Good morning: I'm Dr. Lynn Ringenberg, professor emeritus of pediatrics at the University of South Florida and president of the Florida Chapter of Physicians for Social Responsibility, and president-elect of national PSR in Washington D.C., an organization of health care professionals dealing with issues that pose the gravest threats to human health and survival: Climate change and nuclear weapons. PSR shared the Nobel Peace Prize for our nuclear work in 1985.

I want to thank the EPA for this opportunity to speak to you today. I know there are others here today speaking in opposition to this rule, but as a physician who has practiced medicine for over 30 years and witnessed the decline in children's health over this period, I stand in strong support of the EPA Clean Power Plan. Everyday I practice, I see children struggling to breath due to asthma worsened by carbon pollution and young kids on 3 or 4 different medications to control their asthma symptoms. The quality of life for these children and their families is significantly impacted in a negative way by carbon pollution. It is time-overtime-as a nation- that we stand up to the polluters and say: no more damage to our health....clean it up! Just from soot and smog reductions alone, each dollar we invest in the Clean Power Plan could net American families $7 in health benefits.
I wear this white coat as a symbol of a profession that I believe has an obligation to speak out against those who damage public health! We need to be the voice for those who can't speak for themselves: infants, children, the elderly, those with disabilities, chronic health problems and minority populations who receive the brunt of coal-fired power plant pollution.

➢ There are a toxic slew of air pollutants in coal smoke, but the major one causing so many adverse health problems, like COPD, heart damage, asthma—to name a few—is carbon—the key driver of climate change. 40% of the carbon pollution in the United States comes from coal-fired power plants. There is no such thing as “clean coal”.

➢ Climate change affects health by increasing temperatures causing heat waves that can lead to dehydration, heat stroke and death, especially in young children, those with chronic health problems and the elderly.

➢ As temperatures rise, more populations are exposed to disease-bearing insects, extreme weather events with water contamination, flooding, water-borne diseases and an increase in wildfires causing smoke and particle inhalation that will aggravate asthma and other pulmonary diseases, cause an increase in cardiac deaths and stroke.

➢ Food production is vulnerable to climate change with increasing drought, floods and risk of famine, conflict and war.

Everyone in this room is a parent, grandparent, aunt/uncle, or at least knows a kid—a friend, colleagues or neighbors and all of us are connected by our common humanity to care for our “collective” children. We can leave no greater legacy to our children/grandchildren and the generations that follow than to leave a healthy, carbon pollution-free planet. It is imperative that we set the stage for this life-saving journey through implementing a strong Clean Power Plan that will protect public health and drive innovation in clean energy sources, like solar, wind that will power the 21st century, grow our economy and create good jobs.

Thank you EPA for taking this bold step—the most promising climate proposal in years.
Health Professionals

Support

EPA Clean Power Plan

PHYSICIANS FOR SOCIAL RESPONSIBILITY

U.S. Affiliate of International Physicians for the Prevention of Nuclear War

Working Toward a Healthy, Just and Peaceful World
Human generated greenhouse gas emissions are warming the earth’s climate. The threats to health posed by climate change are multiple, and increasingly severe.

Warming generates more frequent and intense heat waves, extreme weather events, shoreline loss, flooding and drought, air and water pollution, and agricultural losses. These in turn have health consequences: heat-related illness and death; storm-driven mortality and injuries; allergies, asthma, and other conditions exacerbated by pollution; insect and water borne diseases; poorer nutrition and lessened food security, and greater mental and emotional stress.

Researchers have found that climate change may lead to more asthma-related health problems in children, and more emergency room (ER) visits in the next decade.

HEAT WAVES

In most years, heat waves are the leading killer among extreme weather events in the U.S. Extreme heat events are rising in frequency, duration, and magnitude.

- Effects of extreme heat range from cramps to exhaustion and stroke. Heat stroke can result in delirium, convulsions, coma, and even death.
- In the 2003 European heat wave, an estimated 45,000 to 70,000 people died due to heat-related illness. In 2010 a Russian heat wave killed an estimated 56,000. 2013 brought severe and record-breaking heat waves and drought to many U.S. regions and around the world.

- Increasing heat levels and humidity are making outdoor work, play, and sports riskier to health.

EXTREME WEATHER EVENTS AND RISING SEA LEVELS

As the climate heats up, storms and floods are becoming more frequent, widespread, and intense.

- Severe storm surges on coastal areas can be devastating. Hurricane Katrina displaced over 1 million people and caused over 1,800 deaths. Hurricane Sandy inundated parts of New York City, flooding subways and cutting off power. Over fifty health care facilities evacuated their patients during Sandy.

- Thermal expansion and melting polar ice raise sea level, endangering people, animals, and crops in coastal areas worldwide. The city of Miami now has regular sewer backups with high tide and a full moon.

- 2012 and 2013 together saw 21 U.S. weather and climate disaster events that cost more than $1 billion. The 2013 Moore, Oklahoma, tornado measured among the strongest tornadoes ever.

- Extreme weather disasters not only cause event-related death and injury, but due to loss of homes, infrastructure and jobs, markedly worsen social determinants of health. For example, poverty levels rose significantly after Hurricane Katrina and have not returned to baseline eight years later. These effects are much worse on those who are poorer at the time of the event.
AIR POLLUTION

Higher temperatures increase ground-level ozone, a dangerous air pollutant. Almost half of Americans live in urban areas that already fail to meet the health standards for ozone.

- Ozone exposure can reduce lung function, permanently damage lung tissue, provoke new cases of asthma, and aggravate other chronic lung diseases. Ozone also affects the cardiovascular system and can increase the risk of dangerous heart arrhythmias. Further, ozone exposure increases the number of low birth-weight babies, currently the leading cause of infant mortality. Exposure to ozone in the first and third trimesters of pregnancy can cause 20% intrauterine growth retardation.

- Climate change is increasing the extent, intensity, and frequency of wildfires. The smoke contains particulates and toxic gases which aggravate health problems, including heart and lung diseases, infections, and emergency department visits.

- The allergy season will grow longer as ragweed and other pollens spread. Urban heat islands, pollutants, and allergens will combine to aggravate asthma.

WATERBORNE DISEASES

Increases in heavy rainfall, especially when interspersed with periods of drought, can contribute to flooding and contaminate water supplies. Dangerous waterborne diseases include hepatitis, giardiasis, cryptosporidiosis, and Naegleria fowleri — the brain-eating amoeba.

- Flooding can cause sewer overflows, with potential increases in infectious diseases. Flooding can also cause injuries and deaths, mold, psychological effects, and an increase in the populations of rats, mosquitoes and other disease-bearing hosts. In 2013, a thousand-year flood in Colorado caused $2 billion in damage.

- Infectious diarrhea is one of the most prevalent waterborne diseases globally. Severe diarrhea may be life-threatening, particularly in young children and the malnourished. Climate change is expected to worsen this.

VECTOR-BORNE DISEASES

Rising temperatures and changes in precipitation expand the habitable areas for disease-carrying animals, including birds, rodents, snails, and insects. This can increase the spread of such diseases as yellow fever, Schistosomiasis, Lyme disease, tick-borne encephalitis, and hantavirus pulmonary syndrome.

- Mosquitoes carry malaria, dengue fever, West Nile Virus, and other diseases. Higher temperatures boost their reproductive and biting rates, lengthen their breeding season, and accelerate the maturation rate of the malarial pathogen. Dengue or bone-break fever is now present in Texas and Florida, as mosquitoes capable of carrying the disease move north.

- According to the World Health Organization, in 2010, 219 million people around the world were infected and 660,000 died from malaria. As global warming continues, as many as 90 to 200 million additional people may be at risk of malaria by the latter half of this century.

AGRICULTURAL LOSSES

Climate change threatens food supply through severe storms, flooding, heat, drought, water evaporation, decreased pollination, and sea level rise.

- Every 1.8°F increase in global average surface temperature yields an estimated 10% decline.
in the world’s major grain crops. If we continue burning fossil fuels at our current rate, global temperatures may rise as much as 5.4°F to 9°F by the end of the century, with 30% to 50% declines in crop production.

Weather and rising temperatures can damage livestock and fisheries as well as crops. Rapid warming will force farmers to keep changing what they grow as agricultural zones migrate rapidly. Higher food prices resulting from diminished food security will reduce the capacity of people, especially the poor, to consume nutritious diets.

Nearly one-third of the world’s land surface may be at risk of extreme drought by 2100.

In the short term we can adapt to climate change, applying technologies like barriers on coastlines and pumps to avoid sewer backup. But as the climate heats up, the consequences will become catastrophic. The latest IPCC climate report warns that adaptation alone is not possible.

To slow climate change, we must address the largest sources of greenhouse gases. Small steps can help, and some—such as bicycling and eating less meat and palm oil—also contribute to a healthier lifestyle. But to have an impact on a scale adequate to resolve the problem, we must slash fossil fuel combustion. This means transitioning quickly to clean, safe renewable energies. An energy system based on wind, sun and water power will allow us to reduce greenhouse gases and slow and eventually stop climate change. The use of renewable energies also reduces air and water pollution, contributing yet again to healthier conditions for human life.

FOR FURTHER READING


JOIN US!

If you share the goal of reversing climate change, please join today.

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May, 2014
Climate change is acknowledged by scientists around the world to be a reality and to be caused primarily by human activity, especially the burning of fossil fuels. As the earth warms, the delicate balance of climate, weather events, and life is disrupted. Consequences emerge that threaten human health and, ultimately, survival. What is truly needed for health is restoration of a cool and stable climate.

Climate Change Increases the Threat of Disease from Insects

Insects can carry and transmit numerous diseases to humans. One concern about climate change is that it increases the spread of these insects and the diseases they carry.

- Changing temperature and precipitation shifts the geographic range in which insects live, resulting in expansion pole-ward and into higher elevations.
- Individual diseases that are sensitive to heat and precipitation will have a larger range and longer lifespan. The insects that carry them may experience an increase in their reproduction rate.

Climate Change Aids Mosquitoes

As the climate changes, new temperature and rain patterns will affect where mosquitoes live as well as their breeding and feeding patterns.

Higher temperatures:
- Expand the range of mosquitoes pole-ward and to higher elevations, putting previously unexposed populations at risk.
- Boost reproduction rate, lengthen breeding season, make mosquitoes bite more, and speed the development of the disease-causing agents they carry (bacteria, viruses, etc.) to an infectious state.

Rainfall:
- Standing water left by more intense and frequent rainfall, storms and hurricanes in many regions creates sites for mosquitoes to breed.

Mosquitoes and Their Threat to Health

Mosquitoes are transmitters of several viruses that can cause severe illness or death in humans, including West Nile Virus, dengue fever, encephalitis, and malaria.

West Nile Virus
- Between 1999 and 2012, about 37,000 cases of West Nile Virus were reported in the U.S., causing approximately 1,500 deaths annually.
- There are no medications to treat or vaccines to prevent WNV infections
- Approximately 80% of people who contract West Nile Virus do not show any symptoms.
Mosquito-borne Diseases, continued...

Dengue Fever
- Dengue fever can be transmitted by the Asian tiger mosquito, which is found in 36 countries.
- The disease is now established in many countries of the Americas, including popular tourist areas. Cases have been found in Florida.
- The most serious form of dengue, known as dengue hemorrhagic fever (DHF), can be fatal. It kills about 5% of its victims, mostly children and young adults.

Malaria
- In 2012 there were 207 million cases of malaria worldwide, causing some 627,000 deaths, mainly in sub-Saharan Africa.
- Each year in the U.S. there is an average of 1,500 reported cases of malaria, usually brought in by people who contracted the disease in a foreign country.

Climate Change and Ticks
Ticks serve as “bridges,” carrying diseases between affected animals and humans.

Lyme Disease
- Typical symptoms of this tick-borne disease include fever, headache, fatigue, and a characteristic skin rash. If left untreated, infection can spread to joints, the heart, and the nervous system.
- Modeling indicates the tick that carries Lyme disease will reach north into Canada, affecting previously unexposed populations.

Rocky Mountain Spotted Fever
- Rocky Mountain Spotted Fever (RMSF) is a tick-borne disease that is potentially fatal. Typical symptoms include fever, headache, abdominal pain, vomiting, and muscle pain.
- Untreated, RMSF can cause serious damage to internal organs, particularly the kidneys.
- Despite its name, over half of U.S. cases occur in the South Atlantic states (Delaware through Florida).
- Research suggests that, with warming trends, incidence of RMSF will increase in northern latitudes.

Signs like the one above can alert you to tick-prone areas and caution you about the diseases they can carry.

How to Protect Yourself
- Wear protective clothing and insect repellent to prevent insect bites.
- Check yourself and pets for ticks after being in wooded or grassy areas
- Take extra precautions from dusk to dawn, when mosquitoes are most likely to bite.
- Capture and remove or store water runoff that provides a breeding ground for mosquitoes.
- Repair damaged screens to prevent insects from coming inside your home.
- Listen to warning systems and signs to be aware of hazardous areas and outbreaks.

Take action to reduce climate change!

To protect our world from the health effects of climate change, we must take steps that restore the climate. This includes switching from fossil fuels to safe clean renewable energy sources like sun, water and wind. Planting trees and protecting forests. Planning growth to assure efficient, convenient mass transit. Where conditions permit, walking and bicycling more. We’ll all live better on a cool, green, healthy planet!

To learn more about what you can do, visit PSR’s website:
www.psr.org/environment-and-health/climate-change/
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Climate Change and Heat Waves

A heat wave is an extreme weather event when the temperature for a given region is unusually warmer than average, for a period lasting from a few day to months.

It is difficult to directly attribute a specific heat wave to climate change. However, scientists see a strong correlation.

- For the 21st century, the Intergovernmental Panel on Climate Change (IPCC) projects with 80% confidence that extreme heat events will intensify in magnitude and duration over portions of the U.S. where they already occur.

- The IPCC is also “virtually certain” there will be a decrease in the frequency and magnitude of cold days/night and increase in frequency and magnitude of unusually warm days/nights on a global scale.

- Scientists estimate that human influence on climate change more than doubled the probability of the European heat wave of 2003.

Heat and Health

Extreme heat can cause a range of ailments:

- Milder effects: rashes, cramps, heat exhaustion.
- Severe effects: Heat stroke. This is a severe illness. Body temperature rises to 105°F or more and can be accompanied by delirium, convulsions, coma and even death.

The risk of death from heat waves is higher for people with pre-existing heart conditions and respiratory illnesses.

Hospitalizations for stroke and cardiovascular disease also increase as temperature rises.

How serious is the threat?

Serious! 750 people died as a result of heat-related illnesses in the 1995 Chicago heat wave. During the European heat wave in 2003, an estimated 70,000 people died from stroke, heart attack, lung disease, and other causes exacerbated by heat.

Heat and Mental Health

- Long-lasting bouts of heat exacerbate stress and symptoms of mental illness.
- Heat waves have been shown to increase violent behavior, suicide, and homicide.
How to Protect Yourself

- Stay inside air conditioned homes or shelters during heat waves
- Avoid physical exertion outdoors on hot days, especially if you have asthma
- Stay hydrated
- Know the symptoms of heat exhaustion and heat stroke and seek medical attention:
  - Heat Exhaustion:
    - Headache
    - Dizziness
    - Dark colored urine
    - Rapid heartbeat
    - Profuse sweating
    - Confusion
    - Muscle cramps
    - Nausea
    - Fainting
  - Heat Stroke (most of the above plus):
    - Lack of sweat
    - Red, hot, dry skin
    - Fainting and unconsciousness

Who is most vulnerable?

- The elderly, who have diminished ability to regulate body temperature and are more likely to suffer from poor health
- Babies and young children
- Pregnant and nursing mothers
- Those chronically ill with pre-existing cardiovascular, respiratory, neurologic, and psychiatric conditions, or obesity.
- Outdoor workers
- Athletes, and children who are active out of doors.
- People who abuse drugs and alcohol
- People without access to air conditioning including the poor and those in areas previously not warm enough to warrant air conditioning.
- Urban populations. City environments hold more heat and routinely experience temperatures 2-10 degrees Fahrenheit warmer than surrounding areas.

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**Wildfires and Your Health**

Widespread fires have a major impact on human health and life.

- Air pollution particles in smoke and ash can cause coughing, irritated throat and sinuses, shortness of breath, chest pain, headaches, and stinging eyes.

- Smoke worsens respiratory conditions such as allergies, asthma, or chronic obstructive pulmonary disease.

- Inhalation of carbon monoxide can aggravate angina.

- Chronic health effects include increases in cardiovascular disease and mortality in populations living in areas with higher fine particulate air pollution.

- Burns and death. Those who do not evacuate safely and firefighters are at risk of being burned or killed by wildfires. The 2013 wildfire in Arizona killed 19 firefighters.

- Damage to homes affects people’s physical and mental health. It also impacts access to medical care.

**How to Protect Yourself & Others**

- If a wildfire occurs in your area, avoid outdoor activities. People with respiratory problems and chronic heart problems should consult with their doctor about taking extra precautions.

- If you must go outdoors in a smoky area, breathe through a damp cloth. While driving in smoky areas, keep windows and vents closed.

- Know evacuation routes. Listen to evacuation and safety advice if a wildfire occurs.

- Be responsible with fire:
  - Be cautious disposing cigarettes.
  - Only build fires in designated areas and during permitted times. Do not leave campfires unattended. Extinguish them thoroughly.
  - Use spark arrestors on off-road vehicles.

- Make sure trees and woody vegetation are a safe distance from your home. Stick to drought-resistant plants in your yard.
Climate Change Spurs Wildfires

Wildfires are uncontrollable and unpredictable fires in natural landscapes. The frequency of large wildfires and the area they burn has been increasing, especially in the western United States. Climate change is major contributor to this increase, for a number of reasons.

Warmer Temperatures
Average global temperatures have increased by 1.2°C over the past century, primarily because of increasing heat-trapping greenhouse gases, including carbon dioxide.

As global temperatures rise, fire seasons become longer as warmer temperatures begin earlier and extend into the fall.

Insects
Higher temperatures allow for a longer lifecycle for beetles and other insects that eat trees. Dry conditions also weaken trees and make it easier for these insects to damage them further, resulting in dead and highly combustible plants.

Drier Conditions
Snow packs are now melting up to four weeks earlier than they did 50 years ago, due to warmer temperatures. The water these snow packs supply soaks into the soil and then evaporates earlier than it would have years ago. As the season progresses, forests and grasses have less summer water source, making them more prone to drought, and ultimately, wildfires.

In addition, areas in the Western United States that already naturally experience fires, are experiencing decreased precipitation. In recent years, this region has been experiencing drought conditions, drying out vegetation -- and dry plant matter burns at higher temperatures. Combined with large quantities of fuel, this can lead to catastrophic fires.

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Climate Change and Waterborne Diseases

Climate change is making heavy intense downpours, droughts and rising water temperatures more common. This can alter the quality of our drinking and recreational water. Bacteria and viruses thrive in these new conditions and when they come into contact with humans, can cause numerous illnesses. Lack of water can also impact human health, especially in drought conditions.

Flooding and Runoff Contaminate Water

Contamination of drinking water by bacteria, viruses, and protozoa can trigger outbreaks of illnesses such as the diarrheal diseases legionella, campylobacter, and cholera.

- From 2009–2010, 33 water-associated disease outbreaks were reported in the U.S. They caused 1,040 cases of illness, 85 hospitalizations, and nine deaths.

Many regions of the world, including the Northeast and Southern Great Plains of the United States, have experienced an increase in precipitation. This is expected to continue as climate change persists.

Some regions, like the Midwest, have experienced alternating patterns of flooding and drought. Drought reduces the earth’s ability to absorb the water. When precipitation falls as more intense storms or as hurricanes that can cause flooding and jeopardize water quality.

- In rural areas, water runoff picks up animal wastes, pesticides, and fertilizers.

- In cities, runoff both carries pollutants and overwhelms sewage systems, causing untreated sewage to flow into drinking and recreational water sources.

Drought Disrupts Water, Food, and Health

Some regions, such as the Southwest U.S. and at times the Midwest, will experience decreased precipitation and longer, more frequent droughts. These conditions can also impact waterborne disease.

- As water sources decline, the concentration of contaminants increases, making them more likely to affect human health.

- Lack of clean water prevents adequate hydration and disrupts good hygiene.

- Periods of drought impact crops and livestock production and increase the price of food.

- Severe drought can also create dust-storm conditions, which can increase the risk of respiratory infections and exacerbate asthma.
The Dying Oceans

The vast oceans are not immune to climate change. Rising carbon dioxide emissions increase ocean temperatures and acidity.

- The combination of higher surface water and increased nutrient loading from agricultural runoff contribute to harmful algae blooms that produce biotoxins.
- Consumption of fish or shellfish contaminated with toxins can cause neurological damage, respiratory harm, skin irritations and diarrhea.
- Increases in ocean acidity threaten coral reefs and the future of shellfish like oysters, clams, and mussels. Where people depend heavily on seafood for food and income, incomes and nutrition are both likely to suffer.

How to protect yourself and your planet

- Decrease your household water use, especially during periods of drought.
- Listen to federal, state, and local fish consumption advisories for fish that are unsafe to eat.
  - Limit consumption of fish that typically have higher levels of mercury. These include tuna, swordfish, mackerel, sea bass, and grouper.
  - If pregnant, avoid completely fish with the highest amount of mercury.
- Listen to warnings about pollution and outbreaks of illnesses related to water.
  - Avoid pollution-prone beaches and lakes when notified, especially after rainfall.
- Take government or medically advised precautions when contamination is detected in drinking water, such as boiling the water before use.

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One of the most visible ways in which humans experience climate change is through extreme weather events. Large storms, hurricanes, and flooding create situations that are hazardous to human health.

How to Protect Yourself and Others

Regardless of the type of storm, it is important to take precautions to stay safe.

Before the storm:
- Make an emergency plan with your household.
- Have a small stockpile of bottled water, non-perishable food, manual can opener, flashlight and batteries.
- Pay attention to important warning and safety announcements.
- Monitor the weather and safety warnings with a television or battery-powered radio.
- Be prepared to evacuate.

During a storm:
- In case of a tornado, seek shelter in a basement or most interior room, preferably without windows. Get out of mobile homes. If outdoors, lie flat in the lowest-lying ditch.
- In case of hurricane, listen to evacuation advice. In a building, seek shelter in an interior room on the lowest floor. If in a mobile home, seek shelter elsewhere. Avoid windows.
- Shut off water and gas if instructed to do so.
- If the power goes out, use flashlights. Do NOT use candles.
- Stay away from floodwaters. Do NOT attempt to cross flowing water on foot or in a vehicle.

After the storm:
- Continue to avoid floodwaters.
- Stay away from downed power lines.
  - Be careful near debris.

Climate and Intense Storms

Heavy and extreme precipitation events are increasing in many regions and their frequency has increased as temperatures have risen.

Health impacts of heavy precipitation include crop damage and soil erosion, potentially affecting food supply; injuries due to flooding; standing water that provides a breeding ground for mold and disease carrying insects, and water contamination.

EPA data shows that a significant portion of total annual rainfall in the United States comes from extreme single-day precipitation events.

Extreme storm events are often associated with conditions that can develop tornadoes. A 2013 study from Stanford University found that sustained warming would boost by 40% the number of intense storms. Thanks to improved forecasting and early warning systems, injury and death tolls from tornadoes have dropped significantly.
Climate and Hurricanes

As with storms, hurricane winds and high water levels harm human health by posing the risk of personal injury and death. They can also damage health care infrastructure including buildings, power lines, and roads that are important in accessing health care.

The combination of flooding and damage creates a risk of water contamination leading to spread of waterborne diseases like cholera, legionella, and campylobacter.

Standing water also provides a breeding ground for mold as well as disease-carrying insects like mosquitoes. This poses the risk of outbreaks of West Nile Virus and other insect-borne disease.

After storms, mental health is also a major concern. If people have experienced separation from family, displacement, or loss of home, they are likely to need help. Research shows 30-40% of disaster victims are at risk of a new mental disorder, especially depression and post-traumatic stress disorder.

The National Oceanic and Atmospheric Administration (NOAA) reports that by the end of the 21st century, atmospheric warming will cause hurricanes to be more intense and have 20% higher rainfall rates.

NOAA also projects a greater chance of increased numbers of very intense hurricanes in some ocean basins.

Storm surge is sea level rise that occurs when water is pushed toward the shore by the winds associated with storms and hurricanes. Along the coast, storm surge is often the greatest threat to life and property from a hurricane.

At least 1,500 persons lost their lives during Hurricane Katrina. Many of those deaths occurred directly or indirectly as a result of the 27.8-foot storm surge.

The Intergovernmental Panel on Climate Change reports sea level has risen up to 8 inches during the past century. Assuming trends continue, global sea level is projected to rise another two feet by 2100.

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Sea Level Rise

Climate change also causes sea levels to rise due to melting ice caps and expansion of water as it warms. The combination of rising sea level and increased hurricane intensity is making coastal areas more vulnerable to flooding from storm surges.
Climate change is already threatening the Earth’s ability to produce food. These effects are expected to worsen as climate change worsens. Estimates vary, but for every 1.8°F increase in global average surface temperature, we can expect about a 10% decline in yields of the world’s major grain crops—corn, soybean, rice and wheat. Climate experts predict that global temperature may rise as much as 5.4°F to 9°F if we continue burning fossil fuels at our current rate. This could lead to 30% to 50% declines in crop production. Already, one in seven people, including many living in the U.S., is hungry every day.

Most models only consider the effect of rising temperatures and carbon dioxide (CO₂) levels on crop growth, and thus represent relatively conservative scenarios. Climate change will disrupt food production and distribution in other ways that are hard to quantify and include in prediction models, such as:

- More droughts causing large-scale crop loss
- Increasing frequent, severe, and longer-lasting heat waves killing crops
- Thriving plant pests and diseases destroying crops
- Heavy rains and storms flooding fields, eroding soils and washing away crops
- Melting glaciers and changing river flows reducing water availability for irrigation
- Rising sea levels and storm surges flooding crops and salting soils
- Higher ozone levels damaging plants and reducing crop yields

Specific climate change impacts

RISING TEMPERATURES: The effects of warmer temperatures on crop production will vary by region and crop, but almost all estimates indicate eventual reduced overall crop yields. Higher temperatures decrease rates of photosynthesis, reduce soil moisture, increase water demand and lead to increased survival of plant pests, diseases and weeds—all of which combine to reduce final yields.

INCREASING CO₂: In certain plants, like wheat, soybeans and rice, higher CO₂ levels actually increase

Thirty percent of Russia’s wheat crop was lost to fire 2010. Climate change will disrupt food production and distribution.
growth by the "CO₂ fertilization effect". Higher CO₂ levels increase photosynthesis and reduce plant water loss. However most experts agree that the CO₂-related benefits on some crops will be outweighed by other negative effects of climate change as global temperatures continue to rise.

**INCREASING TEMPERATURE EXTREMES:** An increase in the number of days of extreme heat leads to large declines in crop yields, especially when they occur during key stages of plant development such as flowering and grain-filling. Extreme heat damages photosynthetic and reproductive cells, causing decreased growth and sterility, and can decrease grain quality.

**INCREASING DROUGHT:** Climate change will cause more frequent, severe and long-lasting droughts. Many of the largest crop losses in history can be attributed to drought and it is the main cause of year-to-year variations in yields. Eighty percent of agriculture is rain-fed and especially susceptible to drought, but even irrigated agriculture is threatened by drought as stored water supplies are depleted. The area of land producing major crops (corn, rice, soy, wheat, sorghum and barley) affected by drought has risen from 5-10% in the 1960s to 15-25% today.

**HEAVY RAINS, FLOODS AND TROPICAL STORMS:** Extreme rainfall events and intensity of tropical storms is increasing. Rainfall intensity could increase by 25% in many agricultural areas. Heavy rainfalls reduce crop productivity by a number of mechanisms. Flooding wipes out vast areas of crops and damages others. In Bangladesh in 2007, cyclone Sidr damaged 1.6 million acres of cropland and over 25% of the rice crop. Heavy rains also cause significant soil erosion reducing long-term productivity. Waterlogged soils reduce plant growth and increase fungal diseases. Farming operations are often delayed when soils

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**U.S. Drought Monitor**

http://droughtmonitor.unl.edu/archive.html

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Fifty percent of cropland had significant drought in 2012.
are too wet for heavy machinery and flooding can destroy farming supplies, machinery and other infrastructure. Finally, coastal storm surges contribute to soil salinization making widespread areas unfit for planting.

**MELTING GLACIERS AND CHANGING RIVER FLOWS:** Glaciers are a critical water supply for drinking and irrigation but the majority of the world’s glaciers are shrinking. Glacier runoff provides water through the year where rainfall is limited, allowing irrigation during dry seasons. Receding glaciers threaten large rivers, such as the Ganges, Indus and Brahmaputra in India, on which over 500 million people depend, to become seasonal—devastating regional agriculture if adaptations are not made.

**SEA LEVEL RISE:** As sea levels rise, low-lying coastal agriculture in major river deltas and small island nations is especially vulnerable. Rising seas and storm surges will inundate agricultural lands, and salinization of soils and aquifers will threaten agriculture.

**PESTS AND DISEASES:** Many crop pests, such as aphids and weevils, grow better and live in a wider range of areas in warmer temperatures and higher CO$_2$ levels. Changes in climate also shift the geographic range and frequency of crop diseases, altering the predictability of outbreaks. Environmental stresses may cause mutations in crop diseases that increase their destructiveness. Heat and water stress reduce crop resistance to pests and diseases.

**WEEDS:** Certain invasive weeds, such as privet and kudzu in the United States, benefit from increasing temperatures and CO$_2$ levels more than crops. There is evidence that herbicides may lose effectiveness at elevated CO$_2$ levels. As increasing amounts of herbicide are required to maintain productivity, significant economic, environmental and health costs will result.

**INCREASING OZONE:** Ground-level ozone is a major air pollutant that results from burning fossil fuels. Ozone inhibits photosynthesis and stunts plant growth. Current ozone levels are already suppressing yields of many crops (alfalfa, beans, peanut, potato, rice, soy and wheat) and these effects will worsen as ozone levels continue to rise.

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**Conclusion**

Farmers are resilient and frequently adapt to changes in weather. However, climate change will create conditions outside of human experience, challenging farmers’ ability to adapt. While farmers with more wealth and resources are more likely to be able to adapt to a changing climate through investments in new technologies, seed varieties and cropping patterns, poorer subsistence farmers will be less likely to adapt and are thus more vulnerable. Regardless of wealth, complete adaptation is not possible.

Increasing extreme weather events has the potential to devastate infrastructure of the entire food system. Storms and flooding can destroy food processing, packaging and storage facilities and disrupt transportation infrastructure such as roads, bridges, railways, airports and shipping routes preventing available food from getting to where it is needed.

Though this fact sheet focuses on agricultural crops, they are only one part of the food supply. The changing climate also affects animal production. Decreasing supply and increasing prices of feed grains will increase the price of meat. Temperature extremes will increase animal deaths and the cost of cooling animal facilities. Rising temperatures and changing rainfall patterns will alter the distribution of animal diseases such as anthrax and blackleg, potentially reducing production. The overall impact on fisheries is uncertain, however a 40% catch decline is expected in the tropics as commercial species move north out of warming waters.

Food prices will rise as climate change reduces the amount of food available. And people get angry, even violent, when food becomes more expensive.
In 2008, world wheat, rice, corn and soybean prices tripled. Food riots erupted across Egypt, Yemen, Morocco, Cameroon, Senegal, Ethiopia, Haiti, Indonesia, Mexico, and the Philippines. Social order unraveled as armed Thai villagers guarded their rice fields against rice rustlers; grain trucks were hijacked in Sudanese refugee camps; Pakistani troops had to guard grain elevators and wheat trucks. There is concern about increased conflict and violence as food supplies constrain. 

Already one billion people in the world go hungry every day—that’s one in every seven people. Every year one third of child deaths are caused in part by under-nutrition. World population continues to grow and is expected to reach 9 billion by 2050. To feed this many people and their rising demand for animal products, overall food production must rise by 70% from 2005–07 levels. But a 5°F to 9°F rise in global average temperature could reduce grain yields by 30% to 50%, and global food supplies even more. The combination of decreasing food production in the face of increasing food demand would likely lead to widespread social unrest and hunger—even catastrophic global famine.

This is the future that awaits us if we fail to act. But we can rewrite the future from this grim view IF we work to create many solutions, from efficiencies to new renewable energy, to reduce greenhouse gas emissions by 80% by 2050. To find out how you can get involved in making a better future, visit WWW.PSR.ORG to discover actions going on in your area.

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**Endnotes**