



“Climate change is perhaps the largest looming public health challenge we face, certainly in the environmental health field.”

—Dr. Howard Frumkin, director, National Center for Environmental Health, 2006

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LOOMING PUBLIC HEALTH RISKS For more than a thousand years, the atmospheric carbon dioxide level has stayed relatively stable at 280 parts per million. When Patz started working on climate change issues about 14 years ago, the carbon dioxide level had risen to 370 parts per million; today, it stands at 385 parts per million. Accompanying this rapid rise in heat-trapping carbon dioxide has been a rapid rise in the global average temperature. It is already warmer now than any time in the last 1,000 years, and temperatures are expected to increase five to 10 degrees Fahrenheit over the next 100 years. Temperatures may become warmer than at any time in the last 400,000 years.

HEALTH RISKS OF A WARMER, WETTER WISCONSIN

Based on a presentation by Jonathan Patz, Associate Professor of Environmental Studies and Population Health Sciences, University of Wisconsin-Madison, and member of the Intergovernmental Panel on Climate Change

To summarize the problem, climate change has three main physical effects:

- Rising temperatures—more heat waves, stronger thunderstorms
- Rising sea level from melting ice caps and thermo-expansion of saltwater
- Hydrologic extremes—more floods, more droughts

So what does this mean for us and our health? Certainly we know about people dying from heat stress and cardio-respiratory failure during heat waves. The “urban heat island effect” occurs when sprawling cities with lots of black asphalt highways and concrete absorb the heat and hold it. So in the center of a large city, where the majority of people live, it’s going to be a lot warmer than it is on the outskirts of the city.

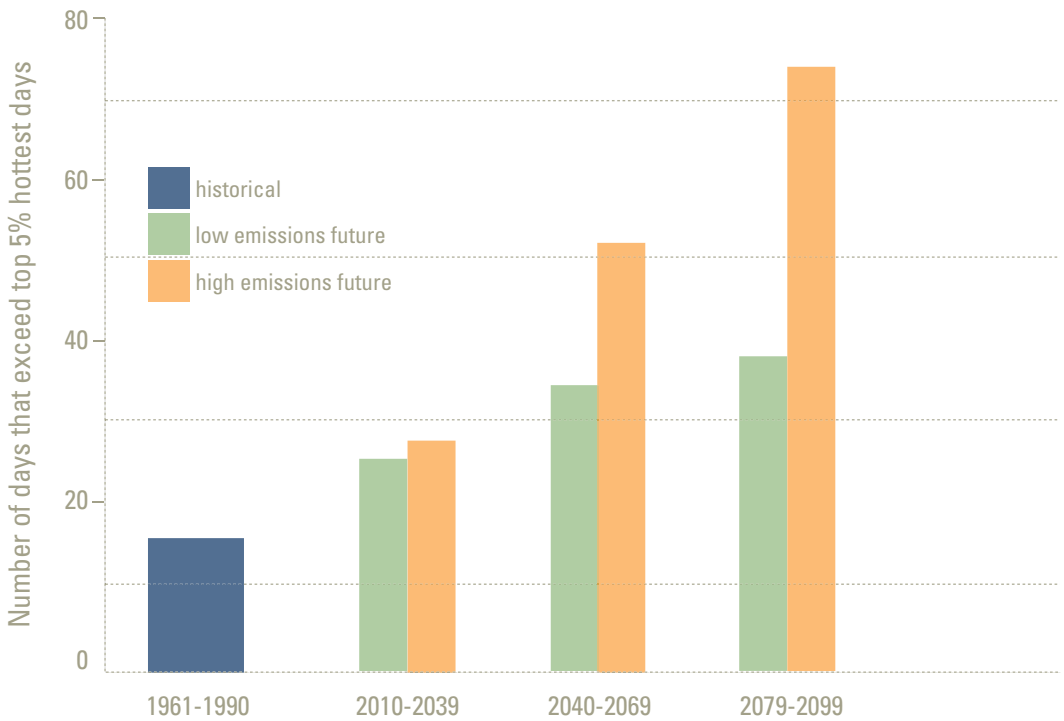
Other health effects of climate change include:

- Air pollution and allergens (asthma, chronic bronchitis, emphysema and other respiratory diseases)
- Vector-borne diseases (malaria, dengue, encephalitis, hantavirus, Rift Valley fever)
- Water-borne diseases (cholera, cyclospora, cryptosporidiosis, campylobacter, leptospirosis)
- Food and water supply (malnutrition, diarrhea, toxic Red Tides)
- Environmental refugees (forced migration, overcrowding, infectious diseases, human conflicts)

It’s the extremes of temperature and precipitation that most adversely affect people, and for Wisconsin the projected changes in extremes are for less cold weather and more hot weather, and more days with heavy precipitation.

With a STAR (Science to Achieve Results) grant from the U.S. Environmental Protection Agency, Patz is presently working with climatologists and Wisconsin public health officials to assess future climate change-related public health risks for residents of Wisconsin and the Chicago area.

HEAT WAVES Project climatologist Steve Vavrus at the UW-Madison Center for Climatic Research examined the changes in the number of extremely hot and cold days for southern Wisconsin using seven different



global climate change models. While there were some large differences in the models' projections for the frequency of extremely hot days, all of them agreed that by the end of this century, southern Wisconsin can expect fewer cold days but many more hot days.


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Moreover, the rise in degrees of temperature will be much larger on the hot side than on the cold side; in other words, extremely hot days will get much hotter than extremely cold days will be less cold. How much hotter it gets depends on how quickly and how much we reduce greenhouse gas emissions. While there is little difference in the short run, by the end of the century a low emissions scenario indicates we can reduce the number of extremely hot days by about half of what they will be under the scenario of continued high emission rates.

Either way, the projected increase in extreme heat poses significant public health problems. More than 70,000 people died in the heat wave that struck Europe in the summer of 2003. Temperatures during that heat wave were running about 40 degrees above normal, causing extraordinary electricity demand, difficulties cooling electrical power plants and numerous power outages. At Chinon, France, the temperature of the Vienne River topped 90 degrees.

We talk about being ready for such events, but are we really ready for extremes like that? We may have some surprises to deal with in extreme heat waves.

Global warming doesn't just mean the thermometer is creeping up. Climatologists say it means greater variability, and greater variability is



extremely difficult to plan for. Rather than just the average temperature going up, we will have more frequent extremely hot days, more days topping 100 degrees. Adjusting to this type of variability could be the most difficult for us.

AIR POLLUTION When a heat wave occurs, it is usually accompanied by a stagnant air mass, and stagnant hot air can cause tremendous pollution problems. In the 2003 European heat wave, a quarter of the deaths in England were attributed to air pollution associated with the heat wave.

According to the Intergovernmental Panel on Climate Change, the severity and duration of summer air pollution episodes are projected to increase in the Northeast and Midwest regions of the United States by 2045-52 due to climate change-induced decreases in the frequency of low pressure (storm) systems—in other words, more stagnant air. By 2050, the IPCC warns that warming alone may increase the number of Red Ozone Alert days across the Eastern United States by 68 percent. This is referring to ground level ozone, or photochemical smog pollution, rather than the ozone layer high in the stratosphere that protects us from the sun’s ultraviolet radiation. Ground-level ozone is extremely sensitive to temperature, so warmer temperatures may also mean greater health risks from higher ozone levels.

A study by UW-Madison’s Tracey Holloway (currently under review) examined air pollution in Chicago under different climate model scenarios. Chicago averages three to seven days each year that exceed the U.S. Environmental Protection Agency’s 84 parts per billion threshold for unsafe ozone levels. All six model projections say the number of days that ozone exceeds safe levels in Chicago is going to increase, although the models differ greatly on how many.

According to two of the models, the annual number of ozone red alerts in Chicago might frequently exceed 20 days by mid-century and average more than 20 days per year by the end of the century.

To make matters worse, some studies have shown that ragweed responds to warmer temperatures and more carbon dioxide in the atmosphere by producing more pollen. If the ozone season lengthens and goes into the spring, the combination of ozone and more pollen could worsen the situation for asthma sufferers.

INFECTIOUS DISEASES Global warming's greatest threat may also be the smallest. Mosquitoes are cold-blooded, which means their body temperature is the same as the air temperature. If a mosquito is carrying a nasty virus inside its body, air temperature can have a lot to do with the time it takes for that virus to develop inside the mosquito, which can result in more or less infectious mosquito bites. In general, when it's warmer, they become infectious more quickly. This is where a rise of one or two degrees in average temperature becomes important.

These cold-blooded insects carry lots of diseases, and one of the diseases spread by mosquitoes in this part of the world is West Nile virus. This is a zoonotic disease that cycles between mosquitoes and birds, but horses and people also can get infected, and for us it can be very serious.

West Nile virus arrived in the United States in New York in 1999 and has since spread across the country. It is believed to have spread so quickly because birds were carrying the virus up and down their migratory flyways on the Pacific and Atlantic coasts, across the Great Plains and along the Mississippi River.

Wisconsin had a large West Nile virus epidemic in 2002, when the summer average temperature was 10 degrees warmer than normal. The following summer was four degrees cooler than normal, and we had no epidemic. The reason for the 2002 epidemic was partly due to birds arriving here with the virus and partly because of the virus mutating into a more dangerous form, but some new research suggests that climate may have had something to do with it as well.

Recently published research on the strain of the West Nile virus that came into New York during the record-hot summer of 1999 found that its development requires warmer temperatures than other strains of the virus. The researchers also linked the West Nile epidemics in the summers of 2002-2004 to locations in the United States experiencing above-average temperatures, so health officials now think extremes in temperature may have something to do with modulating West Nile virus epidemics.



The common flood mosquitoes that appear after heavy rains generally are not carriers of West Nile virus. The primary West Nile virus mosquito belongs to the *Culex* genus of mosquitoes. These mosquitoes like dirty, concentrated water and thrive in hot drought conditions. In other parts of the world, heat waves and/or drought conditions have been associated with increases in the number of West Nile virus cases.

EXTREME STORMS, FLOODS Climate change is not just about warming, it's also about greater extremes in the hydrologic cycle. For much of the United States, global warming is expected to bring greater amounts of precipitation. Since the 1930s, a growing proportion of the United States has been indeed reporting much above-normal annual precipitation due to heavy rain, which is defined as more than two inches of rain in a day.

In a study of extreme precipitation and waterborne disease outbreaks in the United States during the 1948-94 period, Patz found that more than two-thirds of all outbreaks of waterborne diseases followed unusually heavy rains (above the 80th percentile), particularly surface water-related outbreaks. For example, the heaviest rainfall in 50 years preceded the 1993 cryptosporidium epidemic in Milwaukee, in which 405,000 people were exposed and 54 died.

Milwaukee is one of more than 900 communities in the United States that still have a combined sewer and stormwater system. Heavy rains can cause what are called combined sewer overflow events. This is not a new problem, and cities have been trying to clean this up, but it costs billions

and billions of dollars to redo a city's sewer and stormwater system. Climate change is expected to bring heavier rains with greater stormwater runoff, so bigger and more frequent combined sewer overflow events—which already discharge about 1.2 trillion gallons of sewage and stormwater each year—could become a serious public health problem in hundreds of communities.

Vavrus' climate research indicates the number of days with rainfalls totaling more than an inch are predicted to increase by 25 percent in Chicago by the late 21st century. Based on her Sea Grant study of stormwater contamination of Lake Michigan beaches, UW-Milwaukee's Sandra McLellan says that two inches is the threshold above which waterborne diseases and lots of contamination occur, so this could become another important public health issue in the future.

What we do to our landscape has a lot to do with our vulnerability to climate change. It can make things worse or better. As noted earlier, sprawling concrete cities with asphalt streets and highways can cause "urban heat islands." Hurricane Katrina was a disaster because of the size and power of the hurricane, but it was made worse because of the destruction of the Mississippi River delta coastal wetlands that once protected New Orleans.

A MATTER OF ETHICS There is also an ethical issue here. Hurricane Katrina was also a major social disaster, because it was mostly the poor people who couldn't get out of town, became stranded and died in the flood waters. There's a similar difference in who is most at risk from climate change. Climate change is a local problem, a regional problem and a global problem. How we behave and act locally can actually affect other people in our region and around the world.

Climate change is already contributing to deaths and disease around the world. Between 1970 and 2000, the World Health Organization estimates global warming caused at least 160,000 deaths and five million illnesses annually from malaria, diarrhea, malnutrition and flooding alone.

Climate-related mortality affects people in poor countries the most right now, especially in sub-Saharan Africa, but also in India and the Middle East. It is not an issue yet for nations in the Northern Hemisphere, who have been by far the biggest emitters of greenhouse gases and are most responsible for global warming. The people who have emitted the least amount of greenhouse gases are suffering the most.

Is it ethical that our energy policy and the way we live are contributing to deaths and disease around the world?

MITIGATION AND ADAPTATION People talk about mitigation mainly in terms of reducing the burning of fossil fuels. However, deforestation contributes about 20 percent to this problem. Trees absorb a lot of carbon dioxide, so when we cut down forests, we are actually making global warming worse. Earth has warmed already more than a degree in the last 90 years, and it's projected to keep getting warmer. We need to quit fueling the problem by burning fossil fuels and cranking out carbon dioxide. At the same, we need to try to protect our society from the warming that is expected to occur. We need both of these to happen at the same time.

The good news is that if we tackle the causes of global warming, we get lots of other benefits. About 800,000 people every year die from particulate air pollution. Burning gasoline or oil not only emits greenhouse gases and contributes to global warming, but it also releases particulate matter, which is the most dangerous form of air pollution. By reducing the burning of fossil fuels, we would not only reduce global warming but particulate air pollution as well.

Major efforts to do this are already underway around the nation and in Wisconsin as well. California Gov. Arnold Schwarzenegger has launched several major climate change initiatives to reduce greenhouse gases in that state. The mayors of more than 600 cities across the United States—including Mayor Dave Cieslewicz of Madison—have signed the “U.S. Mayors’ Climate Protection Agreement,” pledging to reduce their greenhouse gases emissions. Governor Jim Doyle has formed a Task Force on Global Warming to find ways to cut greenhouse gases with the goal of reducing Wisconsin’s carbon dioxide emissions 60 to 80 percent by 2050. The state Department of Natural Resources and UW-Madison also have formed a commission to look at this issue. Political will is growing, people are taking action, and change is starting to occur.

A HEALTHY WAY TO FIGHT CLIMATE CHANGE Climate change could be the greatest public health opportunity in more than a century in terms of Americans’ number one public health problem: being overweight. Two major factors in this problem are (1) the mass marketing and availability of junk food and “supersized” servings, and (2) a sedentary lifestyle.

It is estimated that two-thirds of Americans over age 20, plus 15 percent of those ages 6-19, are overweight. About seven percent of us—20.8 million people—have diabetes. Around 60 percent of American adults do not meet recommended levels of physical activity, and about 25 percent are completely sedentary.

Urban and neighborhood design that encourage sedentary lifestyles contribute to both obesity and greater greenhouse gas emissions. An example of this is an urban design that encourages driving and discourages bicycling and walking. According to the U.S. Department of Transportation, about 40 percent of all trips made by car are less than two miles long, which in most cases could be easily traveled by bicycle. However, drivers in most cities don't expect to see bicyclists on the street and roadways, and many people are killed in bicycling accidents as a result. We need to redesign our cities to prevent that. Designing safer bicycle routes would help us reach a threshold level of enough bikes on the road such that seeing bikes becomes the norm, and fewer bicyclists would get hit.

The top six leading causes of death in the United States can be grouped as (1) heart disease, strokes and diabetes; (2) cancer and respiratory problems, and (3) unintentional injury, most cases of which are, respectively, the result of (1) a sedentary lifestyle and obesity, (2) air pollution, and (3) motor vehicle accidents.

Patz is involved in the "Triple-Win Bike Project," which promotes bicycling over driving as a way to improve personal health through better physical fitness and at the same time reduce local air pollution and fight global climate change through reductions in greenhouse gas emissions.

Using Madison as an example, Patz said that if 20 percent of trips made by car were replaced with bicycling, it would reduce carbon dioxide emissions by nearly 17,000 tons a year and result in a 12 percent reduction in both ozone and nitrous oxide levels and a two percent reduction in particulate air pollution. That reduction in air pollution, in turn, would result in about 14,500 fewer acute respiratory cases and 2,000 fewer asthma admissions annually, which would save \$40 million in health care costs and prevent the loss of about 18,000 work-days each year. Each bicycle commuter making the typical seven-mile roundtrip to work could lose 10 pounds per year until reaching his/her optimum weight.

To that end, Mayor Cieslewicz recently appointed a Platinum Bicycling Committee in an effort to make Madison the first city "with real winter weather" to achieve platinum certification from the League of American Bicyclists for being bike friendly. Presently, Davis, Calif., is the only city in the nation with platinum status because 17 to 20 percent of its commuters bicycle. Madison is one of four U.S. cities to earn a gold rating. About 3.5 percent of Madison's population bikes to work. The national average is a mere one percent.