



CLIMATE CHANGE AND HEALTH IN INDIANA

Human-induced climate change is well-studied and documented. Despite the G-8 nations' agreement to limit warming to 3.6°F by 2050, Northern Hemisphere average temperatures have already increased by 1.4°F in the past 100 years and are anticipated to exceed this target even with substantial reductions in carbon emissions. At almost half the target, major human health impacts have been observed and, as warming progresses, are likely to increase. This document provides an overview of how climate change affects the health of Indiana's residents and has been reviewed by Harvard Medical School faculty members who specialize in the health impacts of global environmental change and hold degrees in medicine and public health.

KEY FINDINGS FOR INDIANA: CLIMATE CHANGE AND HEALTH

- 1) By 2040, 3 of every 4 Indiana summers are expected to be hotter than the hottest summer recorded to date, causing longer and more frequent heat waves, that contribute to life-threatening heat stroke and more respiratory disease from air pollution.
- 2) Indiana's residents may be more prone to develop kidney stones as rising temperatures predispose to dehydration.
- 3) More frequent heavy rainfall events and flooding, likely to be more common as the climate warms, may cause more water borne disease outbreaks from pathogens such as *E. coli*, *Cryptosporidium*, *Giardia* and hepatitis A.

CLIMATE CHANGE RESEARCH RELEVANT TO HEALTH OUTCOMES IN INDIANA

Increased greenhouse gas concentrations in the atmosphere have already changed, and will continue to change, the climate in Indiana.

- » In the past 30 years, winter temperatures have risen in the Midwest and northern Great Plains more than 7°F - faster than any other season and faster than past assessments suggested (USGCRP 2009).
- » By 2030, average temperatures across Indiana are expected to rise another 3°F and by up to 13°F towards the end of this century.
 - » By 2030, Indiana's summer climate is expected to feel like that of present day Missouri; winters will feel like those in current-day southern Ohio (UCS 2009).
- » Very heavy precipitation events (days with roughly 6 or more inches a day) increased 31% from 1958 to 2007 in the Midwest (USGCRP 2009).
 - » Within the next three decades, days with heavy rainfall in Indiana are projected to become more frequent (UCS 2009).
 - » During summer months, despite heavier daily downpours, overall precipitation raise the risk of drought (UCS 2009).

MAJOR HEALTH EFFECTS OF CLIMATE CHANGE IN INDIANA

A rise in deaths from respiratory disease and heart disease will result from elevated temperatures and increased frequency and duration of heat waves.

- » Models project that by 2050, Indianapolis will experience a heat wave each summer similar in magnitude to the 1995 Chicago heat wave that killed 739 people (EPA 2008).
- » Over the coming decades, several climate models indicate that air stagnation events over Indiana will become more common, perhaps by as much as 30% over current levels by 2100 (Differbaugh 2008). Stagnant air masses amplify the effects of air pollution from ground-level ozone (smog) and particulates (soot).
- » The formation of ground-level ozone increases during heat waves. Higher ozone causes asthma attacks and increases hospitalization rates and death, especially among those with chronic heart and lung disease.
 - » Ozone levels in 12 counties around Indianapolis already exceed EPA standards.
 - » Under further warming conditions, models project a ~10 part per billion by volume (ppbv) increase in average ozone levels for the Midwest by the 2050s (Racherla 2009).
 - » Relatively small increases in ozone (10ppbv) can increase daily mortality by 0.5% (Bell 2004). For Indiana, this would translate into an additional 730 deaths each year.

- » High ozone levels may contribute to the development of asthma in children (McConnell et al. 2002).
- » Severe ozone episodes, when ozone concentrations reach 20-30ppbv higher than average, are expected to be more common by the 2050s in the Midwest (Racherla 2009).

Kidney stones are more common with high temperature exposure, due to low urine volume. With projected temperature increases, Indiana’s population will be at higher risk for the development of kidney stones. (Brikowski et al. 2008)

- » By 2050, southern Indiana will fall into the high prevalence kidney zone (Brikowski et al. 2008).
- » By 2100, the zone will encompass the entire state (Brikowski et al. 2008).

Heavy rainfall events have become more common, and are associated with more frequent flooding and outbreaks of water borne disease.

- » In 2008, Indiana experienced several heavy rainfall events of 5 to 10 inches a day. One city, Martinsville, received more than 20 inches of rain in June alone (NCDC 2008).
 - » Between June 3-10, 2009, Indiana received a once-in-a-century period of rainfall. The resulting flooding closed major power plants, cut electricity supplies to thousands of residents and damaged hundreds of homes and businesses. The estimated damages exceeded \$100 million (MRCC 2008).
- » Indiana’s spring rainfall is projected to increase by 15% in the coming decades, with heavy downpours of over 2” a day increasing by 35% in Indianapolis (UCS 2009).
- » Heavy rains cause sewage to overflow into freshwater supplies and can lead to water borne disease outbreaks. Heavy rains (above 2 inches/day) are associated with water borne disease outbreaks from microbes such as *E. coli*, *Cryptosporidium*, *Giardia* and hepatitis A in the U.S.
 - » In Marion County, ~8 billion gallons of untreated sewage spill into Fall Creek and its tributaries annually (EPA 2006).
 - » Following legal action by the EPA, Indianapolis is spending nearly \$2 billion (over the next 20 years) on measures designed to reduce the average number of overflows to four per year (EPA 2006).
 - » Raw sewage spillage into the White River is likely to increase with the projected rise in heavy precipitation events.

More winter precipitation is falling as rain, creating conditions conducive to ice storms, which are hazardous for walking, traveling and power grids.

- » Carbon monoxide poisoning is more likely following ice storms from interrupted power supplies and poorly ventilated gas generators in households (Daley 2000).
- » Heavy winter storms increase hazards for motor and air travel.
- » Injuries sustained from falls on ice, including bone fractures and muscle sprains, are much more common after ice storms and can increase patient congestion in emergency facilities.

Climate change will affect the viability of agriculture in Indiana and the livelihoods of those dependent upon it. Financial stress and job loss are major contributors to depression and anxiety disorders, worsening certain physical diseases including diabetes, ulcers, heart disease and rheumatoid arthritis.

- » 15% of Indiana’s jobs are farm-related, contributing \$8 billion to the state’s economy.
- » Indiana ranks 4th and 5th in corn and soybean production, respectively, in the U.S.; 56% of Indiana’s land is devoted to crop production.
- » Crops will face growing stresses from more volatile weather and the proliferation of pests, pathogens and weeds (Rosenzweig et al. 2001).
 - » Corn crops often fail when temperatures reach 95°F, due to heat stress.
 - » More than 25% of the corn and soybean crops were lost in the 1988 heat wave. Over the coming decades, most Indiana summers are projected to be hotter than that of 1988.
 - » Warming and resultant increased winter survival of insect larvae are projected to expand the range of four corn pests: the corn earworm, northern and western rootworm complex of beetles, and the European corn borer.
- » The use of pesticides, fungicides and herbicides will likely increase with warming, increasing the concentration of these chemicals in freshwater bodies, contaminating drinking water supplies, coastal waters, recreation areas and waterfowl habitat (USGCRP 2009).

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Full references are available at <http://chge.med.harvard.edu>, “Policymaker Education”