



Union of
Concerned
Scientists

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Confronting Climate Change in the U.S. Midwest



ILLINOIS

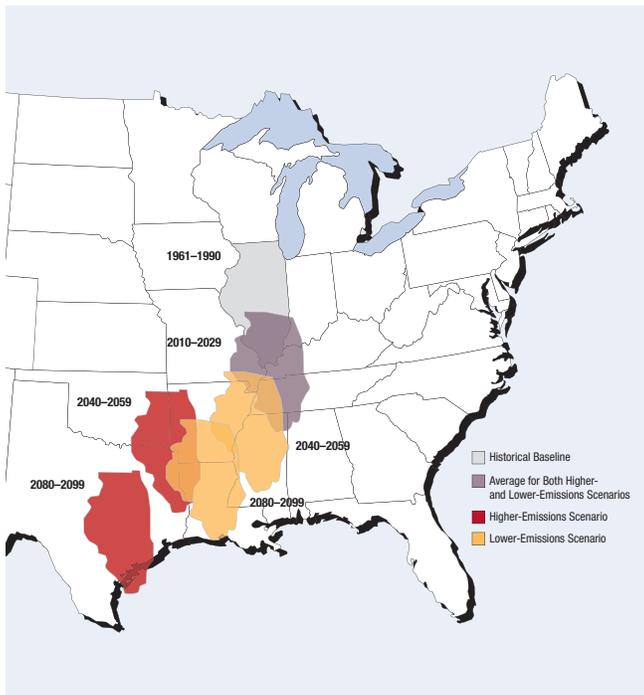
From its fertile farmlands and many riverside communities to its economy, infrastructure, and lifestyle, Illinois has been strongly shaped by its climate. However, that climate is changing due to global warming, and unless we make deep and swift cuts in our heat-trapping emissions, the changes ahead could be dramatic. This report presents new projections showing some of the potential impacts of global warming on Illinois, including severe summer heat, more dangerous storms and floods, and new threats to agricultural production.

GLOBAL WARMING AND THE MIDWEST

Global warming is caused by an increase of pollutants in the atmosphere, including carbon dioxide produced by human activities such as the burning of fossil fuels and

the clearing of forests. Carbon dioxide acts like a blanket that traps heat in our atmosphere and warms our climate; oceans, forests, and land can absorb some of this carbon, but not as fast as we are creating it. As a result, heat-trapping emissions are building up in our atmosphere to levels that could produce severe effects including extreme heat, prolonged droughts, intense storms, corrosive ocean acidification, and dangerous sea-level rise.

The climate of the Midwest has already changed measurably over the last half century (De Gaetano 2002; Kunkel et al. 1999). Average annual temperatures have risen, accompanied by a number of major heat waves in the last few years. There have been fewer cold snaps, and ice and snow are melting sooner in the spring and arriving later in the fall. Heavy rains are occurring about twice as frequently as they did a century ago, increasing the risk of flooding.



Illinois' Climate Migrates South

Changes in average summer "heat index"—a measure of how hot it actually feels based on a specific combination of temperature and humidity—could strongly affect Midwesterners' quality of life in the future. For example, the red outlines track what summers in Illinois could feel like over the course of the century under the higher-emissions scenario; the yellow outlines track what summers could feel like under the lower-emissions scenario.



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New Climate Projections for Illinois

New research summarized here projects significant consequences for Illinois as soon as the next few decades, increasing in severity into the middle and end of this century. This report considers these consequences in terms of three time frames: 2010–2039 (“the next few decades”), 2040–2069 (“mid-century”), and 2070–2099 (“toward the end of the century”). We compare these periods with the climate in Illinois during 1961–1990 (“the historical baseline”).

Toward the end of the century, if current pollution trends continue, projected effects in the state include:

Far more scorching summers

- Every summer in Illinois would be hotter than 1983—the hottest summer during the historical baseline.
- Chicago would experience more than 70 days per summer with highs over 90 degrees Fahrenheit (°F) and a month of days with highs over 100°F.
- Chicago would face at least two heat waves per summer like the one that killed hundreds in Chicago in 1995, and one heat wave every other summer like the even deadlier European heat wave of 2003.
- Air quality would deteriorate, as hotter weather causes more severe smog problems (assuming similar levels of tailpipe and smokestack emissions). This would have serious consequences for public health, including a greater incidence of asthma attacks and other respiratory conditions.

Dangerous storms and flooding

- Heavy rains would become more common throughout the year, leading to a greater incidence of flash flooding.
- Winters and springs, when the flood risk is already high, would become more than 25 percent wetter.

New threats to agriculture

- Crops and livestock would face substantially more heat stress, decreasing crop yields and livestock productivity.
- Warmer winters and a growing season up to six weeks longer would enable pests like the corn earworm to expand their range.
- Crop production would be inhibited by changing rain patterns such as wetter springs (which delay planting and increase flood risk) and almost 15 percent less rain during the increasingly hot summers.

Effective and Affordable Solutions

The most dangerous effects of climate change are likely to occur if the global average temperature rises more than two degrees Celsius above where it stood in 1850. Science shows we still have a chance of keeping temperatures below this level if we cut heat-trapping emissions deeply and

quickly—and limit atmospheric levels of carbon dioxide to 450 parts per million (see www.ucsusa.org/mwclimate for more details).

Illinois can do its part by implementing its own carbon-reducing state policies and investing in clean energy technologies that can both reduce consumer energy costs and

build new growth industries in the state. Illinois can also play a lead role in calling for strong federal legislation that would provide climate-friendly choices for Illinois consumers and businesses and help for resource managers and local governments that must prepare for the effects of climate change that cannot be avoided.

A recent analysis by the Union of Concerned Scientists (UCS), *Climate 2030: A National Blueprint for a Clean Energy Economy* (Cleetus, Clemmer, and Friedman 2009), demonstrates that the United States can cut heat-trapping emissions deeply and swiftly enough to avoid the most dangerous consequences of climate change. A comprehensive climate and energy approach—combining a cap on emissions with policies that encourage renewable electricity, energy efficiency, and cleaner transportation choices—can reduce emissions 26 percent below 2005 levels by 2020 and 56 percent below 2005 levels by 2030 while saving consumers and businesses money.

Our Analysis

Our analysis considers two different possible futures: one with a lower level of global warming pollution and one with a higher level (see www.ucsusa.org/mwclimate). These futures represent the best and worst cases of the emissions scenarios described by the international scientific community in 2000 and which have been used for scientific analysis ever since. However, they by no means encompass the full range of futures that could plausibly unfold.

Climate protection policies, if implemented quickly, could reduce emissions significantly below the lower-emissions scenario considered here. On the other hand, up until 2008, global emissions have been

higher than the higher-emissions scenario being considered.

HOW WILL EMISSIONS CHOICES AFFECT ILLINOIS' FUTURE?

Dangerously Hot Summers

Our new analysis projects dramatically hotter summers for Illinois. This is true under both the lower- and higher-emissions scenarios, but the prevalence of extreme heat is much greater under the higher-emissions scenario. The conditions that constitute “extreme” heat were measured in three ways: comparing future summers with the hottest summer during the historical baseline, counting the expected number of days above 90°F and 100°F per summer, and projecting the likelihood of extreme heat waves similar to those that hit Chicago in 1995 and much of Europe in 2003. By all three measures, summers in Illinois will become dangerously hot.

Comparisons with the historical baseline

As soon as the next few decades, almost three-quarters of Illinois' summers could be hotter than the hottest summer the state experienced during the historical baseline (1983, closely followed by 1988). Under the higher-emissions scenario every Illinois summer at mid-century is projected to be hotter than 1983. Even under the lower-emissions scenario 90 percent of summers at mid-century would be hotter than 1983, and all summers would be hotter toward the end of the century (though not as hot as under the higher-emissions scenario).

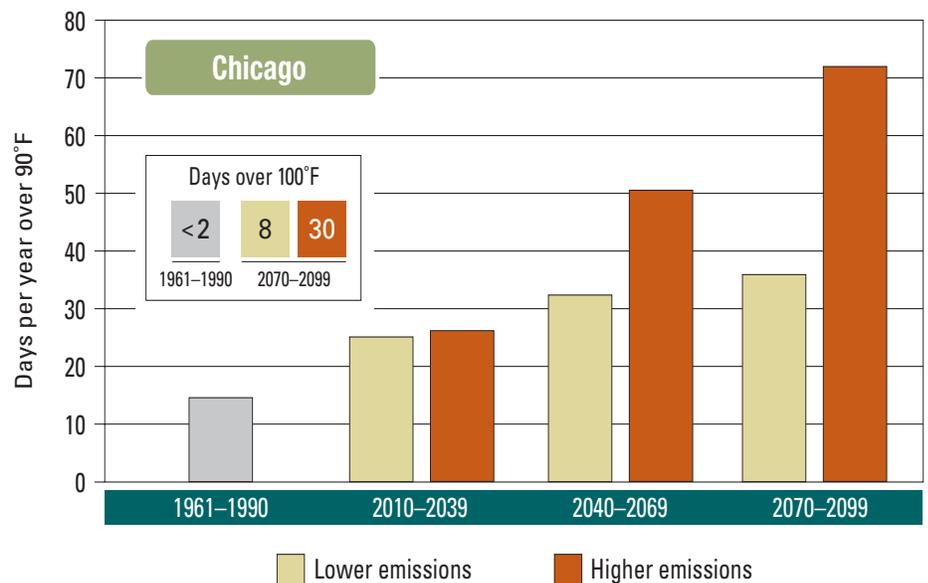
These findings are particularly troubling because the scorching summers of 1983 and 1988 brought

record-breaking heat to Illinois and much of the nation. The average temperature in Illinois in both summers was 3°F higher than normal. The unusual heat of 1988 combined with widespread drought to cause an astonishing \$40 billion in losses to agriculture and related industries nationwide—the United States' second costliest weather-related disaster in modern times (after Hurricane Katrina) (Lott et al. 2009). By mid-century, summers like 1983 and 1988 will likely be considered *cooler* than average.

More days over 90°F and 100°F

Because heat waves are especially lethal in cities, where urban landscapes

absorb more heat during the day and are less effective at releasing it at night (the “heat island” effect), our analysis focused on the extreme heat projected for the state's largest city, Chicago, and the number of days each year likely to exceed 90°F and 100°F. During the historical baseline Chicago averaged only 15 days per summer with highs over 90°F. That number rises substantially in the next few decades to more than 25 days, and toward the end of the century under the higher-emissions scenario, the city is projected to experience more than 70 days above 90°F—more than two months of the summer. Under the lower-emissions scenario that number would be cut by about half.



Extreme Heat Becomes More Frequent

Under the higher-emissions scenario, Chicago could experience more than 70 days above 90°F toward the end of the century. Under the lower-emissions scenario, the number of such days would be halved. Dangerously hot days over 100°F (shown in the inset box) are also projected to increase dramatically, with a month of such days expected under the higher-emissions scenario. Under the higher-emissions scenario, average summer temperatures are projected to increase over the next several decades by more than 3°F and, toward the end of the century, by an extraordinary 13°F. Under the lower-emissions scenario, that increase would be halved.

Illinois Could Face Heat Waves of Historic Proportions

In July 1995, Chicago experienced its worst weather-related disaster ever. Temperatures reached or exceeded 90°F for seven days in a row and exceeded 100°F on two of those days (Kaiser et al. 2007). Conditions were made worse by high humidity levels, unusually warm night-time temperatures, and pollution that built up in the stagnant air. Thousands of Chicagoans developed serious heat-related conditions, overwhelming the city's emergency responders and forcing 23 hospitals to close their emergency room doors to new patients. Like the city's hospitals, the county morgue was completely overwhelmed (Klinenberg 2002).

The heat wave was ultimately responsible for between 450 and 700 deaths in Chicago (Klinenberg 2002; CDC 1995). Most hospital admissions were due to dehydration, heat stroke, and heat exhaustion among people with underlying medical conditions.

If our heat-trapping emissions continue unabated, heat waves of historic proportions are projected to become routine in Illinois.

Of those admitted with heat stroke, one of every five died in the hospital and one of every four died during the following year (Dematte et al. 1998). Hundreds of additional heat-related deaths occurred in other parts of the Midwest and along the East Coast (NOAA 1996).

Yet Chicago's experience pales in comparison to the European heat wave of 2003—the worst of the past 150 years in terms of both duration and intensity. For almost three months daily high temperatures

were hotter than normal, with half of those days more than 10°F above normal. Daily low temperatures were also abnormally hot. The death toll was initially estimated around 30,000 (UNEP 2004), but more recent analyses have identified 70,000 heat-related deaths that summer in 16 countries (Robine et al. 2008). Hardest hit was France, where fatalities exceeded 2,000 per day during the heat wave's peak (Pirard et al. 2005).

If our heat-trapping emissions continue unabated, heat waves like these are projected to become routine in Illinois: under the higher-emissions scenario, Chicago would experience a heat wave comparable to the 2003 European heat wave every fifth year by mid-century. Toward the end of the century Chicago would suffer such a heat wave every other year under the higher-emissions scenario and once a decade under the lower-emissions scenario.

As for the more dangerous days over 100°F, Chicago averaged only about two such days each summer during the historical baseline. But toward the end of the century under the higher-emissions scenario, the city is projected to face 30 such days—an entire month. That number would be reduced to eight under the lower-emissions scenario. Compounding matters is the likelihood that Illinois' summers will continue to be humid—probably even more humid. Other Illinois cities such as Peoria, Rockford, and Springfield will face conditions similar to Chicago.

More deadly heat waves

The severe heat projected for Illinois poses serious health risks for residents. Heat waves already kill more people

in the United States each year than hurricanes, tornadoes, floods, and lightning combined (CDC 2006), and the average annual death toll of nearly 700 may well be an underestimate, since there are no uniform reporting requirements and many deaths are probably misclassified (Luber and McGeekin 2008). Studies show that deaths from many causes, including cardiovascular and respiratory disease, increase during heat waves.

The health costs associated with heat waves are not limited to deaths; many other people become sick enough to be hospitalized. In 2005, medical costs related to extreme heat and cold totaled \$1.5 billion nationwide, or more than \$16,000 per patient. The Chicago heat wave of 1995 increased admissions to Cook

County hospitals 11 percent (more than 1,000 patients) during the peak week (Semenza et al. 1999). Many heat-related deaths and illnesses can be prevented by improving warning systems, access to air conditioning, and year-round medical staffing.

Our research projects how likely Chicago would be to experience heat waves as severe as those that affected the city in 1995 or Europe in 2003 (see the text box above). Our findings are disturbing; under the higher-emissions scenario, for example:

- By mid-century Chicago would experience a heat wave as hot as the 1995 Chicago heat wave every summer and a heat wave like the 2003 European heat wave at least every fifth summer

- Toward the end of the century Chicago would experience at least two heat waves as hot as the 1995 Chicago heat wave every summer and a heat wave like the 2003 European heat wave every other summer

A heat wave similar to the 2003 European heat wave would cause more than 1,070 deaths in Chicago (37 per every 100,000 residents), compared with 94 heat-related deaths per summer during the baseline period. This assumes the demographics, vulnerability, and infrastructure of Chicago do not change from today. Increased use of air conditioning in the city would likely reduce the death toll, but the general aging of the population would likely increase the death toll since the elderly are most vulnerable to heat. The number of Illinois residents older than 65 is projected to be more than 1.6 times higher in 2030 than 2000, rising to 18 percent of the state's population (U.S. Census Bureau 2004).

Changes in air quality could also play a role: for example, if air quality deteriorates because warmer temperatures exacerbate smog and soot pollution, and we continue to burn more fossil fuels in our power plants and vehicles, heat-related mortality would likely rise. Conversely, cleaner air created by a shift away from fossil fuels would likely reduce heat-related mortality.

More dangerous air pollution

In areas where there are local sources of fossil fuel emissions, ground-level ozone—a dangerous air pollutant and the main component of smog—increases at temperatures over 90°F (Luber and McGeehin 2008). Since our projections show that, under the higher-emissions scenario, Illinois will

experience such temperatures virtually the entire summer toward the end of the century, the state can also expect far more days of unhealthy ozone levels than would occur without global warming. This is particularly bad news for the 12 Illinois counties (including those around Chicago and St. Louis, MO) that already experience ozone levels higher than the Environmental Protection Agency's (EPA's) health-based ozone standard (EPA 2008b).

High concentrations of ground-level ozone (not to be confused with ozone in the stratosphere, which provides an important natural shield against solar radiation) diminish lung function, cause a burning sensation in the lungs, and aggravate asthma and other respiratory conditions. Ozone may also contribute to premature death, especially in people with heart and lung disease (EPA 2008). Studies show that when ozone levels go up, so do hospitalizations for asthma and other lung conditions, and it appears that heat and ozone together increase mortality (Luber and McGeehin 2008). Ozone also damages plant life; the EPA warns that a climate change-induced increase in ozone could damage

ecosystems and agriculture as well as human health (EPA 2008).

Another air contaminant of particular concern in Illinois is small particulate pollution (or soot); the 12 counties mentioned above have already been identified as failing to meet federal air quality standards for this pollutant (EPA 2004), and Chicago ranks among the nation's 10 most soot-polluted cities (ALA 2009). Small particulates increase the severity of asthma attacks in children, increase the number of heart attacks and hospitalizations related to cardiovascular disease and asthma, and cause early deaths from heart and lung disease (ALA 2009).

The leading source of small particulate air pollution is coal-fired power plants, and as demand for electricity increases in response to rising temperatures, power plants generate more emissions. Therefore, climate change threatens to exacerbate Illinois' particulate air pollution.

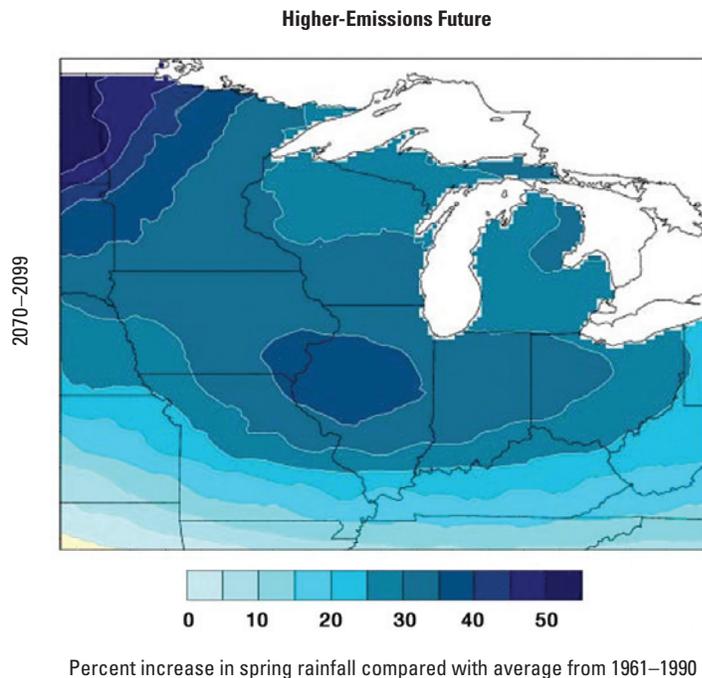
In Illinois today, more than 8 percent of the population (more than 244,000 children and more than 650,000 adults) suffers from asthma (ALA 2009). Heart disease caused 548 of every 100,000 deaths among

Warming Climate Leads to Poor Air Quality

The fact that air pollution worsens as temperatures rise should concern residents of large cities in Illinois—poor air quality already puts large numbers of people at risk from respiratory illnesses such as asthma, chronic bronchitis, and emphysema. Higher temperatures are also expected to increase the dangers of allergy-related diseases (Ziska et al. 2008).



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Spring Rains Increase

Heavy downpours are now twice as frequent in the Midwest as they were a century ago. Under the higher-emissions scenario, Illinois' spring rainfall is projected to increase almost 15 percent over the next several decades and more than 30 percent toward the end of the century. This may lead to more flooding, delays in the planting of spring crops, and declining water quality in rivers, streams, and storage reservoirs.

residents older than 35 between 1996 and 2000 (CDC 2009). The combination of increasing heat, ozone, and small particulate pollution can be especially dangerous for these populations.

Changes in Storm, Flood, and Drought Patterns

In 2008 Illinois experienced a year of devastating storms and flooding, which affected virtually every part of the state between January and September. In June alone, floods caused hundreds of evacuations; breached levees along the Mississippi, Embarras, and Wabash Rivers; and threatened thousands of acres of the state's agricultural land. Twenty-nine counties were declared federal disaster areas and the state received more than

\$90 million in federal disaster assistance (FEMA 2008).

As heavy rainfalls become more common, the threat of flooding will rise, as will the value of the property at risk and the costs of emergency response systems and flood control measures such as levees and dams.

More frequent downpours and flooding

Heavy downpours are already twice as frequent in the Midwest as they were a century ago (Kunkel et al. 1999). While scientists cannot attribute any single storm to climate change, more heavy precipitation can be attributed to climate change that has already occurred over the past 50 years (Trenberth et al. 2007).

Our analysis indicates that the warming ahead will make Illinois substantially more vulnerable to the kind of natural disasters it suffered in 2008. Two findings stand out from the research:

- **Precipitation is more likely to arrive in the form of heavy rains.** Under the higher-emissions scenario Chicago is projected to experience a more than 20 percent increase in heavy rainfalls (defined as more than two inches of rain in one day) over the next few decades. Toward the end of the century, heavy rainfalls are projected to be 50 percent more frequent under the higher-emissions scenario and 35 percent more frequent under the lower-emissions scenario.
- **Winters, springs, and falls will be wetter but summers will be drier.** Winters and springs are projected to see almost one-third more precipitation toward the end of the century under the higher-emissions scenario, and autumns are projected to see more precipitation as well. Meanwhile, summers will see almost 15 percent less rain. As described above, more of the rain that does fall will be in the form of downpours.

These projections show a substantially increased risk of flooding in Illinois as the century progresses, especially if emissions are high. While there is likely to be some increase in local summertime flooding due to more frequent downpours, the greatest flooding risk will occur in the winter and spring, when seasonal precipitation is expected to increase the most. In fact, analyses of various rivers in the Midwest (which used a level of emissions somewhat lower than our higher-emissions scenario) projected more than triple the number of high-flow days toward the end

of the century (Cherkauer and Sinha 2009; Wuebbles et al. 2008).

More frequent short-term droughts

Paradoxically, Illinois could face not only the risk of greater flooding but also the risk of greater drought, although climate projections are less consistent in this regard. The more temperatures rise, the more water evaporates from the soil and plants, requiring more rainfall just to maintain the same soil moisture levels. However, the Midwest is projected to receive less rain in the summer (when temperatures are hottest), not more. As a result, the likelihood of drought in the region will increase, as overall water levels in rivers, streams, and wetlands are likely to decline. In Illinois, short-term droughts are projected to increase, but long-duration droughts (lasting more than two years) are likely to decline.

Lower water levels in the Great Lakes

Water levels in the Great Lakes are projected to decline both in summer (due to increased evaporation caused by higher temperatures) and winter (due to a decrease in lake ice) (Angel and Kunkel 2009; Hayhoe et al. 2009). The greatest declines are expected for Lake Huron and Lake Michigan. Under the lower-emissions scenario, water levels are projected to fall less than one foot toward the end of the century; under the higher-emissions scenario, levels are projected to fall between one and two feet. A decline of this magnitude can have significant economic, aesthetic, recreational, and environmental impacts, such as significantly lengthening the distance to the lakeshore, affecting beach and coastal ecosystems, exposing toxic contaminants, and impairing recreational boating and commercial shipping.

More threats to water quality

Heavy rains increase runoff that not only washes pollutants into waterways but—in cities such as Chicago—also causes raw sewage to spill from sewers into rivers and lakes. In the Chicago region, a mix of storm water and untreated sewage flows into Lake Michigan when more than about two inches of rain falls in one day (Lanyon 2007). Heavier downpours ahead mean the typical overflows of years past are likely to be exceeded.

To deal with this excess runoff, the city of Chicago is currently adding reservoirs to the existing network of sewage tunnels 200 feet below the Chicago River system. These reservoirs, which will be completed in phases over the next 10 years, will hold excess storm water and should reduce the occurrence of overflows (DWM 2009). Other cities may also need adaptation plans and new infra-

structure to cope with the projected changes in rainfall.

New Threats to Illinois' Agriculture

Illinois is an important part of the nation's agricultural heartland. Nearly 67 percent of the state's acreage is devoted to cropland (USDA 2009a); it ranks second nationally in total crop value, second in acres devoted to corn and soybeans, and first in grain, oilseed, dry bean, and dry pea sales. Illinois also boasts one of the nation's most productive livestock industries, ranking fourth in hog and pig sales (USDA 2009b). In 2002, nearly 13 percent of Illinois' jobs were farm-related (USDA 2005) and, in 2007, agricultural commodities brought more than \$11 billion to the state (USDA 2009a).

The heat and precipitation changes projected for Illinois have potentially profound implications for agricultural production. Toward the



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Changes Mean Uncertainty for Agriculture

Farmers in Illinois would benefit from the longer growing seasons expected to accompany global warming, but projected increases in spring rains could interfere with planting and cause more flooding. Farmers therefore face greater risk and expense if climate change continues unabated.



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Livestock Face Increasing Heat Stress

If heat-trapping emissions continue to rise at their current pace, the state's dairy cattle, hogs, pigs, and other livestock may experience near-permanent heat stress during the average summer toward the end of the century. Adaptation options include costly measures such as air-conditioned barns and spraying livestock with water during the hottest periods.

end of the century, growing seasons are likely to lengthen by three weeks under the lower-emissions scenario and by six to seven weeks under the higher-emissions scenario. Also, rising CO₂ levels have a fertilizing effect on crops. These changes by themselves would increase crop production, but they will be accompanied by many other changes that threaten production, such as heat stress, increased drought and flood risks, and an expansion of crop pests' range.

More heat stress for crops

The extreme summer heat projected for Illinois, particularly under the higher-emissions scenario, puts the region's crops at significant risk. Corn crops, for example, can fail at 95°F, with the risk increasing the longer the heat lasts. When such hot spells

coincide with droughts, as they often do, crop losses can be severe.

The United States lost \$40 billion from a 1988 heat wave—mostly due to crop losses. Crop yields in Illinois dropped precipitously that year, with corn and soybeans falling well below three-quarters of their average annual yields for the period 1978–1997 (USDA 2009c). Over the next few decades (under both emissions scenarios) most Illinois summers are projected to be hotter than 1988, and by mid-century under the higher-emissions scenario, all Illinois summers are projected to be hotter than 1988.

Our analysis projects the frequency with which Illinois and the Midwest would face three- and seven-day periods of crop-damaging temperatures of 95°F or higher. During

the historical baseline such periods of intense heat were extremely rare in the Midwest, with three-day periods occurring about once every 10 years and seven-day periods occurring on average only once every 30 years in the more southern states.

Under the higher-emissions scenario, however, a three-day period with temperatures reaching 95°F or higher is projected to occur at least every other summer in Illinois within the next few decades, and every summer toward the end of the century. A more destructive seven-day period would occur every other summer by mid-century and in at least three of every four summers toward the end of the century. Under the lower-emissions scenario, the frequency of such periods would be significantly less toward the end of the century, with a week-long period of extreme heat occurring in less than half of Illinois' summers.

The possibility of crop-damaging heat waves becoming commonplace in Illinois within a few decades represents a significant threat to the state's economy, which took in nearly \$5.7 billion from corn alone in 2007 (USDA 2009a). Crops such as wheat that fail at lower temperatures than corn are even more vulnerable.

A detailed study of the expected effects of climate change on crop yields in five Midwest states shows that corn yields in Illinois may decline as much as 50 percent by the middle of this century under a variety of scenarios and assumptions (Southworth et al. 2000). For soybeans, a crop that benefits more than corn from CO₂ fertilization, results were mixed, with some scenarios showing small yield gains and others showing decreases. In neighboring Indiana, the study's two locations had

differing results for wheat, with yields declining as much as 15 percent in southwestern Indiana but increasing by small amounts in east-central Indiana.

Hotter projected temperatures led to lower yields in all cases; corn yields, for example, begin to decline at 92°F and fall sharply at 100°F. Widely varying climate conditions during the growing season also decreased average yields in all of the study's models, so as temperatures continue to rise and weather becomes more extreme and variable, yields of all major crops will likely decline.

More heat stress for livestock

Extreme heat is also projected to cause heat stress for much of Illinois' livestock. Dairy cattle are particularly vulnerable to high temperatures, and milk production can decline when temperatures exceed 75°F to 80°F depending on humidity. Hogs, whose sale brought more than \$800 million to Illinois in 2007 (USDA 2009a), begin to feel heat stress when the heat index (a combined measure of temperature and humidity) surpasses 72°F. Illinois already loses \$20.5 million each year due to heat stress in swine (St.-Pierre, Cobanov, and Schnitkey 2003), and under the higher-emissions scenario, near-permanent heat stress will affect dairy cattle, hogs, pigs, and other livestock during the average Illinois summer toward the end of the century—unless they are kept cool using costly measures such as air-conditioned barns.

Wider spread of pests

The warmer winters ahead mean that crop pests and pathogens normally kept in check by cold temperatures are projected to expand their ranges northward. A recent study warned

that the expanding ranges of corn pests could have a substantial economic impact in the form of higher seed and insecticide costs and lower yields (Diffenbaugh et al. 2008).

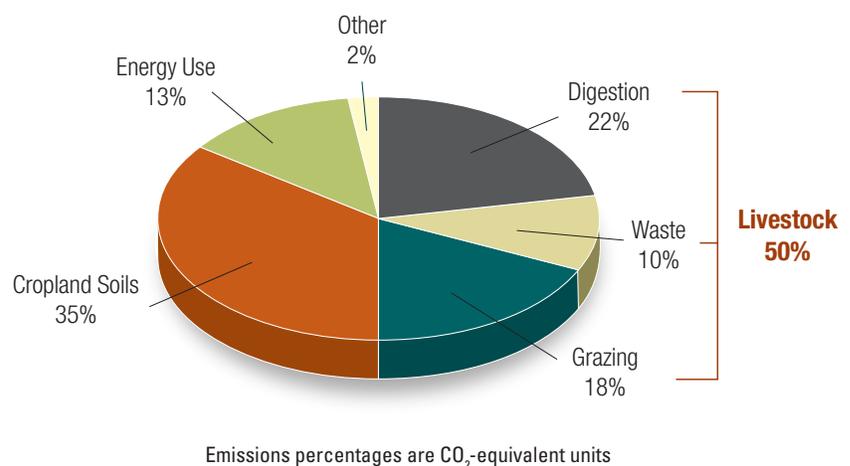
Already, corn pests cost U.S. corn producers more than \$1 billion annually; the corn earworm alone is responsible for destroying about 2 percent of the nation's corn crop every year, and it has shown resistance to a wide range of insecticides (Diffenbaugh et al. 2008).

Illinois' valuable corn crop would be at risk if the corn earworm does indeed move north. During the historical baseline, conditions conducive to the corn earworm occurred about once every 15 years in central Illinois and once every three years in parts of southern Illinois. Under the higher-emissions scenario, however, conditions conducive to the corn earworm would occur in about half of all years

toward the end of the century in central Illinois, and almost every year in southern Illinois.

Potentially damaging changes in precipitation

Crops under stress from extreme heat need more rain, but Illinois is projected to receive less rain in the summer growing season as the climate warms. Dry conditions will be a particular problem for Illinois' crops because only about 2 percent have access to irrigation (USDA 2009a). In addition, the projected increase in spring rains could interfere with planting and pose a greater risk of floods like those of June 2008, which affected thousands of acres of Illinois farmland (MRCC 2009). Changes in precipitation are therefore likely to limit farmers' ability to take advantage of the longer growing seasons expected to accompany future climate change.



Agriculture Contributes to Warmer Temperatures

Agriculture generates 7 percent of total U.S. heat-trapping emissions, including three potent global warming gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Half of these emissions come from livestock production, one-third from the cultivation and fertilization of cropland (which decreases its ability to absorb carbon), and the rest from energy used for power generation, transportation, and construction (USDA 2008).

CLIMATE SOLUTIONS FOR ILLINOIS

Illinois is the sixth largest producer of global warming emissions among all the states (EIA 2008a). Energy use, largely in the form of electricity generation and transportation, accounts for 85 percent of the state's emissions.

These emissions would be significantly lower if electricity generation in Illinois had not increased by 50 percent—almost double the national growth rate—since 1990, primarily as a result of deregulation. Illinois now generates about 30 percent more electricity than it uses, exporting the excess to other states (ICCAG 2009). Less than 1 percent of this electricity comes from clean, renewable

resources such as hydro, solar, and wind power; 48 percent comes from risky nuclear power and the rest from dirty fossil fuels: 47 percent coal and 3 percent natural gas (EIA 2009b).

If Illinois and the world are to avoid the worst consequences of climate change, the state must aggressively reduce its emissions by:

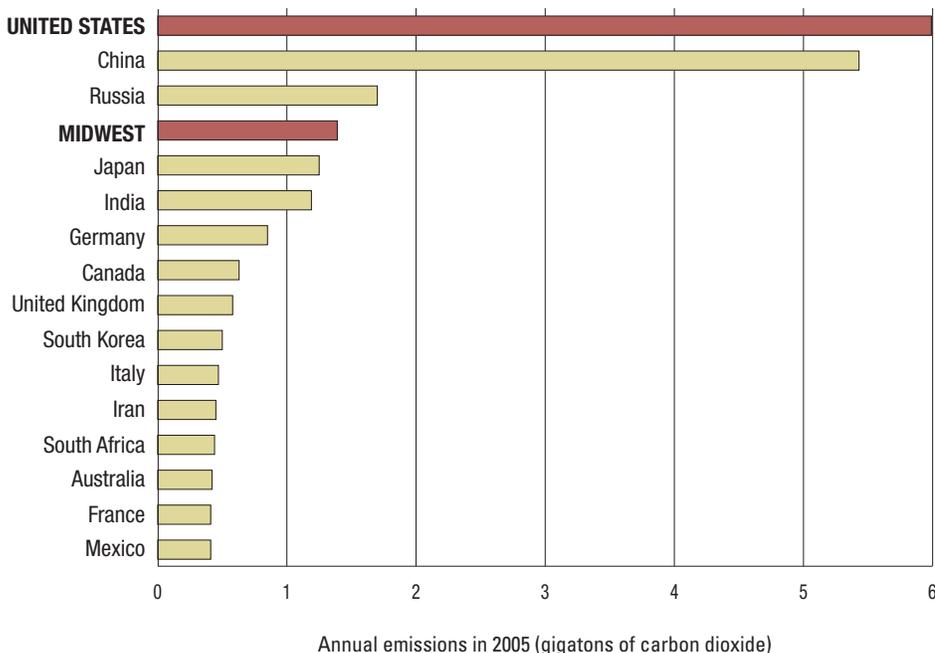
- increasing energy efficiency and conservation in industries and homes;
- boosting the use of renewable energy resources such as wind power, advanced biofuels, and geothermal energy;
- improving vehicle fuel efficiency and reducing the number of miles driven; and
- improving agricultural practices to reduce the release of heat-trapping

emissions from soil tilling and fertilizer application.

These actions will also provide benefits such as lower energy costs (after just a few years), new local jobs, and cleaner air and water. A recent analysis by the Union of Concerned Scientists shows that businesses and industries in the Midwest could collectively save \$3.8 billion on their electricity bills in 2020 and \$11.9 billion in 2030 by instituting these kinds of changes (Cleetus, Clemmer, and Friedman 2009).

Illinois has made strides toward implementing a number of the strategies listed above and deserves credit for its progress on the following initiatives:

- One of the strongest renewable energy standards in the nation, requiring utilities to supply customers with 25 percent renewable electricity by 2025.
- A requirement that electric and natural gas utilities reduce energy demand through energy efficiency programs. Illinois is one of only four Midwest states with such a policy, which can save consumers money, reduce global warming emissions, and create local jobs for people who perform energy audits, weatherize homes, and manufacture efficient windows.
- Building codes that will require new construction statewide to meet the regularly updated standards of the International Energy Conservation Code (IECC). Homes built to the 2009 IECC standards could save Illinois homeowners between \$300 and \$650 in annual energy costs (MEEA 2009).



The Midwest Burns More Fossil Fuels Than Entire Nations

The total combined emissions from eight states (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin) would make the Midwest the world's fourth largest polluter if it were a nation. The region's emissions are more than double those of the United Kingdom, which has about the same population (EIA 2008b).

Pathways to Real Progress

Illinois can do much more to take advantage of clean energy opportunities and reduce global warming emissions, by pursuing the cost-effective strategies summarized below.

Stop investing in polluting coal plants

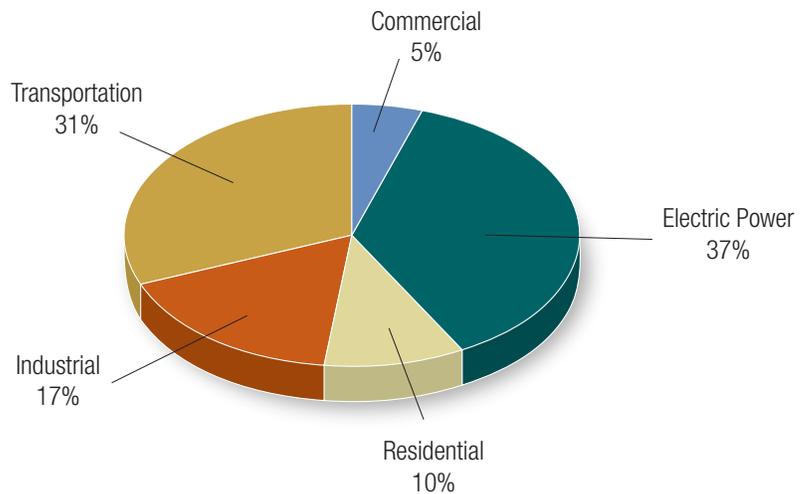
Illinois should adopt a moratorium on both the construction of new coal-fired power plants and the import of power from new coal plants outside the state—unless and until such plants adopt carbon capture and storage (CCS) technology (provided this proves commercially feasible). New financial commitments to coal plants without CCS will lock the state into high emissions for decades, while inhibiting needed investments in clean energy technologies.

Promote combined heat and power

The Illinois Climate Change Advisory Group recommended greater use of combined heat and power (CHP), which uses waste heat from industrial processes to generate electricity. Illinois should encourage the technology's expansion through tax incentives, attractive financing arrangements, and favorable utility rate structures.

Stabilize and expand public transit and high-speed rail

Only California and New York boast more public-transit ridership than Illinois (BTS 2001), and the numbers can be expected to grow due to rising gasoline prices, clogged highways, and the economic recession. Unfortunately, because the Chicago Transit Authority (CTA) is chronically under-funded, its trains are in poor condition, routes are being cut, and fares increased—all of which can put people back on the roads and add to Illinois' global warming emissions.



Vehicles and Power Plants Are Illinois' Biggest Polluters

Transportation and electricity generation—primarily from coal-fired power plants—are the largest sources of heat-trapping emissions in Illinois (EIA 2008a). This chart reflects CO₂ emitted by power plants within the state; it has not been adjusted to reflect power imported to or exported from Illinois.

The state needs to correct these problems and make a new investment in clean, efficient transit.

In addition, a high-speed rail network throughout the region would offer a low-carbon alternative to driving and flying, but after years of discussion, little progress has been made. Illinois and other midwestern states should aggressively pursue federal stimulus dollars and other funding for this project.

Building More Resilient Communities

Because climate change is already upon us and some amount of additional warming is inevitable, Illinois must adapt to higher temperatures and more heavy rains while working to reduce its emissions. Any delay in emissions reductions will make it more difficult and costly to adapt; conversely, aggressive steps to reduce emissions *now* will provide the time ecosystems and societies need to become more resilient. For each adaptation measure considered, Illinois' decision makers must carefully

assess the potential barriers, costs, and unintended social and environmental consequences.

A State-Federal Partnership

Although Illinois can achieve much with its own policies and resources, the scale of emissions reductions required suggests that individual states will need strong support from the federal government. The United States should therefore enact a comprehensive set of climate and energy policies including standards for renewable electricity, energy efficiency, and transportation that set a tight limit on heat-trapping emissions nationwide. The goal should be to reduce emissions at least 35 percent below current levels by 2020 and at least 80 percent by 2050.

A national renewable electricity standard and strong fuel economy standards for cars and trucks can boost local economies while substantially reducing emissions nationwide. For example, a renewable electricity standard of 25 percent by 2025

would lower electricity and natural gas bills a total of \$3.28 billion by 2030 (UCS 2009). A separate UCS analysis showed that if every car and light truck on U.S. roads averaged 35 miles per gallon (mpg) by 2018 (compared with the fleetwide average of 26 mpg today), drivers would save enough in fuel costs to create 10,300 new jobs in Illinois by 2020 (UCS 2007b). The Obama administration is currently pursuing new standards that would achieve an average of 35.5 mpg by 2016.

Another complementary federal strategy known as a “cap-and-trade” program would set a price on emissions and require polluters to obtain government-issued permits in order to continue emitting. By auctioning these permits the government could generate revenue for investment in:

- Energy efficiency and renewable energy solutions
- Assistance for consumers, workers, and communities facing the most difficult transition to a clean energy economy (coal miners and mining towns, for example)
- Conservation of precious natural resources
- Assistance for communities that must adapt to unavoidable consequences of climate change

Setting a price on heat-trapping emissions will also stimulate investment



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Green Roofs: A Sign of the Future

A green roof featuring more than 100 plant species was installed on Chicago’s 11-story city hall in 2000. The city wanted to demonstrate how such projects can mitigate the urban “heat island” effect, reduce storm runoff, and lower energy costs by providing extra insulation in the winter and a cooling effect in the summer.

in cleaner and more efficient energy technologies such as CCS by making them more cost-competitive.

Finally, federal resources devoted to climate monitoring and assessments can provide essential information for states and communities that need to devise and implement adaptation plans. Illinois’ U.S. senators and representatives must therefore support strong federal climate and clean energy policies that will help the state reduce emissions, transition to a clean energy economy, and

prepare for the climate change that will occur in the interim.

CONCLUSION

Global warming represents an enormous challenge to Illinois’ way of life and its residents’ livelihoods, but we can meet this challenge if we act swiftly. The emissions choices we make today—in Illinois and throughout the nation—will shape the climate our children and grandchildren inherit. The time to act is now.

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

For more information on the Midwest’s changing climate, along with a list of references for this report, visit:

www.ucsusa.org/mwclimate

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