Union of Concerned Scientists

July 2009

Confronting Climate Change in the U.S. Midwest

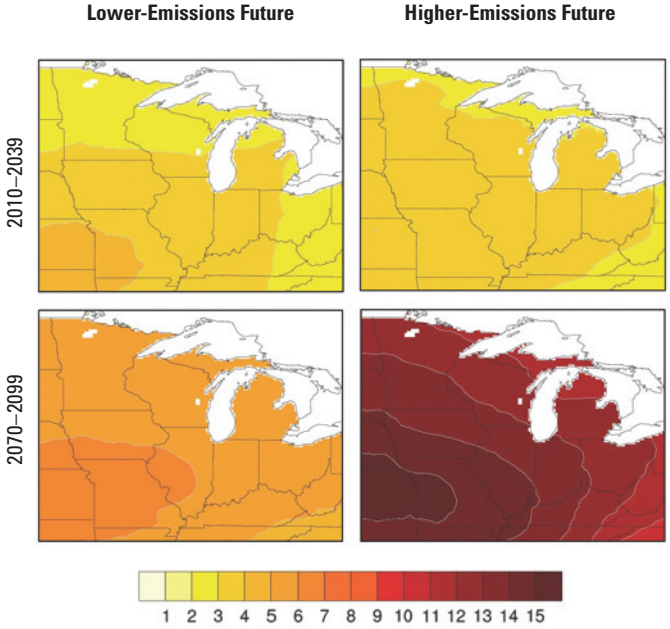
OHIO

From its rich farmlands and hardwood forests to its many riverside communities, Ohio 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 Ohio, 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 from 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.



Degrees F above average summer temperature (1961–1990)

Scorching Summers Become Standard

If our heat-trapping emissions continue to increase at the current rates, every summer in Ohio toward the end of the century is projected to be as hot as or hotter than 2002—Ohio's hottest summer of the last half century. Under the higher-emissions scenario (right), 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 12°F. Under the lower-emissions scenario (left), that increase would be halved.

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New Climate Projections for Ohio

New research summarized here projects significant consequences for Ohio 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 Ohio 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

- Cincinnati would experience more than 85 days per summer with highs over 90 degrees Fahrenheit (°F), and almost a month of days over 100°F. Cleveland would experience more than 60 days over 90°F and three weeks of days over 100°F.
- Cincinnati would face at least two heat waves per summer like the one that killed hundreds in Chicago in 1995. Cleveland would face at least one.
- 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 almost 30 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 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 5 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).

Ohio 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. Ohio can also play a lead role in calling for strong federal legislation that would provide climate-friendly choices for Ohio 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/midwest*). 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 emissions 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.

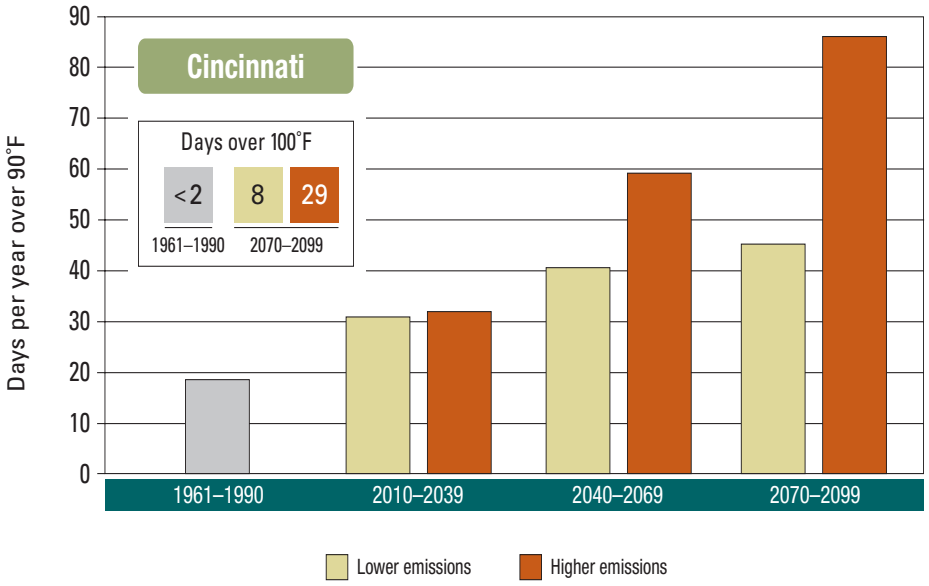
HOW WILL EMISSIONS CHOICES AFFECT OHIO'S FUTURE?

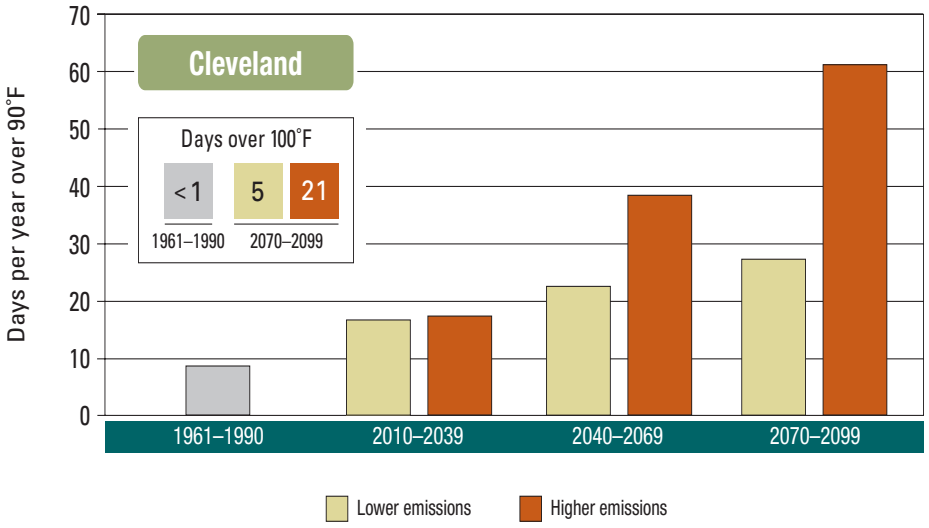
Dangerously Hot Summers Ahead

Our new analysis projects dramatically hotter summers for Ohio. 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 two ways: counting the expected number of days above 90°F and 100°F per summer, and projecting the likelihood of extreme heat waves similar to the one that hit Chicago in 1995 (see the text box on p. 4). By both measures, summers in Ohio will become dangerously hot.

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 two of the state's largest cities, Cincinnati and Cleveland, and the number of days per year likely to exceed 90°F and 100°F. During the historical baseline, Cincinnati averaged more than 18 days per summer with highs over 90°F, while Cleveland averaged half as many. Those numbers rise substantially in the next few decades, and toward the end of the century under the higher-emissions scenario, Cincinnati is projected to experience more than 85 days over 90°F—nearly the entire summer—while Cleveland is projected to experience more than 60 days over 90°F. Under the lower-emissions scenario





Extreme Heat Becomes More Frequent

Under the higher-emissions scenario, both Cincinnati and Cleveland could experience nearly an entire summer of 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: under the higher-emissions scenario, Cincinnati could expect almost a month of such days and Cleveland could expect three weeks of such days.

Ohio 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 days (Kaiser et al. 2007). Conditions were made worse by high humidity levels, unusually warm night-time temperatures, and the 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 heat-related deaths (Klinenberg 2002; CDC 1995). Hundreds of additional heat-related deaths occurred in other parts of the Midwest and along the East Coast (NOAA 1996).

If our heat-trapping emissions continue unabated, heat waves like this are projected to become routine in Ohio. Under the higher-emissions scenario, for example:

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

- By mid-century Cincinnati would experience a heat wave comparable to the 1995 Chicago heat wave nearly every year and Cleveland would experience one every three years
- Toward the end of the century Cincinnati would suffer two such heat waves every year and Cleveland would suffer one each year

Under the lower-emissions scenario, these projections are greatly reduced, with Cincinnati experiencing one such heat wave per decade and Cleveland averaging one every 30 years.

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).

Projections for Indianapolis and Chicago (cities that are generally cooler than Cincinnati) show that these cities are very likely to suffer a heat wave comparable to the 2003 European heat wave in the next several decades. Under the higher-emissions scenario a heat wave of this magnitude would occur at least every fifth year by mid-century, and every other year toward the end of the century.

these numbers would be cut by about half for each city.

As for the more dangerous days over 100°F, Ohio's cities averaged only one or two such days each summer during the historical baseline. But toward the end of the century under the higher-emissions scenario, Cincinnati is projected to face more than 29 such days and Cleveland more than 21. These numbers would be reduced to eight and five, respectively, under the lower-emissions scenario. Compounding matters is the likelihood that Ohio's summers will continue to be humid—probably even more humid. Other Ohio cities such as Columbus and Toledo will face conditions similar to Cincinnati and Cleveland.

The severe heat projected for Ohio poses serious health risks for its 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 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.

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 et al. 2008). Since our projections show that, under the higher-emissions scenario, Ohio will experience such temperatures virtually the entire summer toward the end of the century, the state can expect far more days of unhealthy ozone levels.

This is particularly bad news for the 13 counties in the Cincinnati and Cleveland regions that already experience ozone levels higher than the Environmental Protection Agency's (EPA's) health-based ozone standard (EPA 2008b). Cincinnati itself ranks among the nation's 15 most ozone-polluted cities (ALA 2009). During the three-year period from 2005 to 2007, Ohio experienced more than 1,000 orange ozone alerts and almost 40 red ozone alerts; orange alerts represent ozone levels dangerous to sensitive groups including children, the elderly, athletes, and people with heart and lung diseases, and red alerts indicate the air is unhealthy for anyone to breathe.

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 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).

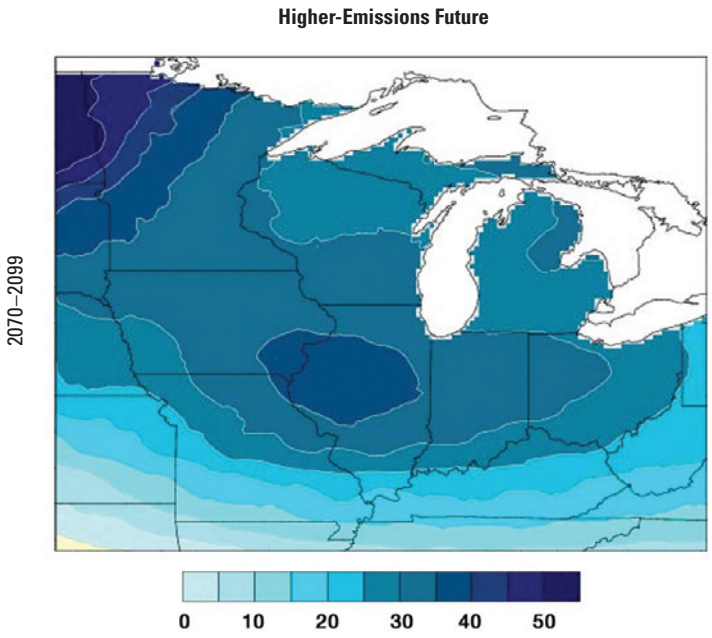
Another air contaminant of particular concern in Ohio is small particulate pollution (or soot); 27 counties, including those around Cincinnati, Cleveland, Columbus, and Dayton, have already been identified as failing to meet federal air quality standards for this pollutant (EPA 2004), and four Ohio cities rank among the nation's 20 most soot-polluted cities (ALA 2009). Small particulates increase the severity of asthma attacks in children, increase the number of heart attacks and hospitalizations for 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 Ohio's particulate air pollution.

In Ohio today, more than 9 percent of the population (more than 190,000 children and more than 500,000 adults) suffers from asthma

Warming Climate Leads to Poor Air Quality

The fact that air pollution worsens as temperatures rise should concern residents of Cincinnati and Cleveland—poor air quality in these cities 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).



Percent increase in spring rainfall compared with average from 1961–1990

Spring Rains Increase

Heavy downpours are now twice as frequent in the Midwest as they were a century ago. Under the higher-emissions scenario, Ohio's spring rainfall is projected to increase almost 15 percent over the next several decades and about 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.

(ALA 2009). Heart disease caused 572 out of every 100,000 deaths in people 35 and older between 1996 and 2000, compared with only 536 nationwide (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

Floods already occur in Ohio almost every year. For example, heavy rains in June 2006 caused flooding along the tributaries of the Cuyahoga River in northeast Ohio. In August 2007, flood emergencies were declared in nine northern Ohio counties in response to the worst flooding in a century, which drove more than 500 people from their homes. Many of the same homes and businesses damaged in 2007 were flooded again in February 2008, and after several more months of record rainfalls, Ohio and much of the Midwest experienced additional flooding that June.

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 Ohio substantially more vulnerable to the kind of weather disasters it suffered over the last several years. Two findings stand out from the research:

- **Precipitation is more likely to come in the form of heavy rains.** Under the higher-emissions scenario Cincinnati is projected to experience a 30 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 occur more than twice as frequently under the higher-emissions scenario. The maximum amount of precipitation falling within a one-, five-, or seven-day period is also projected to rise under both scenarios.
- **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 5 percent less rain. As described above, more of the rain that does fall will be in the form of downpours.

More frequent short-term droughts

Paradoxically, Ohio could face not only the risk of greater flooding, but also the risk of greater drought,

although the 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 Ohio, short-term droughts are projected to increase, but long-duration droughts (lasting more than two years) are likely to decline.

Lower water levels in Great Lakes

Water levels in the Great Lakes are also 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 in Lake Erie are projected to fall less than one foot toward the end of the century, but almost 1.5 feet under the higher-emissions scenario. 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 Cincinnati and Columbus—also causes raw sewage to spill from sewers into rivers. This has been a long-standing problem in Cincinnati, where more than 14 billion gallons of untreated sewage spill into the city's waterways every year (MSDGC 2009). The heavier downpours ahead mean the typical overflow from years past are likely to be exceeded, so raw sewage will continue to spill regularly into Lake Erie and the Cuyahoga, Ohio, Olentangy, and Scioto Rivers and their tributaries—unless the state invests in new infrastructure to prevent this from happening (Ohio EPA 2009).

New Threats to Ohio's Agriculture

Ohio is an important part of the nation's agricultural heartland, with more than 200 different crops under cultivation (ODA 2006) contributing nearly $7 billion to the state economy in 2007 (USDA 2009a). Ohio's production of corn ranks eighth in the nation and its production of soybeans ranks sixth (USDA 2009c); it also produces substantial quantities of wheat, fruits, vegetables, and nursery and greenhouse crops. Nearly half of the state's total acreage is considered prime farmland, and one of every seven residents is employed in the food and agriculture industry (ODA 2006). Ohio also has a thriving livestock industry, ranking second in the nation for number of laying hens, eighth for hog and pig sales, and eleventh for milk and dairy product sales (USDA 2009c).

The heat and precipitation changes projected for Ohio have potentially profound implications for agricultural production. Toward the end of the century, growing seasons are likely to lengthen by three weeks under the lower-emissions scenario and six to seven weeks under the higher-emissions scenario. Also, rising CO_2 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 Ohio, particularly under the higher-emissions scenario, puts the

© Indianapolis Department of Public Works

Storm Runoff Threatens Public Health

Heavy rains often cause raw sewage to spill from city sewers into rivers. Projected increases in rainfall due to climate change would worsen this problem across the Midwest—especially in cities like Cincinnati, where an estimated 14 billion gallons of untreated sewage already spill into the city's waterways every year.

Changes Mean Uncertainty for Agriculture

Ohio's farmers 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.

region's crops at significant risk. Corn crops, for example, can fail at 95°F, with that risk increasing the longer the heat lasts. When such hot spells coincide with droughts, as they often do, crop losses can be severe.

The warmest summer in Ohio during the last half century was 2002. Crop yields dropped precipitously that year, with corn and soybeans falling to two-thirds of their average annual yields for the period 1989–2008 (USDA 2009b).

Our analysis projects the frequency with which Ohio 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 in three of every four summers in Ohio by mid-century, and one is projected to occur almost every summer toward the end of the century. A more destructive seven-day period would occur in at least one of every three summers by mid-century and in three of every four 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 one-quarter of Ohio's summers.

The possibility of crop-damaging heat waves becoming commonplace in Ohio within a few decades represents a significant threat to the state's economy, which took in $1.5 billion from corn alone in 2007 (USDA 2009a). Crops such as soybeans and wheat that fail at lower temperatures are even more vulnerable.

A detailed study of the expected effects of climate change on crop yields in five Midwest states projects lower yields for crops vital to Ohio's agriculture: corn yields, for example, begin to decline at 92°F and fall sharply at 100°F (Southworth et al. 2000). 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 Ohio's 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. During the historical baseline, average summer temperatures and humidity in Ohio did not exceed levels known to cause stress in livestock. Under the higher-emissions scenario, however, dairy cattle and other livestock will endure near-permanent heat stress during the average Ohio summer toward the end of the century unless they are kept cool using costly measures such as air-conditioned barns. This could hurt Ohio's production of milk and other dairy products, which ranks eleventh in the nation and was worth more than $860 million in 2007 (USDA 2009c).

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).

Ohio's 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 five years in parts of southern Ohio and once every 20 years in northern Ohio. Under the higher-emissions scenario, however, conditions conducive to the corn earworm will occur in four of every five years toward the end of the century in southern Ohio and in about half of all years in northern Ohio.

Potentially damaging changes in precipitation

Crops under stress from extreme heat need more rain, but Ohio is projected to receive less rain in the summer growing season as the climate warms. Dry conditions will be a particular problem for Ohio's crops because only a fraction of 1 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 the past several years. Changes in precipitation are therefore likely to limit farmers' ability to take advantage of the longer growing seasons expected to accompany future climate change.

CLIMATE SOLUTIONS FOR OHIO

Ohio is the fourth largest producer of global warming emissions among all the states (EIA 2008a). Its per capita emissions are nearly 19 percent higher than the national average (U.S. Census Bureau 2009; EIA 2008a), mainly because 87 percent of Ohio's electricity comes from coal-fired power plants (compared with the national average of 50 percent) (EIA 2007). Agriculture also produces global warming emissions—close to 7 percent of the U.S. total in 2005 (USDA 2008).

If Ohio 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 Ohioans drive; and
- improving agricultural practices to reduce the release of heat-trapping emissions from soil tilling and fertilizer application.

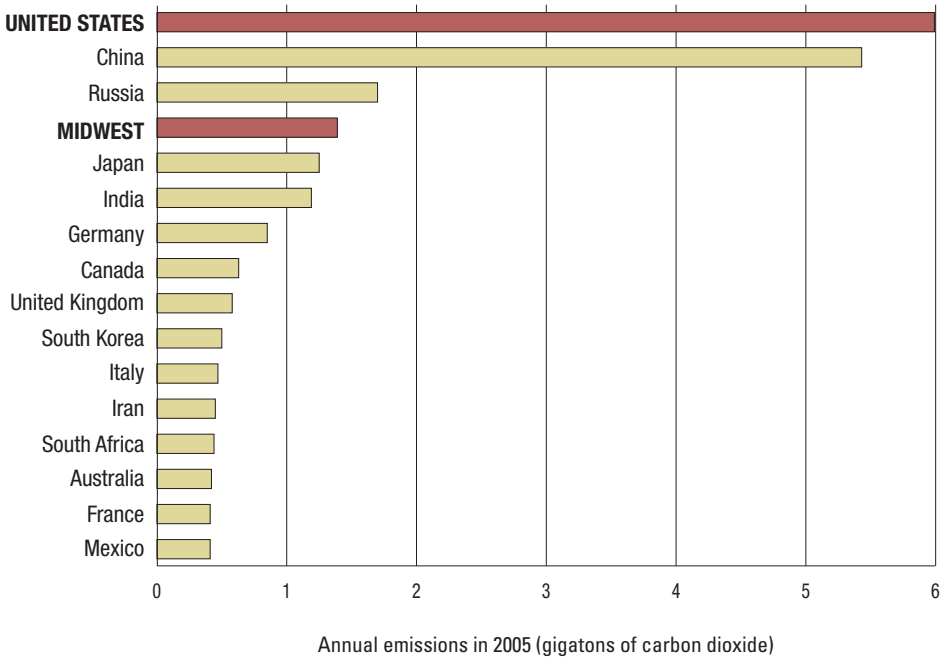
These actions will also provide benefits such as lower energy costs (after just a few years), new local jobs, cleaner air and water, and improved habitats.

Ohio's Accomplishments

In recent years, Ohio has adopted new policies to advance a clean energy economy. Senate Bill 221, for example, includes an alternative energy standard, energy efficiency

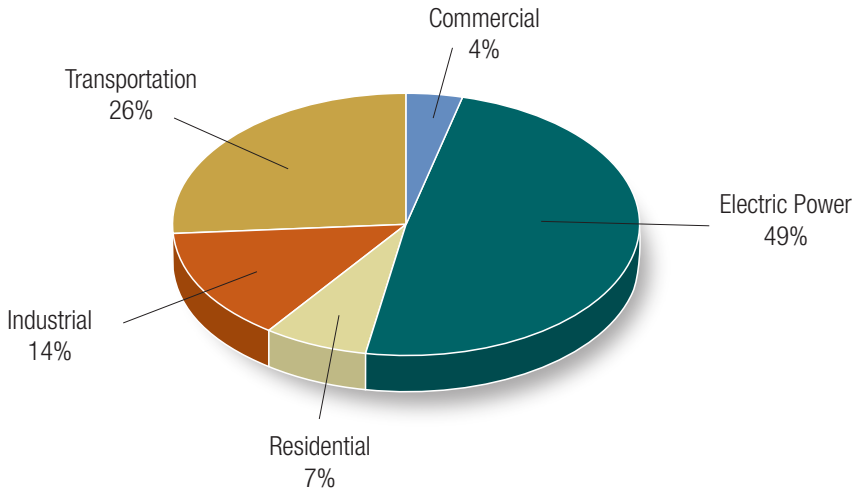
Green Building Design Saves Money and Energy

Cleveland's EcoVillage is a diverse neighborhood that is pedestrian-friendly and community-oriented. The complex of 20 townhouses and five "green" cottages was built with affordability, energy efficiency, and access to public transit in mind.



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).



Power Plants Are Ohio's Biggest Polluters

Electricity generation—primarily from coal-fired power plants—is the largest source of heat-trapping emissions in Ohio, followed by transportation and industry (EIA 2008a).

resource standard (EERS), and a peak-demand reduction requirement.

- The alternative energy standard requires that at least 12.5 percent of the electricity sold in Ohio must come from renewable resources such as wind and solar by 2025; half of that must be generated within the state and the electric utilities must report their CO_2 emissions.
- The EERS requires reductions in energy consumption of 22 percent by 2025. According to the Midwest Energy Efficiency Alliance, "Energy efficiency programs could save Ohio families and businesses $760 million in direct natural gas bill savings and $1.4 billion in direct electricity savings over the next five years" (MEEA 2009).
- Electric utilities must also reduce peak demand (which occurs on hot summer days) beginning in 2009, ultimately achieving a reduction of 7.75 percent in 2018.

In addition, all new schools in Ohio must be built to meet "green" building standards: specifically, the Leadership in Energy and Environmental Design (LEED) Silver requirements.

Pathways to Real Progress

While Ohio has made significant progress, more can be done to take advantage of clean energy opportunities in the Buckeye State, including the cost-effective strategies summarized below.

A stronger renewable electricity standard

Ohio's alternative energy standard is a step in the right direction, but the

state should follow the lead of Illinois and Minnesota, which both have a more ambitious goal of 25 percent renewable electricity by 2025. A stronger standard would save Ohio consumers more money and create more jobs in Ohio's agricultural and manufacturing sectors (as exemplified by First Energy's recently announced plans to reengineer its R.E. Burger coal-fired power plant in Shadyside to run entirely on biomass by 2012).

Better building codes

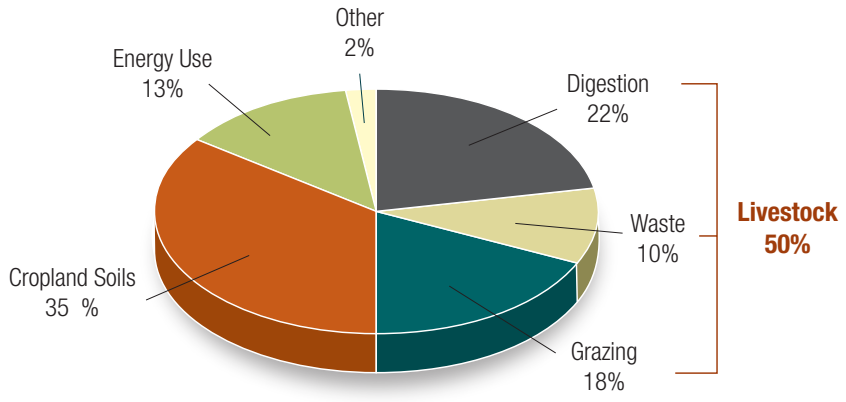
Modern building codes require a minimum level of energy efficiency in the design and construction of new buildings. Unfortunately Ohio's standards are out of date, lagging behind other states such as Iowa and Wisconsin. Updated standards would make Ohio eligible to compete for $3.1 billion in federal stimulus funds available for state energy programs.

Participation in regional emissions reductions

Six Midwest states and a Canadian province are developing the Midwestern Greenhouse Gas Reduction Accord, a regional, market-based program for capping global warming emissions. While these states would prefer a federal program, they see their regional initiative as a "plan B" if Congress fails to act. Ohio is currently an "observer" to the program but should instead become a full participant.

Building More Resilient Communities

Because climate change is already upon us and some amount of additional warming is inevitable, Ohio 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, Ohio's decision makers must carefully assess the potential barriers, costs, and unintended social and environmental consequences.



Emissions percentages are CO_2-equivalent units

Agriculture Contributes to Warmer Temperatures

Agriculture generates 7 percent of total U.S. heat-trapping emissions, including three potent global warming gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). 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).

A State-Federal Partnership

Although Ohio 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 enact a comprehensive set of climate and energy policies combining 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, our analysis found that a renewable electricity standard of 20 percent by 2020 would create 7,360 jobs in Ohio and lower residents' electricity and natural gas bills a total of $213 million by 2020 (UCS 2007). 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 more than 10,500 new jobs in Ohio 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 in cleaner and more efficient energy technologies by making them more cost-competitive. One possibility is power plants equipped with carbon capture and storage technology (if and when this proves commercially feasible).

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Renewable Energy Presents Opportunity for Growth

Low-carbon electricity generation is essential if we are to decrease our heat-trapping emissions deeply and quickly enough to avoid the worst impacts of global warming. Solar energy, for example, could provide not only emissions-free power for our homes and businesses but also jobs and revenue that can help build a clean energy economy.

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. Ohio's 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

Climate change represents an enormous challenge to Ohio's way of life and its residents' livelihoods, but we can meet this challenge if we act swiftly. The emissions choices we make today—in Ohio 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

This report was made possible in part through the generous support of The Energy Foundation, Wallace Research Foundation, and Fresh Sound Foundation, Inc. The report was prepared by the Union of Concerned Scientists, with Melanie Fitzpatrick as project manager, Barbara Freese as lead science writer, and Bryan Wadsworth as editor. Rouwenna Lamm provided invaluable help in all stages of production. Our analysis is based on research conducted by Katharine Hayhoe (Texas Tech University) and Donald Wuebbles (University of Illinois).

Union of Concerned Scientists

National Headquarters
Two Brattle Square
Cambridge, MA 02238-9105
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Ste. 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

West Coast Office
2397 Shattuck Ave., Ste. 203
Berkeley, CA 94704-1567
Phone: (510) 843-1872
Fax: (510) 843-3785

Midwest Office
One N. LaSalle St., Ste. 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751