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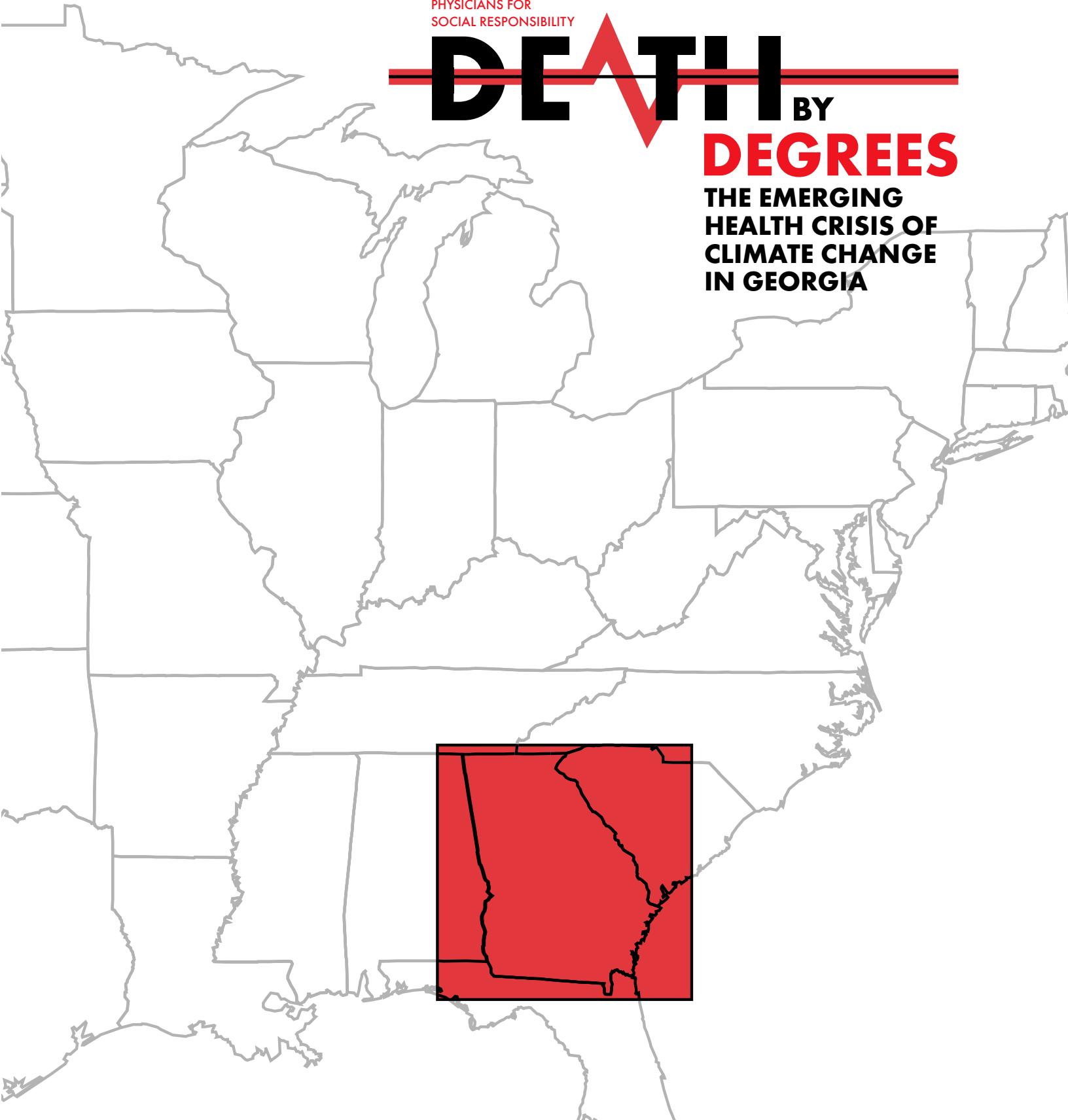
PHYSICIANS FOR
SOCIAL RESPONSIBILITY

DEATH

BY

DEGREES

**THE EMERGING
HEALTH CRISIS OF
CLIMATE CHANGE
IN GEORGIA**



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This report was prepared by Physicians for Social Responsibility to alert residents of Georgia to the damaging health effects of global climate change and to encourage them to take action now by reducing reliance on fossil fuels.

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The world is getting warmer at an unprecedented rate, never before seen in recorded history. During the past one hundred years, average global surface temperatures have increased by approximately one degree. Eight of the warmest ten years on record occurred in the last decade. Alarming, these signs of global warming are becoming more prevalent.

Although uncertainties exist in measuring this complicated phenomenon, an overwhelming consensus has emerged over the last decade among scientists on several key points. First, the increase in temperature is real. Second, human activities—in particular, our burning of fossil fuels—are contributing to global warming. Third, warmer conditions on Earth will directly affect our lives and well-being.¹

This report describes how the changing global climate will compromise human health. Our focus is on Georgia, a state likely to experience many of the worst health problems.

Georgia: A Special Case

Georgia's death rate for heat-related illness (adjusted for age distribution) is one of the 10 highest in the United States.²

—CENTERS FOR DISEASE CONTROL AND PREVENTION

Georgia, a scenic and geographically rich state, is home to over seven million people. This “Empire State of the South” includes the mountains of northwest Georgia, a vast coastal plain, metropolitan Atlanta and the fall-line cities of Augusta, Macon, and Albany, as well as the coastal cities of Savannah and Brunswick and the nearby Golden Isles. From Rabun Gap to Tybee Light, Georgia supports metropolitan areas, a flourishing agricultural industry, and

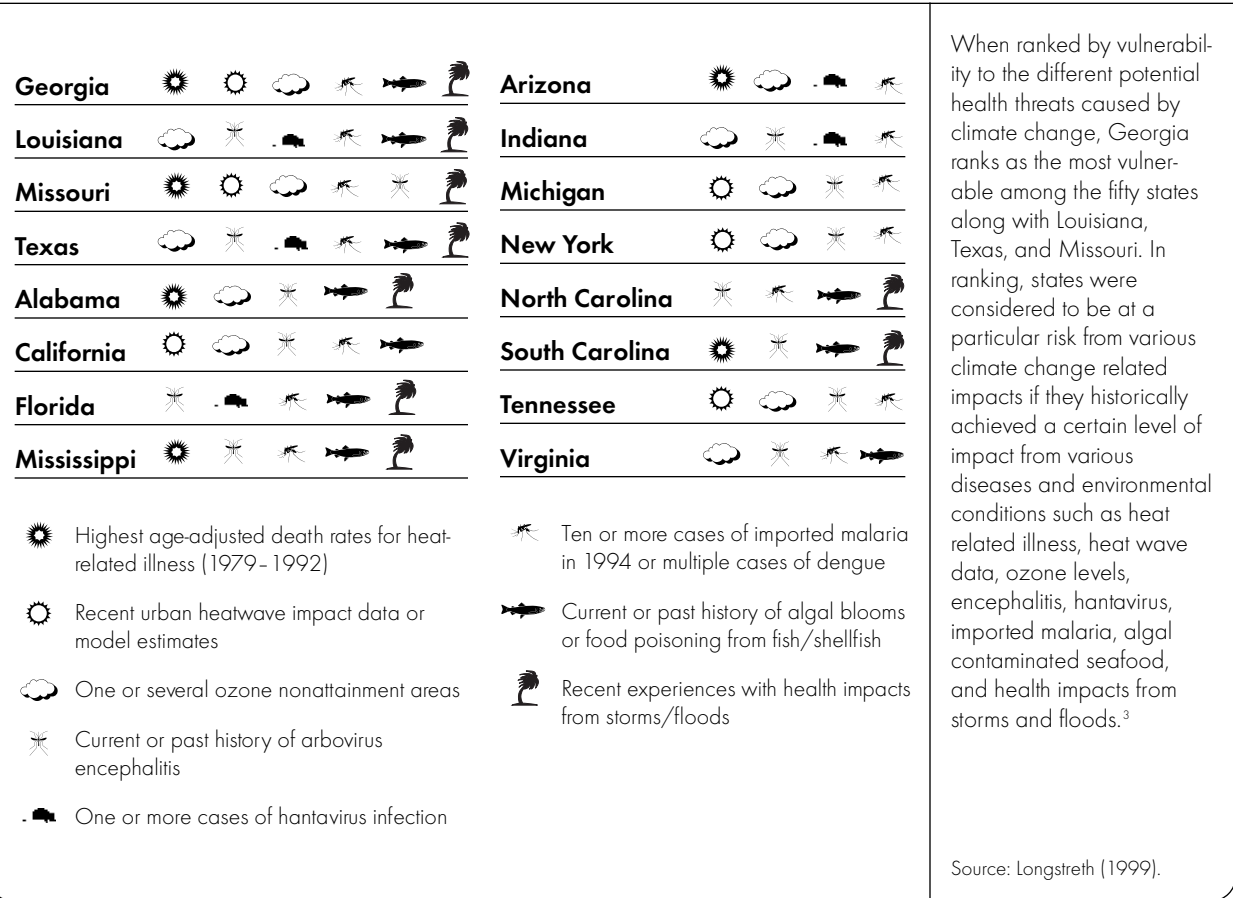
How Global Warming Could Threaten Health in Georgia

Numerous health hazards could increase as a result of global warming. According to physicians who have studied global warming and its effects, the most severe health risks in Georgia include:

- More incidents of heat-related disease, such as heat stroke.
- More respiratory and cardiovascular disease, especially for those with asthma.
- Aggravated allergies.
- More “severe weather events”—hurricanes, floods, and storms—leading to more drownings, electrocutions, and other accidental deaths.
- More reports of waterborne diseases that infect humans via contaminated water, fish, and shellfish.
- More outbreaks of infectious disease spread by insects.
- Interruptions in the food supply.

FIGURE 1

Georgia is most vulnerable to the health effects of climate change.



a natural environment that caters to tourism, hiking, fishing, and coastal activities.

As this report shows, however, Georgia likely will be one of the states hardest hit by global warming. Much of Georgia already has a very warm climate, which probably will get even warmer. More intense hurricanes may be on the horizon. Metropolitan Atlanta and several other cities already suffer unhealthy levels of ozone during most of the summer, levels that will intensify with warmer conditions. Making matters worse, many Georgians are especially vulnerable to the effects of climate change, such as elderly people on Medicare and residents without health insurance.⁴ Sadly, these individuals are the first casualties of warming weather. Georgia, like the rest of the country, needs to be deeply concerned about the impact of climate change on the health of its population.

Are Georgians already experiencing the effects of global warming? We always have had the occasional hot summer, or the unusually bad storm. Such events do not necessarily indicate a long-term pattern. But trends in recent years correspond closely to computer predictions of climate change, and may well be warning signs. Examples include:

- *A spate of heat waves.* Nationwide, the number of heat-stressed days has approximately doubled during the past 50 years. Georgia is no exception. Figure 2 shows the rise in number of four-day heat waves over the past half century in Atlanta. Nightfall once cooled things down, but now nights are getting warmer, too.⁵
- *Rising sea levels along Georgia's coast.* High tides in some locations have risen by more than a foot over the past century. This has caused growing concern among Georgia's coastal communities about property damage, coastal erosion, and drinking water contamination.⁶
- *Increased rainfall, coming more often in the form of heavy downpours.*⁷ The Albany floods of recent years are a stark reminder of the destructive power of such events.

The following sections describe the specific health effects that are predicted to result from global warming over the next 50 to 100 years, together with supporting evidence. In some cases, there is a high level of certainty about the predictions. In others, the evidence is less definitive. In all cases, there is reason for concern.

Direct Effects of Heat in Georgia

*On June 26, 1995, in College Park, Georgia, a grocery store customer found a 6-year-old boy, a 4-year-old girl, and a 2-year-old boy in a locked car with the windows closed in the store parking lot. Paramedics reported the children showed classic signs of heatstroke: They were unresponsive, disoriented, flushed, profusely sweating and had delayed reflexes. The children had been in the car for approximately 10–20 minutes. The outdoor temperature was 84° F and the humidity was 60 percent. Paramedics reported that the children's heatstroke would have become life threatening within 5–10 minutes.*⁹

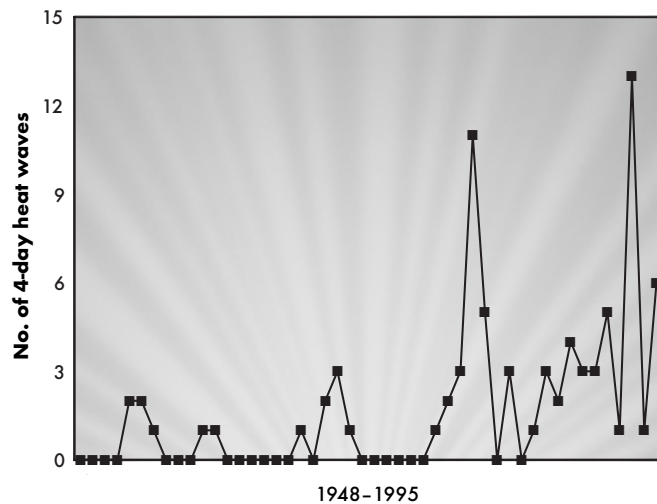
— CASE STUDY FROM THE CENTERS FOR DISEASE CONTROL AND PREVENTION.

According to the EPA, Georgia's average temperature is likely to rise by at least one degree Fahrenheit over the next century, and possibly by as much as nine degrees,¹⁰ depending on the season. This may not seem like much,

FIGURE 2

Occurrence of deadly heat waves on the rise.

This graph shows the rise in number of four-day heat waves annually in Atlanta from 1948 to 1995.⁸



Source: National Oceanic and Atmospheric Administration.

but for hundreds of millions of years, average temperatures across the globe have varied by no more than five to seven degrees Fahrenheit. Keep in mind that the average global temperature at the time of the last ice age was only nine degrees lower than temperatures are today.

In the last 20 years, heat waves have been on the rise. From 1949 to 1995, the number of four-day heat waves in Atlanta went from being negligible in the 1950s and 1960s to 11 in 1980 and 13 in 1993. (See Figure 2.) Significantly, both daytime and nighttime temperatures are warmer.¹¹

Making matters worse, Atlanta is an urban heat island that has temperatures up to ten degrees higher than surrounding areas. Two major factors contribute to urban heat islands: tree removal, and the absorption of heat by paved roads and dark roofing materials. Trees remove carbon dioxide from the atmosphere and act as a buffer against global warming. In addition, they supply shade. Between 1973 and 1998, nearly 350,000 acres of forest area were cleared in the 13 counties of metro Atlanta for residential and commercial development.¹² During the day, dark materials used on rooftops, and in

asphalt, absorb heat. They hold it well into the night, keeping cities hotter for longer periods of time.

According to a NASA-sponsored study, the urban heat island phenomenon influences Atlanta's weather and may even cause thunderstorms.¹³ Metro Atlanta's continued growth and development will further contribute to global warming by removing trees which remove carbon dioxide from the air. As temperatures rise due to global warming, the heat island effect will also get worse. Residents throughout Georgia, especially in the Atlanta area, will feel the impact.

Heat has direct effects on health, as explained below. With heat comes high humidity, which interferes with the body's ability to cool itself through perspiration. Humidity levels tend to be higher in areas at sea level, such as southern Georgia and Georgia's coast.

On average in Atlanta, 25 deaths from excessive heat occur during the summer season. As temperatures rise over the next 50 years, this toll is expected to increase. Exactly how much depends on various forecasting assumptions which range from 33 to 138 additional heat-related deaths.¹⁴

The Complex Origins of Climate Change

Since the end of the last Ice Age 10,000 years ago, temperatures worldwide have risen about 9 degrees, mainly due to natural changes in the geographical distribution of the sun's energy and to the amounts of dust, carbon dioxide, and other gases in the atmosphere.

In recent years, the rate of increase in temperatures has been accelerating. On any given day, the average temperature is about 1 degree higher than it was a century ago. Nine of the ten warmest years in recorded history occurred in just the last decade, with 1999 topping them all.

Human activities are among the most important factors making the earth warmer. When motor vehicles burn gasoline and electric utilities burn coal, they release carbon dioxide and other gases into the atmosphere. These gases trap warm air near the earth's surface, in much the same way as glass panels trap warm air inside a greenhouse—hence the term, "greenhouse effect." Over the past 200 years, the concentration of greenhouse gas in the atmosphere has increased by 30 percent. The gas will remain there for centuries, trapping heat and putting human health at risk.¹⁵

Although the average temperature worldwide is increasing, hence the term "global warming," the story becomes more complex at the local level where resulting weather changes vary from place to place. A warmer atmosphere holds greater amounts of water, resulting in more precipitation. Warmer air also means changes in wind patterns. In general, we can expect more extremes—more heat waves, more storms, wetter climates in some places and drier climates in others, and even cooler temperatures in certain areas. Many scientists, therefore, prefer the term "global climate change" to global warming. In this report, we use the two terms more or less interchangeably.

Heat can lead to severe health problems like heat cramps, heat exhaustion, exertional heat injury, and heat stroke. In addition to heat and humidity, risk factors for these conditions include advanced age, lack of air conditioning, and use of certain medications. Vulnerable populations, including the elderly, children, infants, and the infirm, will suffer the most. Cardiovascular diseases, such as coronary heart disease, which are more prevalent in the South than in other parts of the country, also are a risk factor.¹⁶

Heat cramps are muscle spasms that primarily affect people who exert themselves through strenuous work or exercise. These cramps are believed to be caused by mineral imbalances. Salt and water replacement usually relieves them. A more severe condition is exertional heat injury, which commonly occurs among runners who are not properly conditioned and hydrated. Every year, cases are reported at Atlanta's Peachtree Road Race on the Fourth of July. The body temperature can reach 102 to 104 degrees, with symptoms that include goosebumps, chills, nausea, vomiting, and unsteady gait. In severe cases, people can have incoherent speech, or even lose consciousness. Muscles, kidneys, and blood cells can be damaged.

Heat exhaustion, or heat collapse, is the most common heat-related condition. It occurs when the cardiovascular system cannot keep up with heat demands. An affected person feels dizzy, weak, cold and clammy, and has ashen skin and dilated pupils. The individual may require hospitalization.¹⁷ At greatest risk are infants, small children, the elderly, those working or exercising outdoors, persons with impaired mobility, and individuals suffering from cardiovascular disease.¹⁸ When moved to a cool place, a victim of heat exhaustion usually recovers.

Heat stroke, the most severe of these conditions, can be fatal. If body temperature reaches 106 degrees or above, damage to the kidneys, muscles, heart, and blood cells is likely. Sweating stops altogether. Death can come immediately, or could be delayed until several weeks later.¹⁹ The public health burden is compounded, since excessive heat is an important contributing factor in deaths from other medical conditions.²⁰

Air Pollution, Respiratory and Cardiovascular Disease

Air pollutants such as ozone and volatile organic compounds (VOCs) are affected by heat and have adverse health impacts.

Ozone

Ground-level ozone, also known as smog, is the most pervasive outdoor air pollutant in the United States. It is the major air pollutant in Georgia. Ozone is a toxic gas formed when nitrogen oxides react with hydrocarbons in the presence of heat and sunlight.²¹ As a result, ozone levels are highest on hot, sunny days. The number of such days will increase with global warming.

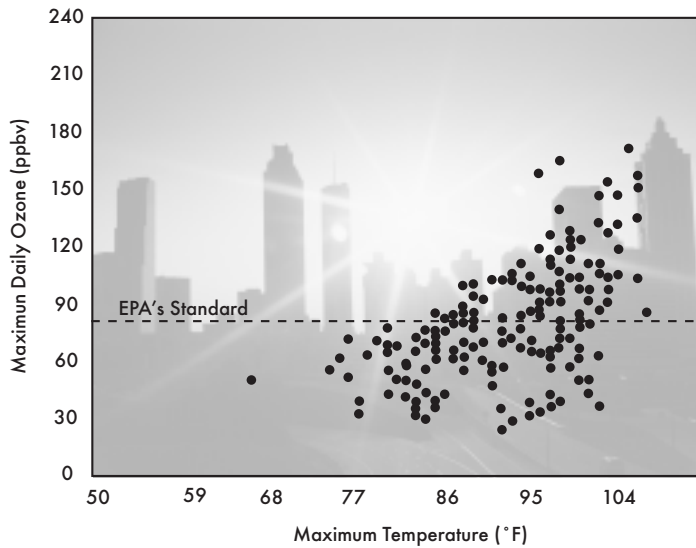
Ozone levels in clean air are 30 parts per billion (ppb) or less.²² In areas such as metropolitan Atlanta, which now leads the nation in miles driven per capita,²³ ozone levels are already high, commonly above 80 ppb, and can

damage human health. Rising temperatures will mean higher ozone levels, resulting in air that is increasingly hazardous to breathe. In fact, studies have linked up to 12 percent of Atlanta's ozone problem with heat.²⁴

During the 1999 ozone season (April 1 through September 30), there were 69 days when Atlanta's 8-hour ozone average exceeded 80 ppb. Atlanta was not the only Georgia city affected. Macon had 14 such days, Columbus

FIGURE 3

Hotter days mean higher concentrations of unhealthy smog.

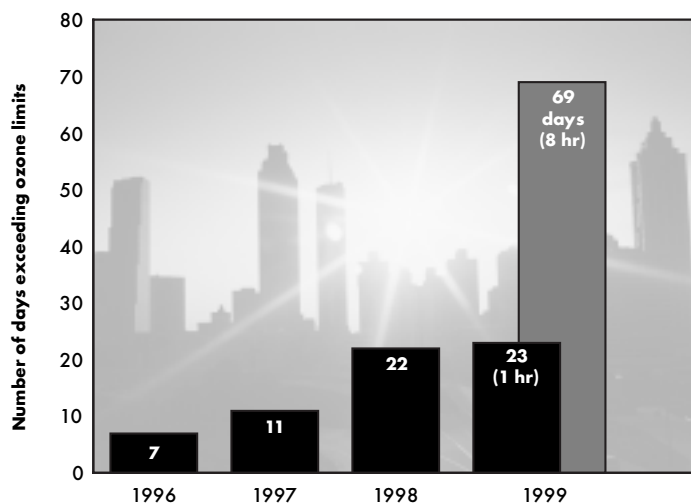


This figure shows the daily maximum ozone concentrations versus maximum daily temperature for summer months (May-October) 1988-1990 in Atlanta. This scatter plot shows that as temperatures rise, so do ground-level ozone concentrations.²⁵

Source: U.S. Environmental Protection Agency.

FIGURE 4

Metro Atlanta's ozone concentrations exceed federal standards.



Metro Atlanta's ozone exceedance days are on the rise. This graph shows how many days ozone concentrations exceeded federal standards in Atlanta during ozone season (May-September) from 1996 to 1999. In 1999, the Georgia Department of Natural Resources switched to the new 8-hour ozone standard from the old 1-hour standard. The graph compares the number of violations of the new standard (ozone levels over 80 ppb in an 8-hour period) to the old standard (120 ppb in a 1-hour period) in 1999.

Source: Georgia Department of Natural Resources, Ambient Monitoring Program.

had 12, and Augusta had 10. There were even exceedances recorded at rural test sites in the north Georgia mountains and in the small town of Leslie, in Sumter County.²⁶

Numerous studies link ozone with health problems, such as aggravation of asthma, impaired immune function, greater susceptibility to respiratory infections (like bronchitis and pneumonia) and lung tissue damage. The symptoms include coughing, shortness of breath, and eye and throat irritation.²⁷ Studies demonstrate that on high ozone days there are more emergency room visits, more hospital admissions, more work and school absences, more need for respiratory medications, and even more deaths.²⁸

Asthma is a special concern. In this condition, the airways become narrowed. Breathing gets difficult, like “sucking a thick milk shake through a straw.”²⁹ For reasons that are not fully understood, asthma is becoming more widespread. The prevalence of asthma in children under age 18 rose 72 percent in the 12 years from 1982 to 1994,³⁰ while the death rate from asthma for children 19 years and younger in the United States increased by 78 percent from 1980 to 1993.³¹ And, asthma already is a leading cause of absences from school.³²

Asthmatics and children are especially susceptible to the effects of ozone. For example, between June 1 and August 31, 1990, asthma-related visits to an Atlanta pediatric emergency room increased by 37 percent following days when the ozone concentration was at its worst.³³ Asthma especially is prevalent in poor communities.³⁴ One reason is that people with low incomes are less likely to have air

Smog Alerts Mean Medical Emergencies

Climate change is expected to heighten Georgia smog levels. As numerous health problems are caused by smog, related illnesses also are expected to increase. Smog can exacerbate asthma, impair breathing, aggravate respiratory disease and impair the body’s immune system. Between April and October of 1997 in Georgia, smog sent an estimated 5,100 persons to hospital rooms with respiratory symptoms. In addition, smog is associated with 240,000 asthma attacks in the state, according to a report by the Clean Air Task Force.³⁵

Georgia has an ozone problem. Ground level ozone, the primary component of smog, forms when nitrogen oxides and volatile organic compounds interact in the presence of sunlight. In 1998 Georgia ranked as the state with the fourth highest exceedance rate for the Environmental Protection Agency’s proposed 8-hour ozone pollution standard. On 55 days in the spring and summer, the concentration of smog in Georgia’s air reached, or exceeded, an unhealthy 85 parts per billion over an eight-hour period.³⁶ In 1999, Atlanta alone had 69 days of unhealthy air, including 36 out of the 38 days between July 16 and August 27.³⁷ Macon, Augusta, Columbus and Savannah also violated the ozone standards in 1999.³⁸

Ozone can affect respiration in healthy individuals, but asthma sufferers especially are at risk. When ozone levels are high, hospital emergency rooms, particularly in low-income neighborhoods, fill with persons suffering from asthma.³⁹ Many asthma patients are children, who breathe more rapidly and whose airways are smaller than those of adults. Children also tend to spend more time outdoors. A leading cause of absences from school, asthma can reduce lung capacity and, if left untreated, can be fatal.

Between June 1 and August 31, 1990, visits to an Atlanta pediatric emergency clinic for asthma or reactive airway disease increased by 37 percent following days when the ozone concentration was at its worst.⁴⁰ In addition, the prevalence of asthma in children under age 18 rose 72 percent in the 12 years from 1982 to 1994.⁴¹ The death rate from asthma for children 19 years and younger in the United States increased by 78 percent from 1980 to 1993.⁴²

Georgia’s problem with ozone is compounded by its increase in heat waves. Ground-level ozone is at its worst on hot, sunny days, which likely will become more prevalent with global warming. In addition, four of Georgia’s power plants are among the top 100 dirtiest power plants in the country for either, or both, nitrogen oxide emissions and carbon dioxide emissions. These plants, Scherer, Bowen, Harllee Branch and Wansley, all owned by Georgia Power Company, add to the state’s ozone problem and to the emissions of greenhouse gases that cause global warming.⁴³

conditioners, thus they are more inclined to keep their windows open during the summer months when ozone levels are at their highest. This increases their exposure to ozone and the chances that ozone will exacerbate asthma episodes.⁴⁴ (See sidebar: Smog Alerts Mean Medical Emergencies.)

Ozone does not just target the young, the asthmatic, or the poor. Healthy adults who are moderately exercising can experience a 15, to over 20, percent temporary reduction in lung function from exposure to low levels of ozone over several hours.⁴⁵ A warmer climate means more ozone, and ozone threatens the respiratory health of all exposed Georgians.

Volatile Organic Compounds (VOCs)

Another set of air pollutants affected by heat consists of VOCs that are emitted by large power plants and municipal waste combustors, as well as by small sources such as dry cleaners, printers, service stations, cars and trucks. VOCs include a variety of hazardous substances, including benzene, toluene, xylene, formaldehyde, and hexane, and may be accompanied by heavy metals such as cadmium, mercury, chromium, and lead. Higher temperatures cause VOCs to evaporate and disperse more rapidly into the atmosphere. These hazardous air pollutants are associated with cancer, as well as neurological, reproductive, and developmental disorders.⁴⁶

Allergies: From Bad to Worse

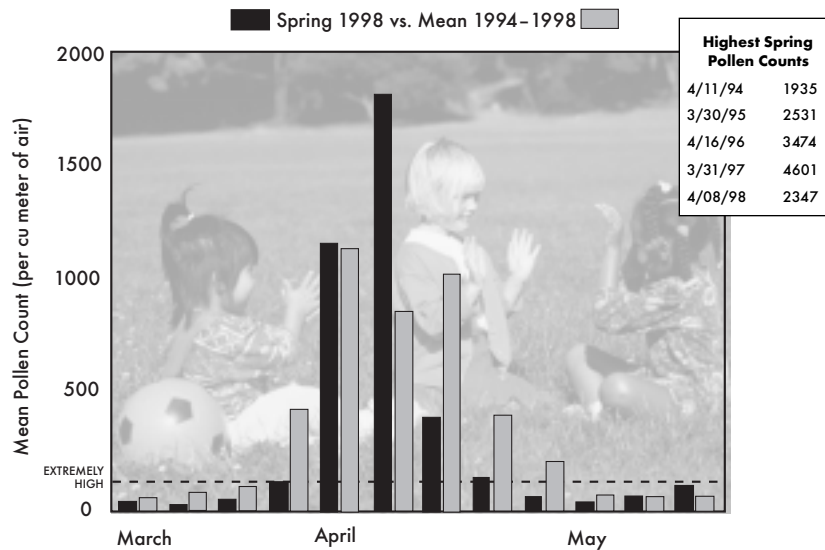
Georgia's climate and ecology encourage the growth of pollen-producing plants, molds, and other allergens, a fact that is not lost upon the many residents who suffer from allergies. Unfortunately, with higher temperatures, the problem is expected to get worse.

Many scientists believe rising temperatures will create favorable conditions for an even wider variety of pollen-producing plants. Hence, hay fever sufferers in Georgia are likely to experience a greater number of attacks during more months of the year.⁴⁷ As shown in Figure 5, the average pollen count (pollen particles within 24 hours in a cubic meter of air) has exceeded acceptable levels throughout the 1990s.

Warmer, wetter conditions also will favor the growth of molds in buildings and other micro-environments. Although precise forecasts are not available, we expect continued warming will cause allergy sufferers in Georgia to experience worse symptoms.

FIGURE 5

Hay fever sufferers endure record-breaking pollen counts.



This bar graph compares pollen counts measured by the Atlanta Allergy and Asthma Clinic in the spring of 1998 to mean pollen counts from 1994 to 1998. Pollen counts are frequently over 120 pollen particles (measured over a 24 hours period in a cubic meter of air), a level considered “extremely high” by the Atlanta Allergy and Asthma Clinic. The clinic rates counts of 0-30 as Low, 31-60 as Moderate, and 61-120 as High.

Source: Atlanta Allergy & Asthma Clinic.⁴⁸

More Disasters Than We Can Manage?

Climate change will be manifested in a catalogue of disasters such as storms, droughts and flooding unparalleled in modern times.⁴⁹

— INTERNATIONAL FEDERATION OF RED CROSS AND RED CRESCENT SOCIETIES

Global warming means not only warmer temperatures, but also more unpredictability in weather patterns and more extreme weather conditions.⁵⁰ The concentration of greenhouse gases that cause global warming also increases heat and moisture in the atmosphere. Heat and water vapor create instability, leading to more frequent, and possibly more severe, weather activity.⁵¹ The expected results: an increase in floods, hurricanes, severe winter storms, tornadoes, droughts, heat waves, and other natural disasters.⁵² These events lead to harsh economic consequences. During 1998 alone, Georgia had 225 million dollars worth of insured losses from weather-related natural disasters.⁵³

Severe weather, and the disasters that result, have wide-reaching health impacts. In the short term, severe weather can lead to injuries and deaths from drowning, automobile crashes, fires, building damage, and other causes. Storms and floods can disrupt electric power supplies, compromise access to public service broadcasts, disable water treatment systems, and contaminate drinking water. Forest fires can occur, especially during times of drought, causing burns and aggravating respiratory disease. Downed electrical power lines and leaks from natural gas or propane tanks can cause fires, electrocutions and explosions. Intense rainstorms can wash raw sewage into drinking

water supplies. This can spread infectious diseases, such as Salmonella, Cryptosporidiosis, and Giardiasis.

Extreme weather events, depending upon their severity, can overtax emergency care systems. Confronted with more frequent, intense storms and major flooding, Georgia's physicians will have to brace for the inevitable health emergencies.

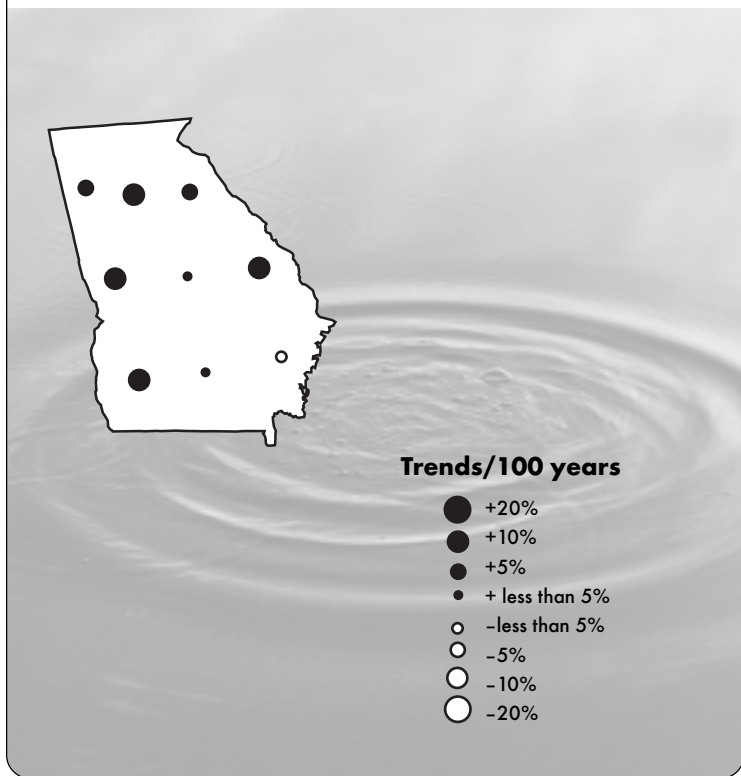
Precipitation, Hurricanes, and Floods

On July 3, 1994, tropical storm Alberto struck the Florida panhandle with maximum sustained winds of 60 miles per hour. On July 4, as the center of the storm deteriorated over Columbus, Georgia, a cold front pushed through Alabama and southwestern Georgia from the northwest, producing warm, moist air and unstable weather resulting in heavy, prolonged thunderstorms. Rainfall totals in some areas of south central Georgia were 12–15 inches during a 24-hour period; Americus, Georgia, recorded 24 inches on July 6. Several rivers, cresting up to 20 feet above flood stage, inundated major portions of the state. Flood waters forced closure of 175 roads in 30 counties, and more than 100 dams and recreational watersheds were either damaged or destroyed. Forty-three (27 percent) of Georgia's 159 counties were declared federal disaster areas, and seven additional counties were declared state disaster areas.⁵⁴

—CENTERS FOR DISEASE CONTROL AND PREVENTION

FIGURE 6
Georgia precipitation on the rise.

This figure shows precipitation trends in Georgia from 1900 to 1996.⁵⁵
Source: U.S. Environmental Protection Agency.



Meteorologists already report more rainfall in many parts of Georgia. Precipitation in the state increased by up to 10 percent in several regions during the last century, as shown in figure 6. In neighboring states, Alabama and South Carolina, rain has increased by up to 20 percent in some areas. By 2100, summer and fall precipitation in Georgia is expected to increase another 15–40 percent. The amount of rain on extremely wet days also is predicted to increase. Thunderstorms likely will occur more frequently and with greater intensity.⁵⁶

Severe rainstorms, combined with water-saturated soil, cause floods.⁵⁷ In heavily developed areas, such as metropolitan Atlanta, where impervious surfaces like asphalt cover large tracts of land, the ground has less capacity to absorb rain. As a result, flooding occurs more often.

Intense storms, and the floods that follow, are likely to increase in Georgia. Since 1990, Georgia has been the subject of 53 Presidential disaster declarations due to severe rains, winds, hurricanes, tornadoes and snowfalls. At least two of these disasters, Tropical Storm Alberto (1994) and Hurricane Opal (1995), affected neighboring states. Alberto cost over one billion dollars and resulted in 32 deaths, while Opal cost over three billion dollars and led to 27 deaths.⁵⁸

Floods can become a public health problem, as residents of Albany may well remember. Floods cause an average of 146 deaths per year nationwide. Most are due to drowning associated with motor vehicles in flash flood conditions.⁵⁹

Floods also can result in cases of infectious disease, through contamination of drinking water supplies by bacteria and parasites. The most common of these illnesses, diarrhea, usually lasts only a few days. For individuals with weakened immune systems, however, this condition can be long-lasting and even fatal.

Floodwaters can contain fecal material from overflowing sewage systems and agricultural and industrial byproducts. Georgia's farming communities, in particular, face risks when grazing pastures and crop fields are flooded. Although skin contact with floodwater does not, by itself, pose a serious health risk, there is a threat of disease from eating or drinking anything contaminated with floodwater. Floods also result in large expanses of standing water in which mosquitoes proliferate. These insects can carry disease-causing viruses, such as encephalitis or malaria.⁶⁰

Floods can cause not only physical, but also mental, illnesses. Residents displaced from their homes can experience psychological problems, ranging from depression to post-traumatic stress syndrome.⁶¹

Over the next several decades, Georgia can expect a 10 percent, or greater, increase in winter precipitation.⁶² This may pose a variety of health risks, such as accidents and hypothermia. While most people associate hypothermia with regions that experience cold winter weather, hypothermia-related deaths also occur in states with milder climates. In fact, between 1979 and 1995, Georgia had hypothermia-related death rates equal to, or higher than, those of Michigan, Maine, and Illinois.⁶³

Droughts and Forest Fires

*The drought that has gripped Georgia since the summer of 1998 is expected to continue well into 2000. Dry conditions are increasing the risk of wildfires. Lakes, ponds, rivers, and streams remain extremely low across the state.*⁶⁴

—DAVID STOOKSBURY, STATE CLIMATOLOGIST AND UGA ENGINEERING PROFESSOR

It may seem odd to think about droughts alongside floods and increased rainfall, but a variable and unstable climate that shifts from one extreme to another will also bring dry periods. The climate changes predicted by some models may increase the frequency and severity of droughts, like the one Georgia has been experiencing since 1998.

In addition to economic losses, drought can result in water shortages and impaired local sewer systems, that force individuals to curtail their use of

water for hygiene, washing food, irrigation, and caring for livestock. Droughts concentrate microorganisms and encourage increases in pest populations, like aphids, locust, and whiteflies.⁶⁵ A pattern of drought interrupted by sudden rains could lead to a large increase in rodent populations.⁶⁶

Droughts also dry forests, paving the way for forest fires. In 1998, forest fires caused Charlton county and the town of St. George to be declared Presidential disaster areas.⁶⁷ Forest fires pose numerous public health concerns, including injury and fatalities to firefighters and nearby residents, and increased respiratory illness, such as asthma and chronic obstructive pulmonary disease, particularly for people with pre-existing respiratory conditions.⁶⁸

Climate Change, Water Quality and Disease

Research shows that climate change will have major effects on precipitation, stream flows, storm surges, runoff, water temperatures, and evaporation,

thereby affecting Georgia's water supply. Both the quantity and quality of available water could be at risk. Georgia's water supply is already heavily used and is the subject of heated negotiation between Georgia, Florida, and Alabama, states that rely on the Apalachicola-Chatahoochee-Flint and Alabama-Coosa-Tallapoosa river basins for their water supplies. Increasing saltwater intrusion from rising sea levels also will affect rivers and aquifers.⁶⁹

Considerable uncertainty remains as to what specific changes global warming could bring to regional precipitation and waterways. Certain facts, however, are clear. Low stream flows cause substances in the water to concentrate. Excess water runoff, on the other hand, can bring more agricultural wastes and pesticides into the water supply.

In the northern part of Georgia, most water comes from surface water sources, except in the western corner where water is extracted from large limestone aquifers. Over 90 percent of the water used for domestic purposes statewide, though, is groundwater.⁷⁰ Coastal aquifers that supply the southern part of Georgia with

The State of the Science

Our current understanding of the potential impacts of climate change is limited by a number of factors. Climate models that project climatic changes and their impacts are still being developed and perfected. Natural climate variability and other factors, such as air quality, land use, population, water quality, health care infrastructure and the economy, also can impact projections. A few scientists even argue that countervailing climatic forces, such as sulfur dioxide, are actually cooling the atmosphere. The majority of climate scientists, however, agree that greenhouse gases produced by humans are changing Earth's atmosphere and that now is the time to take action on a global level.

Forecasting models are gaining credibility every day as weather, and other environmental occurrences confirm projected scenarios. Additionally, scientists continue to uncover data that supports the presence of climate change. For example, a study published in the summer 1999 issue of the scientific journal *Nature* examined the Antarctic ice cores. Scientists found that atmospheric temperatures historically correlate with atmospheric concentrations of the greenhouse gases carbon dioxide and methane. Today, concentrations of these gases appear higher than they have been in the past 450,000 years.⁷¹

Even if certain individuals are able to adapt to changes caused by global warming, some populations will remain susceptible. These populations include infants, children, the elderly, and the infirm. Atlanta will remain among the regions most vulnerable to climate change because of its diminished air quality.⁷²

Clearly the availability and continued development of better information on the potential impacts of climate change, and the interaction of these impacts with other important factors, is critical if society is to understand the science of climate change and to prepare for the changes global warming will bring.

water, like similar systems in Florida, already are being depleted faster than they can recharge. Hotter, drier conditions would likely increase water withdrawals and decrease aquifer recharge.

Extreme weather events that cause flooding or disruptions in water supplies may bring on other types of gastrointestinal diseases. Two of the newest and greatest threats are from *Giardia* and *Cryptosporidium*.

- *Giardiasis*: Giardiasis is an illness caused by a one-celled, microscopic parasite that lives in the intestines of people and animals. It thrives in water. During the past 15 years, *Giardia lamblia* has become recognized as one of the most common causes of waterborne human disease in the United States.⁷³ In 1998, 1,215 cases were reported in Georgia,⁷⁴ but the true number of cases in the state was probably several times higher. Diarrhea, abdominal cramps, and nausea are the most common symptoms of giardiasis.
- *Cryptosporidiosis*: Another major threat to the United States water supply is from an organism called *Cryptosporidium*, which is small, difficult to filter, resistant to chlorine, and ubiquitous in many animals.⁷⁵ Symptoms include diarrhea, stomach cramps, upset stomach, or slight fever. *Cryptosporidiosis* can be serious, long-lasting, and sometimes fatal for people with AIDS and others whose immune systems are weakened.⁷⁶ In 1999, there were almost 3,500 cases of *Cryptosporidiosis* in the United States. In 1998 there were 152 reported cases in Georgia,⁷⁷ and 122 cases in 1999.⁷⁸

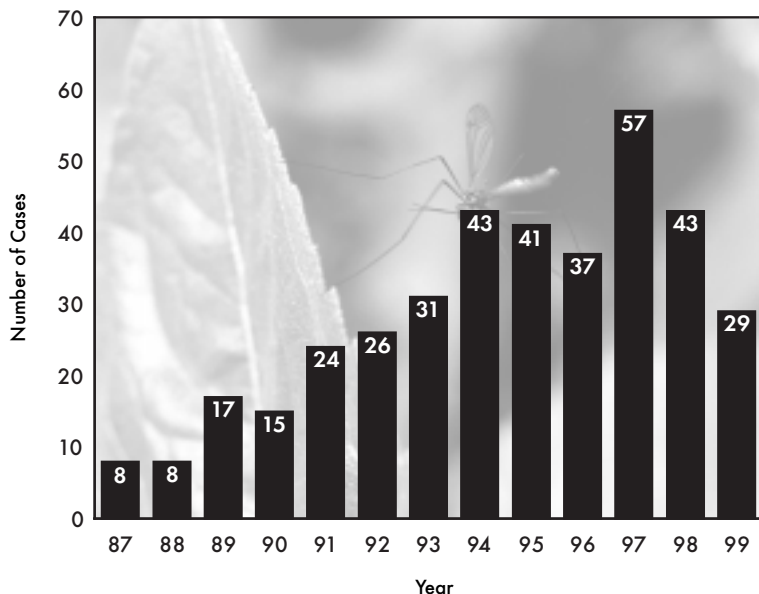
Warmer, moister weather also encourages the spread of diseases caused by food contaminated with toxic *E. coli*, *Salmonella*, *Cyclospora*, and *Hepatitis-A*.⁷⁹ *Hepatitis-A* is a liver disease with symptoms that include jaundice, fatigue, abdominal pain, loss of appetite, intermittent nausea, and diarrhea. An estimated 125,000–200,000 total infections of *Hepatitis-A* occur each year in the United States, of which about two-thirds cause clinical disease and approximately 100 are fatal.⁸⁰ *Hepatitis-A* usually is transmitted by fecal-oral routes of exposure or food/waterborne outbreaks. In Georgia, 879 cases were reported in 1998.⁸¹

Infectious Disease

Public health officials throughout the world are seeing an alarming resurgence of parasitic diseases and arboviruses. Malaria, encephalitis, dengue fever and other such diseases are carried by insects or rodents, which medical researchers refer to as vectors. Warm, wet climates are favorable to many disease-carrying vectors. As temperature increases and Georgia becomes wetter, insects and rodents will multiply. Vector larvae, or the vectors themselves, live in water bodies that may become more abundant with climate change because of increased rainfall, or increased droughts that necessitate irrigation. As a result, pools of brackish water are created that are ideal for breeding. In addition to warmer winters, this will allow some insect vectors to survive longer and to procreate more.

FIGURE 7

Annual cases of Malaria in Georgia.



This bar graph shows the number of cases of malaria reported in Georgia each year from 1987 to 1999.

Source: Georgia Division of Public Health; 1999 data from Centers for Disease Control & Prevention.

An increased number of vectors could heighten the number of outbreaks of encephalitis, malaria, hantavirus, and other diseases. The World Health Organization stated that the distribution of malaria was likely to vary with climate change, and that the distribution of yellow fever, dengue fever, onchocerciasis, and schistosomiasis is very likely to change world wide.⁸² New diseases affecting people could also appear as the climate changes. Recently, public health officials and the U.S. Centers for Disease Control and Prevention expressed concern over the spread of West Nile fever, which first appeared in this country in New York in August 1999. They feared it could travel south via migrating birds carrying the disease.⁸³

Climate change, while not a direct cause of vector disease outbreaks, contributes to a favorable breeding environment for mosquitoes, the carriers of malaria, dengue fever, and encephalitis. Simultaneous increases in temperature and humidity will likely lead to a denser mosquito population and add to the chances that residents of Georgia will be bitten and infected. To date, there are no vaccines to combat these diseases.

Female anopheles mosquitoes carry malaria in the form of parasites. The mosquitoes contract the parasite when they bite someone carrying the disease and transmit it by biting another person. The range of temperature in which the parasite and the carrier can exist is very narrow. As temperature ranges alter, the number of mosquitoes carrying malaria may, in fact, decrease in areas that are currently tropical, but could increase in areas where the climate has changed.⁸⁴

Malaria was once found in Georgia, but the disease has been virtually eliminated, mostly due to improvements in health care infrastructure, housing, and increases in screen use. The mosquitoes capable of carrying malaria, however, still exist in Georgia.⁸⁵ Climate change could lead to a reappearance of the disease. If this happens, its impact could be worsened by the occurrence of more severe extreme weather events. People would be displaced from their homes, and the health care system would already be overburdened with more illness due to heat, water-borne disease and injuries caused by storms.

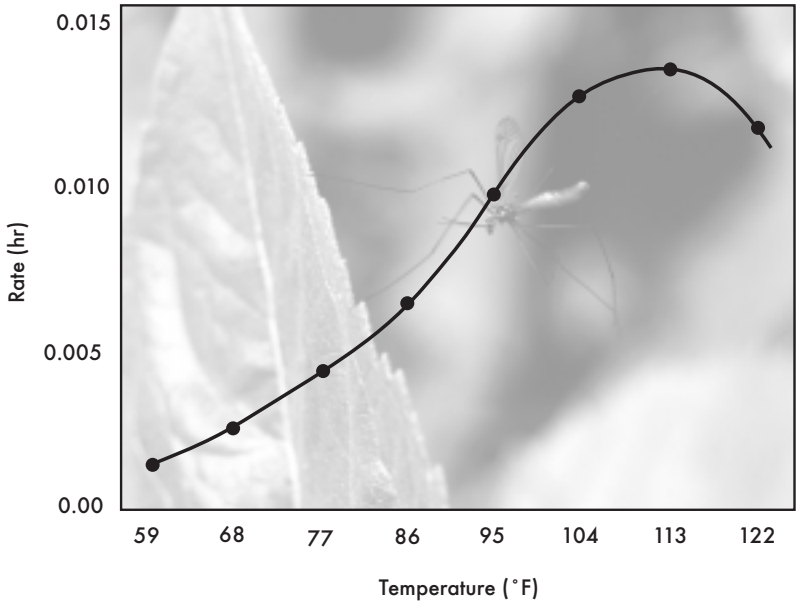
Recently incidences of malaria have been reoccurring in areas of the world that have been malaria-free for the past 50 years. The United States could experience a similar resurgence. While malaria in general is not currently contracted locally in Georgia, there have been over 350 incidences of malaria reported in Georgia since 1990.⁹⁰

Ideal Weather for Disease Carriers

Public health officials throughout the world are seeing an alarming resurgence of parasitic diseases, such as malaria, and arboviruses (viruses borne by arthropods), like dengue fever. Outbreaks even are occurring more frequently in the United States, due to factors such as immigration and increased travel abroad by Americans, who bring the diseases home with them.⁸⁶ At least one recent case of malaria is thought to have been contracted within Georgia.⁸⁷

Climate change, while not a cause of the outbreaks, contributes to a favorable breeding environment for mosquitoes, the carriers of malaria and dengue fever. Figure 8 shows that warmer temperatures speed up the rate at which mosquito larvae mature. Simultaneous increases in temperature and humidity will likely lead to a denser mosquito population and add to the chances that residents of Georgia will be bitten and infected.⁸⁸

FIGURE 8
Warmer weather promotes breeding by disease-carrying mosquitoes.



This graph shows the correlation between temperature and the rate at which mosquito larvae mature.⁸⁹

Source: Focks et al 1993.

And, at least one case is thought to have been contracted locally within Georgia in the past five years.⁹¹

Other diseases carried by mosquitoes are dengue fever and encephalitis. The *Aedes Aegypti* mosquito, currently found in Georgia during the summer months, carries dengue fever. Dengue is a mosquito-transmitted disease characterized by the sudden onset of fever, headache, myalgia, arthralgia, rash, nausea, and vomiting.⁹² In 1996 there were 11 suspected cases of dengue fever in Georgia.⁹³ Several strands of encephalitis also presently exist in the United States. Increased numbers of mosquitoes will advance the potential spread of the disease in Georgia. The elderly and children are particularly susceptible to encephalitis, especially in urban settings.⁹⁴

As climate changes disrupt agriculture, rodents are more likely to move into urban areas, increasing the incidence of hantavirus and lyme disease.⁹⁵ In addition to the Southwest, hantavirus has been documented in the Mid-Atlantic coastal and Mid-West regions of the United States.⁹⁶ Although Georgia does not have a history of rodent-carried disease, hantavirus could become a problem.

Climate Change and the Food Supply

Climate change can affect what humans need most to survive: food and water supplies. The quality and volume of agricultural crops, livestock, fisheries, and water all are dependent, in varying levels, on temperature and weather patterns. Globally, the impact of climate change on food and water sources will affect millions. Locally, Georgians will be more able to adapt, but many residents will be affected by changes in agricultural productivity and water quality. Most will feel the impact, at least financially, and some could suffer physically.

Agriculture

A phenomenon that affects agriculture will also influence the physical, mental and financial stability of a significant portion of Georgia residents. Agriculture is Georgia's largest industry. The 1997 Census of Agriculture reported almost 5 billion dollars in sales of Georgia agricultural products. Georgia's agribusiness sector contributes over 46 billion dollars to the state's annual economic output.⁹⁷ One in every six Georgians works in an agriculturally related sector of the economy. There are over 10 million acres of farmland in the state.⁹⁸

Climate is the primary determinant of agricultural productivity.⁹⁹ Thus, the variable weather conditions predicted to occur due to global warming will have a significant impact on Georgia's residents and their economy. Any weather changes linked to climate variability will affect crop growth and production. Crop yields are sensitive to exactly those climate conditions predicted to change and intensify: temperature, precipitation, and the frequency of extreme weather events, such as hurricanes, floods, droughts, wind, and hail.¹⁰⁰ Models show that different climate change scenarios could

affect the amount of time farmers can spend in the field, the duration of the growing season, crop yields, CO₂ levels, weed and insect populations, and soil conditions, all of which have either a direct, or indirect, impact on agriculture.

Climate change could force farmers to adapt to more extreme conditions, including warmer, colder, and more variable weather patterns. This may improve production of some crops, but others could be put out of business, permanently. For example, peach trees that produce the delicious central Georgia peach crops need to be dormant each winter in order to be productive. For this to occur, the temperature between November and February must drop below 45 degrees during a certain number of hours each year. If winters get warmer and night temperatures rise, peach trees could be denied their necessary dormancy, thereby significantly impacting the crop, the farmer, and the Georgia economy.

Not all of climate change's effects on agriculture are negative. While global warming could decrease soybean and peanut yield, the raised levels of CO₂ in the atmosphere that cause climate change could increase certain crop yields.¹⁰¹ Most crops, however, including all spring crops, peanuts, maize, soybean and winter wheat, are sensitive to precipitation, temperature, and humidity. Spring crops especially are reliant on appropriate amounts of summer rainfall. Drought conditions, which could become more frequent with climate change, may, therefore, cause considerable harm. Georgia's corn crop in 1998 dramatically suffered from a cool, wet spring that delayed planting. This was followed by a hot, dry summer. The number of acres harvested dropped 41 percent and grain production dropped 52 percent from 1997 levels.¹⁰² Cotton, soybean, and hay also suffered.¹⁰³ While droughts are difficult to predict, Georgia's drought conditions in 1998 and 1999 have persisted long enough that some scientists at the University of Georgia are asking if the conditions are becoming more frequent or extensive.¹⁰⁴

Fisheries

Many Georgians enjoy local seafood, including fish, shrimp, crab, clams, and oysters. Climate change could affect local seafood by raising ocean levels and temperature. Rivers could flood. These events could stimulate the growth of harmful bacteria and algae in the water.

Water quality affects shellfish. Clams and oysters pump large quantities of water through their bodies daily in order to get food. When the water flowing through these living filters is contaminated by dangerous bacteria, the shellfish themselves become contaminated.¹⁰⁵ If bacteria is detected in local coastal waters, a shellfish fishery can be closed in order to protect human health. Such a closure occurred for almost two months along the entire Georgia coast in April and May of 1998.

High levels of harmful bacteria often are associated with raised water levels in coastal rivers that carry partially treated sewage, animal waste, and pollutants to estuaries and near shore waters.¹⁰⁶ Climate change is predicted to bring more severe and frequent rains, hurricanes, and floods. These conditions often lead to elevated water levels, thereby increasing the risk of water contamination from runoff and the likelihood of shellfish contamination.

Sea Level Rise in Georgia

The Georgia coastline, about 100 miles long, falls within an area considered to be the most vulnerable to rising seas.¹⁰⁷ Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges.¹⁰⁸ In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.¹⁰⁹

Mid and southern Atlantic coasts are likely to lose large areas of wetlands as the rate of sea level rise accelerates. Coastal development could make wetlands even more vulnerable.¹¹⁰ Wetlands along the low-lying coasts of Georgia already are subsiding and may be flooded, or washed away, as sea levels rise.¹¹¹ A 20-inch rise in sea level would cause a net loss of 17–43 percent of wetlands along the Atlantic and Gulf coasts, and could inundate more than 4,000 square miles of dry land.¹¹² At Fort Pulaski, sea level already is rising by 13 inches per century. It is likely to rise another 25 inches by 2100.¹¹³

The popular barrier island system, The Golden Isles of Georgia, plays a vital role in protecting the mainland from storm surges and tidal action. Behind the barrier islands of the Georgia coast lie 375,000 acres of salt marshes dominated by smooth cordgrass. The highly productive marshes provide homes for oysters and clams and serve as nursery grounds for young shrimp, crab, and fish. The marshes protect the shorelines from erosion. They also act as a purification system, by filtering out many pollutants added to the waters by human activities.¹¹⁴

These islands are at risk. The bay side of the islands could be inundated, while the ocean side may erode. Models estimate that a less than 1/2-inch rise in sea level (1 cm) will cause oceanfront beaches to erode from 6 to 32 feet in Georgia.¹¹⁵

Possible responses to sea level rise include allowing the sea to advance and adapting to it, raising the land by replenishing beach sand, or elevating houses and infrastructure. Each of these responses is costly, either in out-of-pocket costs or in lost land and structures. For example, the cumulative cost of sand replenishment to protect the coast of Georgia from a 20-inch sea level rise by 2100 is estimated at \$154 million to \$1.3 billion.¹¹⁶

Global warming further is predicted to raise the surface temperature of oceans. Higher surface temperatures can stimulate the growth of certain species of algae, known as “red tides,” or harmful algae blooms (HABs).¹¹⁷ These algae contain neurotoxins that can be life-threatening to humans. When fish and shellfish come in contact with the algae, they can carry the poisons to the humans who eat them. Marine phytoplankton and zooplankton can even shelter a dormant form of cholera, which may become infectious to humans if the marine ecosystem undergoes sufficient change.¹¹⁸

Most United States coastal waters are affected by HABs.¹¹⁹ While red tides have not been seen in Georgia waters to date, cases of paralytic shellfish poisoning (PSP) have occurred directly to the north and south of the Georgia coast. PSP affects the nervous system, causing tingling, burning, numbness, fever, rash, fatigue. In the worst cases, it can result in cardiac arrest.¹²⁰ Suspected causes of HABs include pollution runoff and hurricanes, which likely will increase with climate change, as well as ship ballast water. Ports on the Georgia coast, like Savannah, get a significant amount of international marine traffic that can carry contaminated ballast water into local Georgia waters.

What You Can Do

Can Georgians do anything to reverse the trends before global warming creates a perpetual state of emergency? Yes, they can. The number one priority is to lower the use of fossil fuels. Opportunities for doing so are everywhere.

To be sure, questions remain about the exact causes of global warming and how seriously it threatens human health, but enough is known about global warming to require action now. Its potential to cause harm is indicated by the insurance industry's decision to create a \$200 billion reserve to pay for damages expected to be caused by the increase in hurricanes and other extreme weather events.¹²¹ Moreover, the energy conservation techniques recommended here to protect against global warming are basically the same as those desperately needed to cut air pollution. This “no regrets” policy means no regrets now—and none for our children in the future. The quality of our children's lives will depend on the actions we take today.

There is a lot you can do, starting now, to bring down consumption of fossil fuels.

1 Urge the businesses you patronize to become energy-efficient. U.S. businesses spend about \$100 billion on energy each year to operate commercial and industrial buildings. By using energy efficient products and procedures, organizations could reduce their energy use by 35 percent or \$35 billion nationally. There are now numerous programs in place to help businesses change their energy usage and save money at the same time. Put your favorite businesses in touch with EPA's Energy Star Buildings program (1-888-STAR-YES, <http://www.epa.gov/greenlights>), and Climate Wise program (1-800-459-WISE (9473), <http://www.epa.gov/climatewise>).

2 Improve mass transit in Atlanta. Cars create a hefty 30 percent of the greenhouse gases in the air. There is a need for more mass transit, more access to public transportation, and more local pressure on officials to reduce suburban sprawl. Do your part, by using public transportation and supporting smart growth in the metropolitan area, which will reduce the need for Atlanta residents to drive.

3 Demand that electric utilities use low-carbon technologies and renewable energy. Georgia still has some dirty power plants that need to clean up their act. Support efforts to require old power plants to meet the same federal air pollution standards as new plants. Scherer, Bowen, Harlee Branch and Wansley, all owned by Georgia Power Company, are among the top 100 dirtiest power plants in the country for either, or both, nitrogen oxide emissions and carbon dioxide emissions. These plants add to

the state's ozone problem and to the emissions of greenhouse gases that cause global warming.

4 Get your own house in order. Use energy-efficient light bulbs. Install a solar thermal system to help provide your hot water (CO₂ reduction: 720 lbs/year). Recycle all of your home's waste newsprint, cardboard, glass, and metal (CO₂ reduction: 850 lbs/yr). Insulate your home, tune up your furnace, and install energy-efficient showerheads (CO₂ reduction: 2,480 lbs/yr). Leave your car at home for one or two days a week, and you will save tons of CO₂ emissions. Lower your thermostat in winter and raise it in summer, thereby reducing the demand for electricity and the burning of fossil fuels.

5 If you are buying a new car, go for a more energy-efficient one. That means steering clear of gas-guzzling sport utility vehicles (SUVs) which emit up to three times the amount of pollution as regular cars. At a website newly launched by the EPA and the U.S. Department of Energy (<http://www.fueleconomy.gov>), you can do a side-by-side comparison and select the most energy-efficient vehicle that meets your needs.

6 In this election year, work for candidates who are serious about reducing emissions of carbon dioxide and other greenhouse gases. Support senators who have taken a stand in favor of ratifying an international agreement on global climate change. Tell your members of Congress that you are not afraid of higher fuel efficiency ("CAFE") standards—for cars, SUVs, and light trucks—and they should not be either!

7 Work with local groups and chapters of national organizations to promote awareness of global warming issues in Georgia. They include: PSR-Atlanta (404-378-9078), the Medical Association of Georgia (404-876-7535), Campaign for a Prosperous Georgia (404-659-5675), Sierra Club (706-846-2281), Ozone Action/Air Keeper Campaign (404-872-3660), Wilderness Society (404-872-9453), and Union of Concerned Scientists (404-633-9678).

8 Encourage local, state and national decision-makers and politicians to support the Earth Day Clean Energy Agenda. On April 22nd, 2000, the thirtieth annual Earth Day will be celebrated all around the country. This year the Earth Day message includes the Clean Energy Agenda that calls for clean power, clean air, clean cars, and clean investments. A transition to energy efficiency and renewable energy would go a long way in combating global warming. Physicians for Social Responsibility is a member of the Earth Day Network (EDN), a global alliance of environmental organizations working together to battle climate change. Our Death by Degrees report can be used as tool to educate everyone about the potential health effects of global warming as part of a message for the need for cleaner energy. Contact the Earth Day Network (206-264-0144) or see the website at <http://www.earthday.net>, for more information about Earth Day 2000 and to find out what events are planned in your area.

Where Physicians for Social Responsibility (PSR) Stands

Physicians for Social Responsibility (PSR), the social conscience of American medicine, uses its members' expertise and professional leadership, influence within the medical and other communities, and strong links to policy makers to address this century's greatest threats to human welfare and survival.

While we recognize that uncertainties exist in the measurement of global warming—just as all scientific measurement is uncertain—we are moved to action for several compelling reasons. First, the overwhelming consensus among scientists is that Earth's temperature is increasing and weather patterns are changing in ways potentially harmful to human health. This fact is overlooked in statements funded by the energy industry that attempt to minimize the severity of global warming. Second, just like businesses, governments, and responsible individuals, PSR feels the need to act decisively in the face of uncertainty to protect those whose welfare has been entrusted to us.

We cannot say exactly when to expect a noticeable increase in floods, or in deaths from asthma among people living in smog-congested cities. No one can. But as Surgeon General Luther Terry stated in his 1962 report on motor vehicles and air pollution, the need for further research should not stop us from taking "all practicable steps to minimize" the hazard. We are certain that fossil fuels play a role in global warming, one step that we can control. For the sake of our own well-being, and the health of future generations, we need to act now.

PSR is working to create a world free of nuclear weapons, global environmental pollution, and gun violence. In 1985, PSR shared the Nobel Peace Prize with International Physicians for the Prevention of Nuclear War.

NOTES

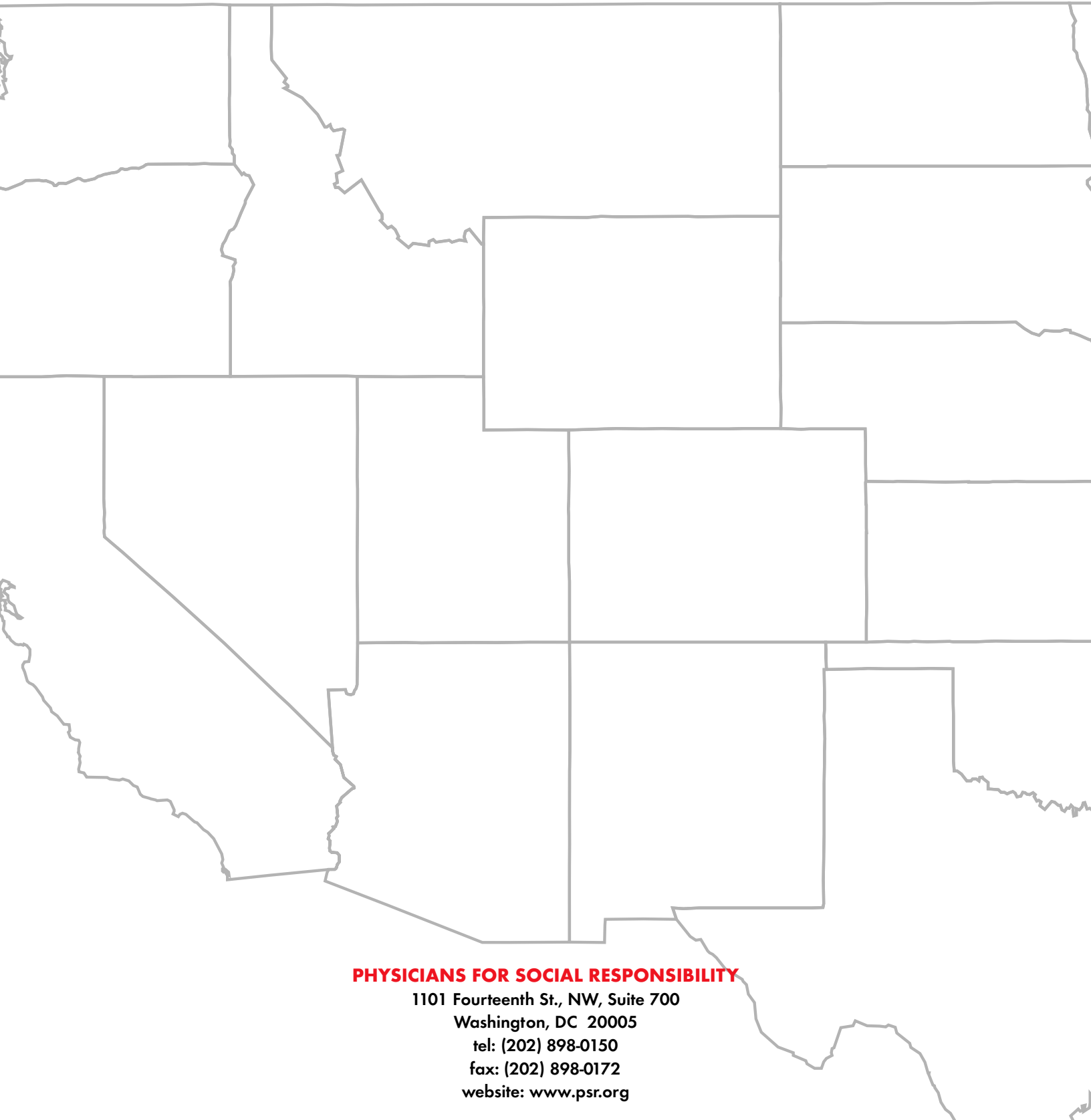
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