, dünyanın her yerinde iklim değişikimi etkisini göstermektedir. Şikago kenti üzerinden tartışılan tüm stratejiler, iklim değişikimine karşı uygulamak üzere, Türk kentleri içinde geçerli olacaktır.