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# CLIMATE CHANGE AND CHICAGO

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PROJECTIONS AND POTENTIAL IMPACTS

CHAPTER ONE - INTRODUCTION

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# INTRODUCTION

Chicago's climate is one of its most recognizable characteristics – windy, icy winters, green springs, hot and humid summers, and crisp autumns define the city for both its inhabitants and visitors alike. The presence of Lake Michigan provides cool relief during summer and a moderating effect in winter.

The Chicago area is mostly flat, with hills virtually nonexistent because of the glacial lakes that covered the area for thousands of years. Most of the Chicago area consists of marshy soil; historically, the land was often flooded because it is only a few feet above the level of Lake Michigan.<sup>1</sup>

Before 1880, Chicago was known as the Garden City - its Latin motto is *Urbs in Horto*, "city in a garden"<sup>2</sup>. However, by the mid-1880s, Chicago became known by its most common appellation, The Windy City. Supposedly, this name arose as an attempt to promote Chicago as a summer resort because of the cool breezes from Lake Michigan. The Chicago Tribune of June 14, 1876 discussed "Chicago as a Summer Resort" at length, proudly declaring that "the people of this city are enjoying cool breezes, refreshing rains, green fields, a grateful sun, and balmy air—winds from the north and east tempered by the coolness of the Lake, and from the south and west, bearing to us frequent hints of the grass, flowers, wheat and corn of the prairies."<sup>3</sup> However, others have suggested the nickname stuck because of the effects of the tall buildings creating man-made wind tunnels in high-density areas.

## GREENHOUSE GASES

Gases in the atmosphere that trap infrared or heat energy emitted by the Earth that would otherwise escape to space.

The most important naturally-occurring greenhouse gas is water vapor.

The most important greenhouse gases produced by human activities are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O).

## GREENHOUSE EFFECT

A natural process by which greenhouse gases in the atmosphere trap heat, keeping Earth's temperature about 60°F warmer than it would otherwise be.

## THE ENHANCED GREENHOUSE EFFECT

A man-made process by which elevated levels of greenhouse gases in the atmosphere, produced from human activities, trap additional heat inside the earth-atmosphere system, artificially raising the Earth's temperature above its natural level.

## Changing Climate

Climate in the Midwest, including Chicago, has changed dramatically over past millennia. Eighteen thousand years ago, for example, when temperatures were an estimated 10 to 15°F cooler than they are today, the region was covered by a mile-thick ice sheet. By 10,000 years ago, the climate had warmed and the glaciers retreated, scouring out many of the lakes and rocky shores typical of the Chicago and Great Lakes region.

In the past, most large-scale climate variations in the Chicago area and around the world have been driven by natural causes. These include gradual, long-term shifts in the amount of energy the Earth receives from the Sun, amplified by natural feedbacks within the earth-ocean-atmosphere system, as well as sudden, short-term changes caused by events such as volcanic eruptions or meteorite collisions.

Today, however, the story is very different. Since the Industrial Revolution, concentrations of greenhouse gases such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) have been rising because of human-related emissions. The burning of fossil fuels (coal, oil, and natural gas), plus land use changes, especially tropical deforestation, are producing increasing amounts of atmospheric CO<sub>2</sub>. Agricultural sources and waste treatment are important sources of CH<sub>4</sub> and N<sub>2</sub>O emissions. Atmospheric particles, such as soot and sulfates, also contribute to the changing climate.

Atmospheric levels of carbon dioxide are now higher than they have been for at least the last 700,000 years<sup>4</sup>. Average surface temperatures in the Northern Hemisphere have risen by more than 1°F over the past 150 years<sup>4</sup>. Based on these and many other lines of evidence, the Intergovernmental Panel on Climate Change, which represents the work of thousands of climate scientists around the world, has concluded that it is very likely (with a certainty of more than 90%) that most of the climate changes observed over the last fifty years have been caused by emissions of heat-trapping or greenhouse gases from human activities<sup>4</sup>.

Although definitive attribution of regional-scale climate change to human causes is still difficult due to the relatively large year-to-year variability in local climate, changes that are at least consistent with global, human-induced warming are already under way in Chicago and across the Midwest. Since 1970, the region has been warming at a rate of more than 0.4°F per decade. Winter temperatures have risen even faster, at a rate of 0.9°F per decade from 1970 to 2000. This warming has been correlated with many noticeable changes, including:

- Increases of 2.6°F in annual average temperatures since 1980, with the greatest increases of almost 4°F occurring in winter
- A longer growing season, with earlier spring flowering of trees and plants, and fall frosts occurring later in the year
- Average minimum temperatures – the lowest temperatures recorded on a given day, usually at night – of 3.4 °F above normal (1971-2000) in 2006.
- Several major heat waves, particularly those in 1995 and 1999
- Decreases in winter ice coverage on Lake Michigan and smaller lakes in the area
- A doubling in the frequency of heavy rainfall events over the last century

The climate of Chicago - and the rest of the planet - is expected to continue to warm over the coming century in response to increasing emissions of heat-trapping gases from human activities. As illustrated in the chapters that follow, however, the extent of this warming and the magnitude of resulting impacts depend strongly on the choices made now and over the next few decades that will determine our future emissions.

## The City

The impacts of climate change on Chicago are directly proportional to the importance of the city itself. Chicago is the largest city in the Midwest and, with a population of just under three million people, is the third most populous city in the United States. Cook County, with over 5.4 million people (5,376,741 in the 2000 census), is the second most populous county in the U.S. Adding in the surrounding metropolitan area creates a population of over 9.5 million people, the third largest metropolitan area in the country.

In addition to being the financial, business, and cultural capital of the Midwest, Chicago is also generally considered to be the most important passenger and freight transport hub in the country, long having been the largest aviation market and having the most rail traffic in the U.S. Over thirty Fortune 500 companies, in an assortment of industries, have their headquarters in the Chicago area. Although its spiderweb of highways is heavily used, Chicago still ranks as 2<sup>nd</sup> in the nation in regional public transportation ridership<sup>5</sup>.

Climate change is not the only way that human activities are affecting the Chicago environment. Warm summer temperatures in combination with emissions of pollutants such as nitrogen oxides and hydrocarbons enhance the production of ground-level ozone in Chicago. Chicago currently fails to meet the

## CHICAGO CLIMATE TASK FORCE

As part of the goal for Chicago to become “the most environmentally friendly city in America”, Mayor Daley is proactive in providing leadership on concerns about climate change. The City of Chicago has already taken initial steps to reduce its greenhouse gas emissions and to adapt to changes in climate. The City believes it is imperative for the government, the business community, and the citizenry to come together to assess the full range of impacts of climate change and to develop a plan for the future. To that end, the City of Chicago and the Global Philanthropy Partnership (GPP) have joined forces to create the Chicago Climate Task Force. Representatives from business, civil society, government, and labor, along with climate scientists, are tasked with the development of an action plan for Chicago. This report is intended as an input to that process. A team of scientists and economic experts is assessing the state of understanding of the potential effects of climate change on the Chicago area and the resulting impacts that would be expected as a

national 8-hour air quality standards for ozone roughly 10 to 30 days per year.<sup>6</sup> While it is not as frequent an issue as many other U.S. metropolitan areas, Chicago still ranks only 43<sup>rd</sup> of the nation’s cities in air quality.

Mayor Richard Daley has led the campaign for Chicago to become “the most environmentally friendly city in America” — as well as the nation’s center for environmental design and the manufacturing of components for the production of alternative energy. At this point, Chicago currently ranks 4<sup>th</sup> in the U.S. in urban sustainability --- this basically implies that the people’s quality of life and city economic and management preparedness are likely to fare well in the face of an uncertain future.<sup>7</sup> In these rankings, Chicago also ranked 10<sup>th</sup> in the use of renewable energy (Chicago’s goal is to increase from 2.5% in 2006 to 20% in 2010) and in urban greening.

Analyses done for this assessment by the Center for Neighborhood Technology estimate that annual emissions of greenhouse gases in Chicago total more than 35 million metric tons of CO<sub>2</sub>-equivalent (which accounts for the other heat-trapping gases in addition to CO<sub>2</sub>).<sup>8</sup> Adding in the six surrounding counties in the Chicago area increases this to about 103 million metric tons. This accounts for about 44% of the total emissions of the state of Illinois. In comparison, greenhouse gas emissions from the Chicago area alone are currently greater than those of 30 individual U.S. states.<sup>9</sup>

## This Assessment

The results presented in this assessment are based on a combination of past observations, the results from past and future simulations by state-of-the-art models of the climate system, and statistical techniques to downscale global climate model projections to individual Chicago weather stations. Potential changes in climate in the Chicago area are evaluated based on two emissions scenarios: a higher scenario where atmospheric CO<sub>2</sub> reaches nearly four times its pre-industrial levels, and a lower scenario where atmospheric CO<sub>2</sub> is limited to about double pre-industrial levels by the end of the century. As shown in this report, the projected changes in climate could have many ramifications for the Chicago area, including potential serious consequences for Chicago’s public health system, water supply, ecosystems, infrastructure, and other key sectors.

Chapter 2 analyzes the past and projected future climate in the Chicago area. This chapter also describes the observational data, models, and methods used in assessing the projections of future climate change.

Chapter 3 examines the potential impacts of climate change on water in the Chicago area, including Lake Michigan and other inland lakes, rivers, and streams. The focus is on the impacts of increasing temperatures and shifts in annual and seasonal rainfall, snow, and precipitation extremes on the region's hydrology, lake levels, water quality, and aquatic ecosystems.

Chapter 4 addresses the potential impacts of climate change on health and on air quality in the Chicago area. It focuses particularly on the potential effects of climate-driven changes in extreme heat and air quality on human health, including mortality (death) and morbidity (illness), also addressing some of the social vulnerabilities leading to these impacts. The latest scientific understanding linking shifting climate zones to allergies and to vector-borne disease is also summarized.

Chapter 5 focuses on the potential impacts of climate change on ecosystems and agriculture, including analyses of the effects of warming temperatures and changing precipitation on tree and plant species, wildlife, invasive species, and pests. These include species both currently native to the Chicago region as well as those that may move into the region as climate zones shift northward over the coming century.

Chapter 6 presents the potential impacts of climate change on infrastructure and the economy. This includes an analysis of impacts on transportation systems, buildings, storm water management and sewers, and energy supply and demand. It also examines the resulting economic impacts on recreation, tourism, transportation and building infrastructure, and insurance.

Finally, Chapter 7 concludes with a review of the main conclusions of this analysis. It also briefly summarizes the findings of the separate adaptation and mitigation reports, placing these in the context of projected climate change impacts under the higher vs. the lower emissions scenarios.

# References

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<sup>1</sup> <http://www.chipublib.org/digital/sewers/history.html>

<sup>2</sup> <http://www.worldwidewords.org/qa/qa-win1.htm>

<sup>3</sup> [http://en.wikipedia.org/wiki/Windy\\_City,\\_Origin\\_of\\_Name\\_\(Chicago\)](http://en.wikipedia.org/wiki/Windy_City,_Origin_of_Name_(Chicago))

<sup>4</sup> IPCC WG1 2007

<sup>5</sup> The Sustainable Lane 2006 U.S. City Rankings (<http://www.sustainablelane.com>)

<sup>6</sup> The World Almanac and Book of Facts 2007 based on data over last decade.

<sup>7</sup> <http://www.sustainablelane.com/us-city-rankings/>

<sup>8</sup> This is likely due to the fact that Illinois is a net electricity exporter and exports approximately 28% of its electricity. Furthermore airport emissions are not included as part of the city's inventory. And lastly, downstate emissions from agriculture and natural gas use are substantial.

<sup>9</sup> Energy Information Administration (EIA), <http://www.eia.doe.gov/environment.html>

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