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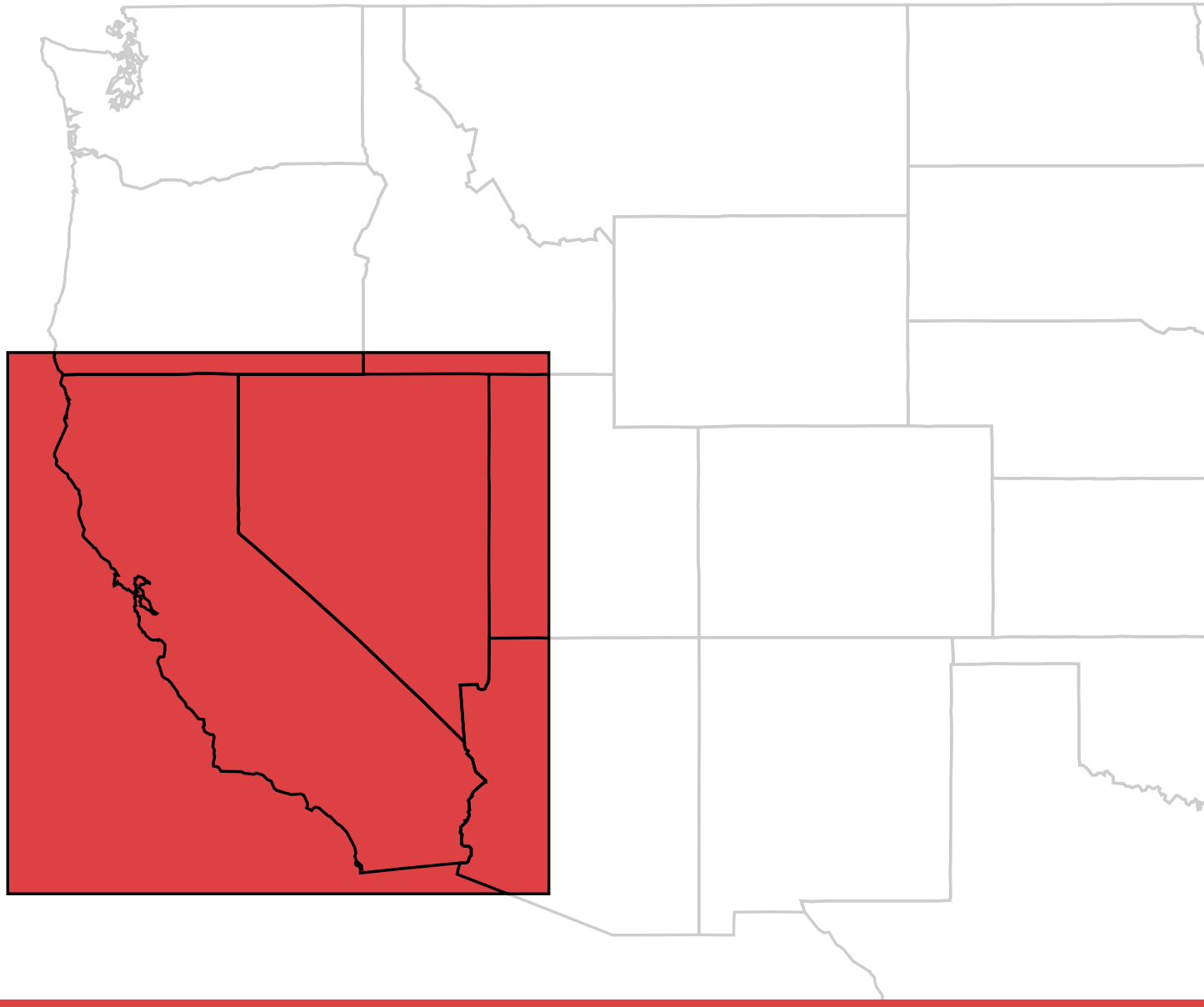
PHYSICIANS FOR SOCIAL RESPONSIBILITY

DEGREES OF DANGER

HOW SMARTER ENERGY CHOICES CAN PROTECT OUR HEALTH IN CALIFORNIA



CALIFORNIA REPORT

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DEGREES OF DANGER

HOW SMARTER ENERGY CHOICES CAN PROTECT OUR HEALTH IN CALIFORNIA

Physicians for Social Responsibility

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April 2003

This report was prepared by Physicians for Social Responsibility to alert California residents to the potential health effects of climate change and air pollution and how our energy choices and reliance on fossil fuels impact our health.

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How Smarter Energy Choices Can Protect Our Health in California

Physicians for Social Responsibility

Executive Summary

"A continuously warming earth will not forever support people; a continuously rising sea is the enemy of coastal dwellers everywhere."

GEORGE WOODWELL[1]

California is a microcosm of America, with the largest, most diverse population of any state, and an equal diversity of climates, landscapes, and ecosystems. From Death Valley to Sequoia National Park, from Sacramento to San Diego, and from the white sandy beaches of La Jolla to Mount Whitney, the tallest mountain in the lower 48 states, Californians can experience almost any weather or terrain imaginable. Many Californians enjoy a quality of life unmatched by that found in other states. However, Californians' quality of life and health now face two major threats: air pollution and global climate change. Fortunately, California has a long history as a leader in improving air pollution and creating innovative technologies. The time has come to use this know-how and ingenuity to protect the health of this great state.

This report will discuss how air pollution is affecting our health, contributing to climate change, and threatening our quality of life and the health of the state's economy, now the fifth largest in the world. It will also outline methods California can take to continue its leadership in environmental innovations in order to move California to a sustainable future by reducing or eliminating air pollution, slowing the rate of climate change, and reducing the negative impacts on the state. Californians have the ability and the responsibility to take action to protect their health and stop the human-made causes of climate change.

The Challenges

Since the end of the last Ice Age 10,000 years ago, our planet has been warming very, very slowly—only 9°F in all that time. Recently, however, the rate of warming has accelerated almost 10-fold. Global mean surface temperatures increased 0.6–1.2°F between 1890 and 1996. The 1990s were the warmest decade of the 20th century.

Scientists attribute this intensified "greenhouse effect" to human activities, namely, human-generated emissions of greenhouse gases. These greenhouse gases accumulate in the atmosphere and act as a blanket, trapping heat underneath and raising temperatures here on the ground. The most important greenhouse gas is carbon dioxide (CO_2), which is responsible for about two-thirds of the climate change.

Because a warmer atmosphere holds more water, climate change will alter precipitation patterns, leading to wetter climates in some places, drier climates in others. Warmer air also changes wind patterns, so the resulting weather changes will vary from place to place. If this process is allowed to continue, the world can expect more extreme weather—more heat waves, more severe storms, and even cooler temperatures in certain areas.

Uncertainties exist concerning the precise effects of global climate change, but the evidence that Earth is warming is now indisputable. Climate change is expected to increase average temperatures worldwide between 2.5 and 10.4°F by 2100. California will not be immune to this trend. Although it is impossible to

How Climate Change Could Threaten the Health of Californians

According to physicians who have studied the effects of climate change, the major health risks in California could include the following:

More frequent gastrointestinal infections caused by shortages of clean water:

- Changes in precipitation amounts and patterns, resulting in more rain and less snow, leading to flooding in some areas and droughts in others, thus decreasing the supply of clean water.
- Floods and droughts, the former contaminating the water supply with bacteria, viruses, and parasites from runoff polluted with animal and human wastes, the latter concentrating the pollutants during low stream flows.
- Rising sea levels contaminating the water supply due to salt intrusion, making it unfit to drink and unsafe for freshwater aquatic life.

More frequent and severe attacks of asthma and worsening of other respiratory and cardiac problems caused by increased air pollution:

- Increased ozone (smog) levels.
- Increased emissions of nitrogen oxides, sulfur dioxide, particulate matter, and other toxic pollutants.
- Smoke from forest fires resulting from drought.
- Increased pollen levels.

Greater risk of vector-borne infectious diseases:

- Hotter temperatures increase the risk of mosquito-borne diseases such as malaria, dengue fever, and West Nile virus.

More accidents, injuries, and loss of life and property:

- A projected increase in sea level of one to three feet by the year 2100 could bring flooding and coastal erosion, especially when complicated by storm surge.
- Extreme weather conditions such as the El Niño ocean warming phenomenon would lead to torrential rainstorms, floods, and mudslides.

More heat-related illness:

- Heat-related deaths could increase significantly.
- Seniors, infants and young children, and the poor face the greatest risk of illness and death from extreme heat.

predict exactly what climate change will mean for California, the evidence suggests that all life in the state—human, wildlife, forests, and crops—will be affected.

The Causes

Air pollution, energy production, and climate change are related to each other and with human health. Most air pollution comes from the production of energy, primarily from burning fossil fuels, such as coal and oil, to power modern life. Air pollution includes greenhouse gases, which contribute to climate change, as well as other pollutants that endanger our health and diminish the quality of our lives.

Fossil fuels, burned to run cars and trucks, heat homes and businesses, and power factories, generate approximately 80% of CO_2 emissions in the U.S. Although the U.S. has only 4% of the world's population, it emits nearly 25% of the total global greenhouse gases, and emissions are rising. Fossil fuel combustion also produces pollutants including nitrogen oxides, sulfur dioxide,

hydrocarbons, mercury, particulates, and carbon monoxide. These pollutants can cause serious health problems like asthma, lung inflammation, bronchitis, pneumonia, decreased resistance to respiratory infections, developmental delays and disabilities, and even premature death.

California has the most polluted air in the country. The top four ozone-polluted metropolitan areas were in California: Los Angeles-Riverside-Orange County, Bakersfield, Fresno, and Visalia-Tulare-Porterville.[2] According to the California Air Resources Board, 90% of Californians breathe unhealthy air during some part of the year. If fossil fuels continue to be the main energy source, climate change is expected to further foul the air.

The Solutions

The potential effects of climate change on our health and the health of California's diverse and fragile ecosystems are daunting. However, California is better positioned than any other state in the nation to lead the way in finding clean energy solutions. A broad range of solutions is already underway in the state, but others remain to be developed and implemented. This report outlines solutions and actions, both personal and political, which can slow and eventually reverse climate change and protect our health and the health of the economy in the process. However, we have a narrow window of opportunity to put that process in motion. As concerned Californians, we have the responsibility to act now.

The number one priority is to reduce air pollution and the emission of greenhouse gases such as CO_2 by decreasing the use of fossil fuels. The first step is to toughen fuel economy standards for gasoline-powered cars and trucks. California's 23.4 million motor vehicles consume 14 billion gallons of gasoline every year and produce 37% of the nation's CO_2 emissions. Tougher fuel economy standards would immediately reduce CO_2 emissions and allows consumers' to save money. America's love affair with the sport utility vehicle (SUV) has helped increase pollution levels and decrease fuel economy standards to their lowest level in 20 years. All vehicles, including light trucks and SUVs, must meet tougher fuel economy standards.

Technology already exists to produce cars with greater fuel economy, which burn less gasoline and emit less CO_2. A limited number of these vehicles are available now, but industry and government must be pressured to invest in these technologies and produce more vehicles that are environmentally responsible

Tougher fuel economy standards are not enough. We must begin a transition to cleaner energy—wind, solar, and biomass energy. These

Solutions to Prevent Climate Change

Clearing the air in California and slowing the rate of climate change demands several approaches. These approaches include:

- **Increasing our use of renewable energy sources** such as wind, solar, and biomass energy.
- **Decreasing our use of fossil fuels** by improving energy efficiency of power plants and motor vehicles and encouraging innovation in developing alternative fuel vehicles.
- **Improving and expanding mass transportation.**
- **Planning for smart growth and restricting sprawl.**

alternative energy sources are clean, safe, renewable, and available or within our reach. An economy based on cleaner fuels will help California prosper, gain its freedom from fossil fuels, and improve human health and quality of life.

The technology exists to transition to cleaner energy. By demanding that government and industry invest in and use renewable sources of energy, CO_2 production can be reduced. Technology also exists to clean up the power plants that help generate California's electricity, which would immediately reduce CO_2 and other greenhouse gas emissions.

Increasing and improving mass transportation will also reduce greenhouse gas emissions. Other options include rideshare programs and high occupancy vehicle (HOV) lanes, now available in Sacramento, San Francisco, San Diego, and other parts of Southern California. Better city and regional planning to decrease urban sprawl will reduce the need for long commutes, thereby reducing greenhouse gas emissions as well as waistlines as Californians walk more.

As we implement these solutions, we must also protect California's most vulnerable populations, regions, and resources. The health and well being of farm workers in the Central Valley, people in border communities, and the young, the old, and the poor throughout California are at risk of harm from climate change. Our limited water resources are also at risk, as are the forests and other fragile ecosystems.

California's booming population—now at 34 million and projected to reach 45 million by 2020—increases the urgency of moving to cleaner, more efficient production and consumption energy and wiser use of natural resources. Without that transition, California will be unable to sustain life as we know it. Making the transition to cleaner energy and cleaner air will take time and money, but most of all, it will take the political will and personal commitment of the people of California.

How Smarter Energy Choices Can Protect Our Health in California

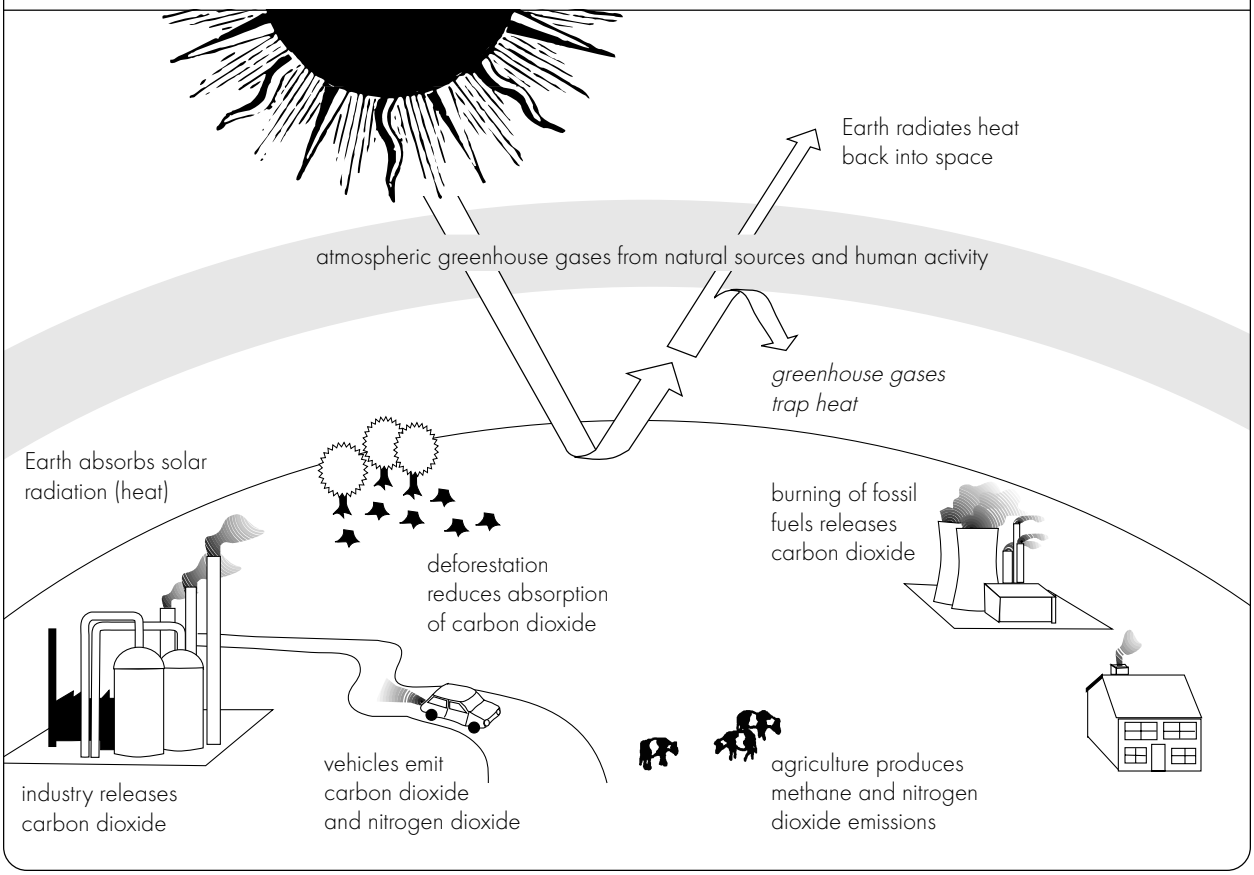
As the fifth largest economy in the world, California has extraordinary influence on national and global trends. What happens in California can affect the entire country and potentially the world. Companies who want to sell products in the Golden State must meet California standards. For example, it may be less expensive for an automobile manufacturer to make all cars meet California's emission control standards, than to have dual production processes. How California responds to global climate change can set the pattern for the entire country.

California has a long history as a leader in improving air pollution and creating innovative technologies, however, much work remains. The time has come to use this know-how and ingenuity to protect the health of this great state and set a nationwide example of clean energy leadership.

The Complex Origins of Climate Change

Energy from the sun controls the earth's weather and climate and heats the earth's surface. The earth in turn radiates energy back into space. Certain atmospheric "greenhouse gases," such as CO_2, methane, nitrous oxides, and water vapor, trap some of the sun's energy, much like the glass panels in a greenhouse or like a CO_2 blanket. This phenomenon is called the "greenhouse effect," which keeps the earth warm enough to sustain life at an average temperature about 60˚F.[3]

FIGURE 1
The Greenhouse Effect



Since the end of the last Ice Age 10,000 years ago, average temperatures worldwide have risen only 9°F. Yet, this small change in global average temperatures has produced dramatic changes in climate. Until recently, this warming trend resulted primarily from natural changes in the geographical distribution of the sun's energy and in the amounts of dust, carbon dioxide, and other natural gases in the atmosphere. In recent years, however, the rate of temperature increase has accelerated. Global average temperatures increased 0.6–1.2°F between 1890 and 1996, and even more so in the past two decades. The 1990s were the warmest decade of the 20th century. Three of the four years between 1996 and 2000 registered as the hottest years on record.

Scientists attribute this intensified greenhouse effect to human activities, namely, human-generated emissions of greenhouse gases due to the combustion of fossil fuels. Since the industrial revolution began in the mid 1700s, the atmospheric concentration of greenhouse gases has greatly increased.

- *Carbon dioxide concentrations are up 31%*. They are responsible for more than 60% of the enhanced greenhouse effect.
- *Methane concentrations have more than doubled*. Methane released from garbage dumps, farm animals, coal mining, melting permafrost in the far North, and natural gas production contribute up to 20% of the enhanced greenhouse effect.
- *Nitrogen oxides (NO_x) concentrations have risen about 15%*. NO_x result from burning fossil fuels and have a lifespan of about 120 years. Thus, combustion byproducts of fuels burned now may remain in the atmosphere and potentially contribute to climate change until the year 2122.[4, 5]

CO_2 is responsible for about two thirds of the potential warming to date; but methane, chlorofluorocarbons, nitrous oxide, and several other gases trap more heat per molecule than CO_2 and are becoming increasingly important.[6]

Fossil fuels, burned to run cars and trucks, heat homes and businesses, and power factories, generate approximately 80% of CO_2 emissions in the U.S.[7] Deforestation, livestock production, landfills, industrial production, and mining also contribute a significant share of these emissions. Together, these increases have enhanced the capability of the earth's atmosphere to trap heat, referred to as "climate change" or "global climate change."

State of the Science of Climate Change

Climate Change on a Global Scale

The Intergovernmental Panel on Climate Change, a United Nations-sponsored group of more than 2,500 experts on climate change, published its Third Assessment Report in 2001.[8] This report has undergone extensive scrutiny and peer review and encompasses the complete range of scientific, technical, economic, and social issues associated with the climate system and climate change deemed important by the scientific and policymaking communities.

This updated report states that by 2100, average global surface temperatures may increase 2.5°–10.4°F (1.4°–5.8°C) if countries continue to rely on burning

fossil fuels for energy. Rates of warming over land areas are likely to be higher. This rise in temperatures far exceeds recent natural fluctuations. The Panel estimates that over the past 140 years, the global average temperature has risen by about 1˚F. This warming effect has caused sea levels to rise 4-10 inches during the past century, snow cover and Arctic sea ice to decrease in the Northern Hemisphere, and precipitation over land to increase.[9]

Predictions about climate change are based on a variety of evidence, including measuring greenhouse gases, using complex computer-generated meteorological models to simulate climate, and studying past weather variables such as precipitation and heat records. In addition, scientists around the world collect satellite data, sea surface temperatures, and changes in coral reefs, tropical glaciers, and the polar regions. Some of the most recent studies have linked progressive warming of tropical oceans since at least 1950 to climate changes in Northern Hemisphere winters.[10] Scientists also have related ocean warming in the upper 3,000 meters of the world's oceans to human activities[11] Although no single line of evidence can "prove" climate change, the combined evidence from these various methods of studying climate change is indisputable.

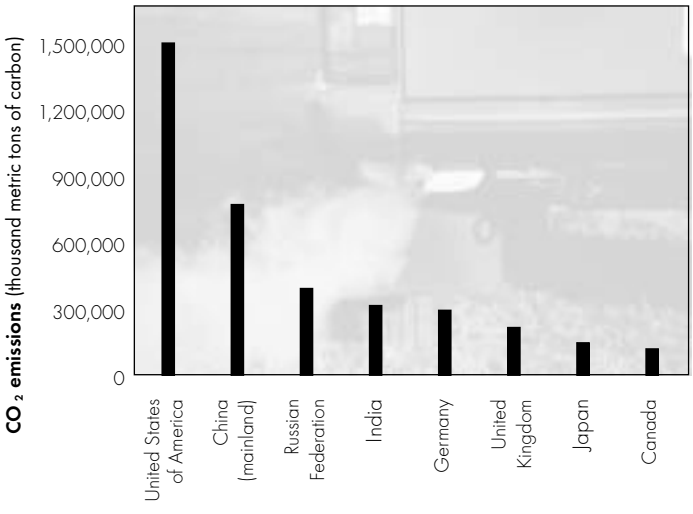
Climate Change on a National Level

In 1990, the U.S. Congress established the U.S. Global Change Research Program, mandating it to conduct a national assessment of the potential impacts of climate variability and change on the U.S. As a result, the U.S. National Assessment of the Potential Consequences of Climate Variability and Change (referred to as the National Assessment) began in 1997 to predict the potential impacts of climate change to 2030 and to 2100 for geographic regions of the U.S. and for various national sectors. Their conclusion: "Humans are exerting a major and growing

FIGURE 2
Climate Change in the U.S.

The U.S. is already feeling the effects of global climate change. Temperatures have increased approximately 1◦F during the past century in the contiguous U.S.[12] Precipitation is also greater, due to increased heavy rainfall (more than 5 cm per day) and decreased light precipitation.[13]

Although the U.S. has only 4% of the world's population, it emits nearly 25% of the total global greenhouse gases {EPA, 1997}, and emissions are rising. In 1996, the U.S. released approximately 24% of global energy-related CO_2 emissions into the atmosphere. Between 1990 and 1999, U.S. greenhouse gas emissions increased 13%, and the Energy Information Administration projects that CO_2 emissions will continue to increase by an average rate of 1.5% per year.[14] If current trends continue, CO_2 concentrations would increase by 30%–150% by the year 2100.[15] One sure way to reduce CO_2 emissions and thereby slow the rate of climate change is to reduce significantly the amount of fossil fuels burned in the U.S.



Source: Oak Ridge National Laboratory and University of North Dakota

influence on some of the key factors that govern climate by changing the composition of the atmosphere and by modifying the land surface...Rising concentrations of CO_2 and other greenhouse gases, are intensifying Earth's natural greenhouse effect."[16]

A recent report from the National Academy of Sciences has further validated the Intergovernmental Panel on Climate Change report, concluding, "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise."[17]

Climate Change on a Regional or Local Level

Although the average temperature worldwide is increasing, the story is even more complex on a regional level. Because a warmer atmosphere holds more water, climate change will increase precipitation. Warmer air also changes wind patterns, so the resulting weather changes will vary from place to place. If this human-made process is allowed to continue, we can expect more extreme weather—more heat waves, more severe storms, wetter climates in some places, drier climates in others, and even cooler temperatures in certain areas.[18] Many scientists, therefore, prefer the term *global climate change* to *global warming* because it better describes the bigger picture. In this report, we use the terms *global climate change and climate change* interchangeably.

Climate change is real and is occurring both globally and locally. How it affects human health and the quality of our lives is up to us. The window of opportunity for corrective action is closing. America needs to take action today to slow, and potentially reverse, climate change and to safeguard our health.

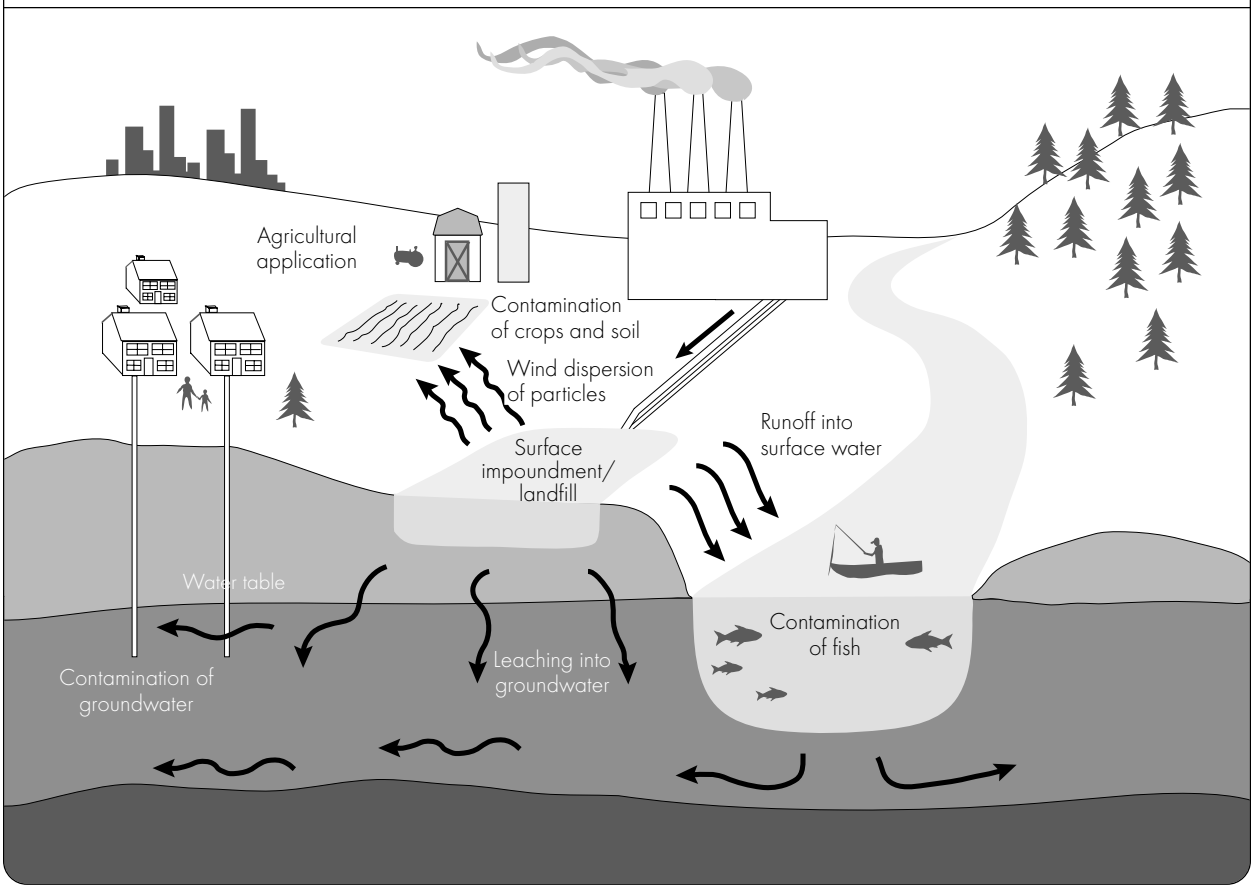
Air Pollution, Energy Production, and Climate Change

Most air pollution comes from the production of energy—primarily from the burning of fossil fuels such as coal and oil—to power modern life. Air pollution includes greenhouse gases, such as CO_2, as well as other pollutants that endanger our health and diminish the quality of our lives.

Electric Power

The electric power industry is one of the most polluting industries in the world. Fossil fuel burning plants account for 30% of California's CO_2 emissions.[19] Power plants built from 1940–1970 burn fossil fuels and produce the vast majority of power plant air pollution. When Congress passed the Clean Air Act in 1970, and amended it in 1977 and 1990, the electric power industry convinced members of Congress that older plants would soon be retired and therefore should be exempted from strict new emission standards. Unfortunately this has not happened, and these old power plants continue to emit, on average, 4–10 times more air pollution than a new plant. This loophole makes it profitable for utilities to keep operating old plants. Utilities

FIGURE 3
The Cycle of Power Plant Pollutants



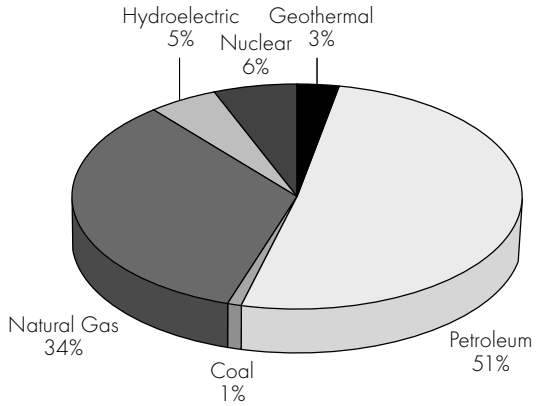
are enjoying bigger profits at the expense of polluting our communities and damaging our environment.

California gets 88% of its energy from unsustainable sources, including fossil fuels, as well as nuclear and hydroelectric facilities, which come with a host of environmental and health concerns outside the scope of this paper.[20]

Transportation

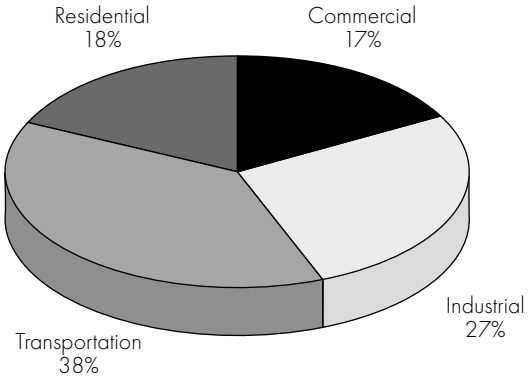
"The fact that air pollution fatalities substantially exceed traffic fatalities worldwide suggests the need to broadly redefine notions of safety to include the goal of decreasing air pollution. While

FIGURE 4
California Fossil Fuel Use



Source: California Energy Commission. (http://www.energy.ca.gov)

FIGURE 5
California Energy Consumption by Sector



Source: California Energy Commission. (http://www.energy.ca.gov)

California's Increasing Population

California's population—now more than 34 million and projected to reach 45 million by 2020—continues to grow, steadily increasing the demand for energy, as well as for water, food, housing, employment, education, health care, and other social services. This adds urgency and importance to the need for a transition to sustainable technologies and conservation of finite resources. Indeed, population growth will be a major challenge for California in terms of climate change and air pollution. A detailed examination of the factors influencing population growth in California is beyond the scope of this report. However, population growth must be factored into all public policy initiatives related to climate change.

only some motorists contribute to traffic fatalities, all motorists contribute to air pollution fatalities."[21]

—BERNIE FISCHLOWITZ-ROBERTS

The largest share of the energy consumed in California (38%) is for transportation; 51% of this energy is derived from petroleum.[22] Industrial use accounts for 27%, commercial use for 17%, and residential use for 18%.[23] There are more than 23.4 million vehicles registered in California.[24] Unfortunately, California's transportation needs are growing as the state's population grows. Since 1973, the number of vehicles in the state has increased 75%.[25]

The U.S. Environmental Protection Agency (EPA) estimates that mobile sources of air toxics account for up to one-half of all cancers attributed to outdoor sources of air toxics, causing up to 1,500 cases of cancer each year.[26] In California alone, 14 billion gallons of gasoline are burned every year to get us where we want to go.[27] Only the U.S. as a whole and the nations of the former USSR exceed the volume of gasoline consumed in the state of California each year.[28]

One reason Californians burn so much gasoline is that vehicle fuel efficiency has decreased over the past 20 years. Since 1999, fuel efficiency has declined for three years in a row. The overall fuel efficiency of the American fleet has decreased because the cars we choose to drive, such as SUVs and minivans, get very few miles per gallon of gasoline. Higher miles per gallon standards would decrease CO_2 emissions as well as emissions of dangerous hydrocarbons. Most carcinogenic air toxics, such as benzene, are hydrocarbons.

How Climate Change Could Affect Air Quality

"Climate change matters in California. The repercussions of a change in climate are serious. They challenge the state's infrastructure investments and touch all sectors of the economy: water supply, agriculture, forestry, energy production, health, transportation, tourism and others."[29]

—CALIFORNIA ENERGY COMMISSION

Climate change is expected to affect air quality in at least five ways:

First, as temperatures rise, ground-level ozone—the main component of smog—will increase. Smog is formed from NO_x and volatile organic compounds (VOCs) (both natural and human-made) in the presence of oxygen, sunlight, and heat. As climate change causes temperature to rise, ground-level ozone formation will increase and can create thermal inversions in geographic basins such as Los Angeles.

Air Pollution and Premature Death

Air pollution contributes to thousands of premature deaths and reduces the quality of life in the U.S. and throughout the world. A recent study suggests that adopting "readily available technologies to lessen fossil fuel emissions over the next two decades" in just four major cities (New York City, Santiago, Sao Paulo, and Mexico City) could prevent approximately 64,000 premature deaths, 65,000 chronic bronchitis cases, and 37 million person-days of work loss.[30] Reducing greenhouse gas emissions would have immediate health benefits by reducing local air pollution.

Second, pollutant concentrations in the air of a specific location may be affected by local and regional weather conditions. Still air could allow pollutants to accumulate; wind could blow pollutants to other areas. Climate change could affect precipitation, wind speed and direction, and other local weather conditions, which in turn could have significant effects on local air quality.

Third, if fossil fuels continue as the main energy source, atmospheric concentrations of human-made pollutants could increase due to escalating energy demand from urban growth and development. Fossil fuel byproducts, such as ground-level ozone, particulate matter, NO_x, and sulfur dioxide have negative health effects. Climate change could increase concentrations of these pollutants and compound their effects.

Fourth, climate change could increase natural emissions of air pollutants such as VOCs from forests. When VOCs combine with NO_x, they form ground-level ozone.

Fifth, climate change may alter the concentration and distribution of pollens and spores, which, together with warmer temperatures, may enhance the formation and persistence of certain pollutants. This could increase the respiratory complications linked to these natural substances for people with asthma, hay fever, and allergies.

To slow the rate of climate change and reduce air pollution, we need to curb emissions of greenhouse gases and toxic air pollutants. One necessary step is to invest in a long-term, responsible energy strategy that lessens the need for dirty fossil fuel use, and instead, includes more energy-efficient power sources, appliances, and vehicles, expanded development of renewable sources of energy, and increased energy conservation. This investment will provide important health benefits by protecting our air, water, and land resources and move California and the nation toward a more sustainable future.

Air Pollution and the Health of Californians

Air pollution takes a heavy toll on the health of all Californians, and contributes both directly and indirectly to respiratory disease, cancers, developmental delays and disabilities, and sometimes to premature death. More than 40% of all deaths in California are attributed to heart disease, strokes, or respiratory

diseases.[31] All these conditions are exacerbated by air pollutants and/or environmental factors that may result from climate change. Long-term exposure to air pollution has been linked to a significant increase in the risk of death.[32]

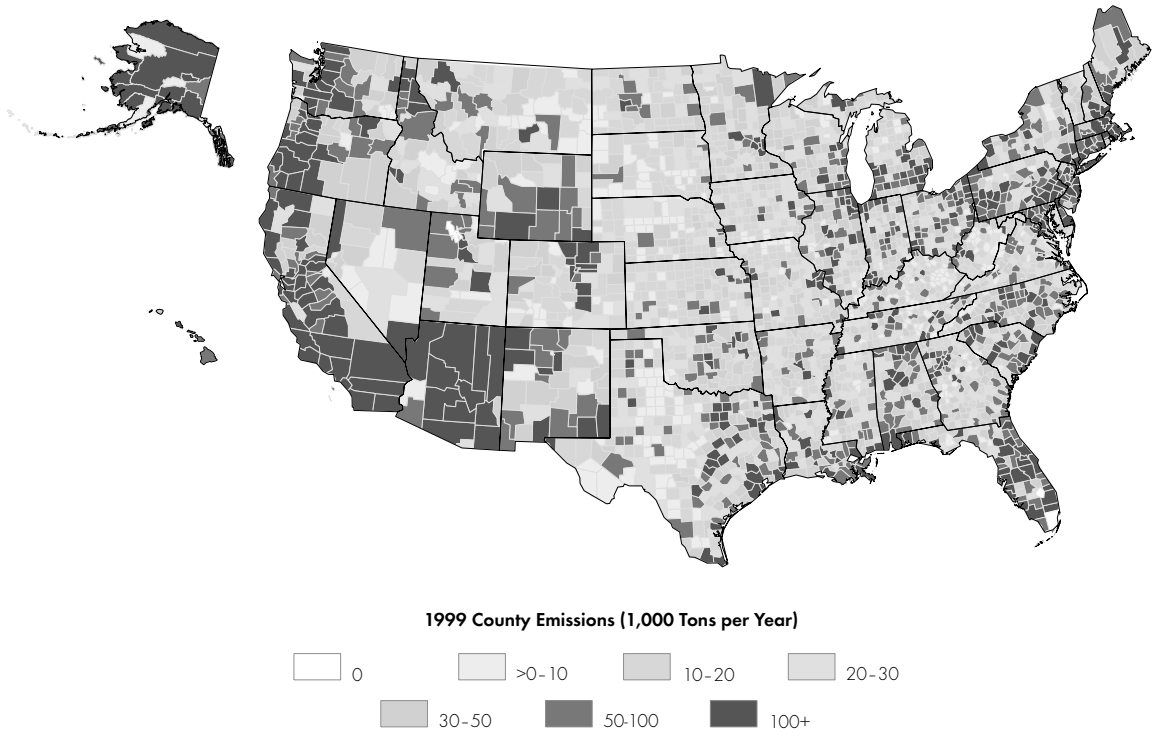
The environmental and health effects of air pollution depend on the concentration of the pollutants and the amount of exposure to them. National ambient air quality standards identify six pollutants of public health concern: ground-level ozone, particulate matter, lead, nitrogen oxide, sulfur dioxide, and carbon monoxide. There are also 188 hazardous air pollutants or air toxics, most of which are VOCs.

Air Pollution: Its Sources and Health Effects

Name of Pollutant	Abbreviation	Source and Environmental Impacts	Health Impacts
Carbon Monoxide	CO	CO is produced by burning organic matter such as fossil fuels, wood and charcoal. Motor vehicles produce 67% of the man-made CO that is released into the atmosphere.	Fatigue, angina, reduced visual perception and dexterity, death in closed space.
Carbon Dioxide	CO_2	CO_2 is produced by burning organic matter such as fossil fuels, wood and charcoal. CO_2 is a greenhouse gas.	Major contributor to global warming, which has been linked to an increase in the spread of disease.
Nitrogen Oxides	NO_X	Oxides of nitrogen are the chemicals responsible for giving smog its brown appearance. NO_X contributes to the formation of ozone, production of particulate matter, and acid rain.	Irritates lung tissue, causes bronchitis and pneumonia, has been linked to a decrease in lung function growth.
Particulate Matter	PM	Particulate mater consists of soot and dust particles that are smaller than the diameter of a human hair. Electricity generation, transportation and industry generate roughly equivalent proportions of PM.	Penetrates deep into the lungs and is associated with numerous respiratory and cardiac problems and cancer.
Sulfur Oxides	SO_X	Oxides of sulfur are produced by the burning of fossil fuels. Large emitters of SO_X include motor vehicles, refineries and power plants. SO_X contributes significantly to acid rain.	Reduces respiratory volume, increases breathing and nasal airway resistance.
Volatile Organic Compounds	VOC/ UHC	VOCs are a class of reactive organic gases that contribute to the formation of ozone and smog. Motor vehicles, refineries and power plants are the primary source of VOCs. Levels of VOCs are often determined by measuring unburned hydrocarbons (UHC)	Coughing, fatigue and nausea; contributes to the inflammation of lung tissue and reduced lung capacity.
Air Toxics		Air toxics like benzene, toluene, and formaldehyde are formed from fossil fuel processing and combustion. The U.S. EPA has identified 188 chemicals as hazardous air pollutants.	Cancer, reproductive disorders, developmental disorders.

Source: Micropower at the Crossroads: Public Health and the Future of Distributed Generation.

FIGURE 6
Total Emissions of Criteria Air Pollutants for the United States



Source: US EPA Office of Air and Radiation, NET Database

Ozone

Ground-level ozone is the major component of what we commonly call smog, the most pervasive outdoor air pollutant in the U.S. Smog is at its worst on hot, sunny days, which are likely to become more numerous with climate change. Ozone is a toxic and irritating gas that even in small amounts can affect health. Ozone, or smog, is formed when NO_x and VOCs emitted from motor vehicles, power plants, refineries, factories, and even some natural sources like plants are heated by sunlight.[33]

Thirty-two counties in California exceeded legal limits for ozone at least once in 2002.[34] High concentrations of ground- level ozone have affected the Los Angeles area for half a century, due in part to the basin shape of the region, high density population, sprawl of the metropolitan area, and the characteristic sunshine. In response, California has some of the strictest restrictions on vehicle emissions in the nation. Despite smog reduction programs, however, ozone problems continue in Southern California, in the San Francisco Bay Area and the Central Valley.[35] Increases in average temperatures would only make those problems worse.

FIGURE 7
Counties Designated Non-Attainment for Ozone

Source: U.S. Environmental Protection Agency

Asthma and Children

Asthma is the most prevalent disease among children, affecting at least 667,000 school-age children in California. Asthma is also the leading cause for school absenteeism.[42]

A recent research study in Southern California suggests that air pollution not only triggers asthma attacks, but also influences the development of new asthma cases.[43] Researchers compared new asthma cases in more than 3,500 children from 12 communities. Six communities had relatively clean air, and six had some of the dirtiest air in the nation. The study focused on children who participated in active sports like soccer, baseball, tennis, basketball, and swimming, for at least five years, beginning at age nine. Researchers found that children most likely to develop asthma were those exercising in the most polluted cities and concluded that in these conditions, air pollution and outdoor exercise could contribute to the development of asthma in children.

Exposure to elevated ozone levels can cause severe coughing, shortness of breath, pain when breathing, lung and eye inflammation, and greater susceptibility to respiratory illnesses such as bronchitis and pneumonia.[36] Even moderately exercising healthy adults can experience from 15% to more than 20% reductions in lung function from exposure to low levels of ozone over several hours.[37] Warmer temperatures can create thermal inversions, holding smog closer to the ground and intensifying its harmful effects.

For the nearly three million residents of California who have asthma, ozone is of special concern.[38] Numerous studies have shown that higher ozone levels cause more asthma attacks, increase the need for medication and other medical treatment, and result in more hospital admissions and visits to emergency rooms for people with asthma.[39] More than 740,000 Californians experience asthma symptoms every week, indicating chronic exposure to environmental triggers.[40]

Volatile organic compounds (VOCs)

VOCs are directly toxic and are associated with cancer, neurological, reproductive, and developmental effects.[41] VOCs can combine with nitrogen dioxide to form ozone. Although ozone in the upper atmosphere (stratospheric

FIGURE 8
Air Quality Index

CATEGORY	RISK LEVEL	HEALTH ADVICE
Green	No increase in risk	No special actions needed
Yellow	Moderate risk	Children, the elderly, and people with lung problems should **decrease long-term outdoor activity**
Orange	Unhealthy for high risk groups	Children, the elderly, and people with asthma or other lung problems should **limit long-term outdoor activity**
Red	Unhealthy	Everyone should limit outdoor activity. Children, the elderly, and people with asthma or other lung problems should **avoid outdoor activity**

Source: U.S. Environmental Protection Agency

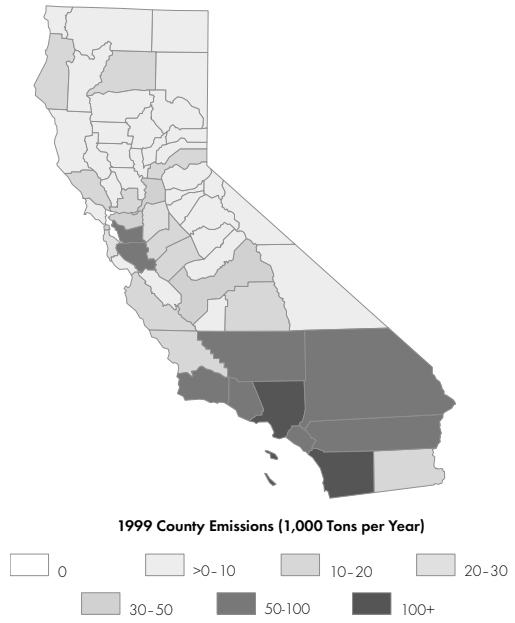
ozone) helps protect us from the damaging effects of the sun's ultraviolet rays, ground-level ozone (tropospheric ozone) is very harmful to breathe.

As temperatures increase, more VOCs are emitted when people fuel and operate motor vehicles.[44] Plants and forests also emit VOCs, and these emissions rise as temperatures increase. For example, pine trees emit more VOCs during warmer temperatures.[45] Thus climate change is expected to increase levels of both human-made and natural sources of VOCs, increasing ground-level ozone concentrations.

Nitrogen oxides (NO_x)

Nitrogen oxides are greenhouse gases that contribute to climate change. Although NO_x can occur naturally, they can have multiple adverse health effects. They also combine with VOCs to form ozone. NO_x also combine with water vapor in the atmosphere to form nitric and nitrous acids, major components of acid rain. Higher temperatures accelerate this process, increasing the potential for acid rain as the climate warms.[46] NO_x combine with sulfur dioxide to form fine aerosol particles known as particulate matter. Nitrogen dioxide, one of the NO_x gases, can be directly

FIGURE 9
California NO_x Emissions



Source: US EPA Office of Air and Radiation, NET Database

toxic in the lungs, where it combines with secretions from the lining of the airways to form acids that damage lung tissue, potentially worsening asthma and allergic symptoms, and causing increased respiratory infections.[47]

Sulfur dioxide and particulate matter

Sulfur dioxide reacts with oxygen in the atmosphere to become acid rain and combines with NO_x to form fine particles called particulate matter that when inhaled, irritate the respiratory tract.[48] Sulfur dioxide is formed from the combustion of coal and oil that contains sulfur. Most of California's power plants burn natural gas, so sulfur dioxide emissions are not a significant problem here. However, they remain a major source of pollution in the Midwest and the Northeastern U.S.

Particulate matter is a problem for California. According to the EPA, 15 counties have non-attainment levels for particulate matter.[49] Particulate matter consists of ash, soot, fibers, dust, and liquid droplets. It is emitted directly into the atmosphere by many combustion sources—industrial processes, diesel buses and trucks, and other vehicles. Particulate matter is also created by the combination of gases such as NO_x and sulfur dioxide.[50]

Fine particulate matter, which is 1/100th the width of a human hair, is of great concern, because it not only circulates in outdoor air, but also penetrates indoor living spaces, thereby increasing human exposure. It tends to lodge deep in the lung with respiratory and cardiovascular health consequences. For example, numerous studies show that hospital admissions of elderly patients and children increase for respiratory and cardiac causes when concentrations of particulate matter increase.[51,52] Scientists in the United Kingdom have concluded that long-term exposure to fine particle pollution is likely to be as dangerous as second hand smoke.[53] Another study showed that particulate matter can trigger a heart attack in people who are obese, inactive, or have a history of heart problems. The risk for heart attack peaked two hours after exposure to particulate matter and again at 24 hours. Significantly, these statistical associations were observed at levels below current federal air quality standards, implying that although an area meets federal Clean Air Act requirements, particulate matter in the air may still pose a health hazard.[54]

One study found that infants living in cities with high levels of fine particles have a 26% increased risk for sudden infant death syndrome (SIDS), and infants living in high pollution areas were 40% more likely to die of respiratory causes.[55]

Carbon monoxide

Carbon monoxide is a dangerous air pollutant with severe health effects. Odorless, invisible, and poisonous, carbon monoxide is the byproduct of the incomplete combustion of carbon-based fuels. Though not a greenhouse gas itself, carbon monoxide can increase the lifespan of other greenhouse gases and worsen climate change. It can also increase the production and concentration of ground level ozone.[56]

Carbon monoxide poisoning can be fatal. Because it binds up the body's oxygen-carrying molecules (hemoglobin) almost 100 times more strongly than

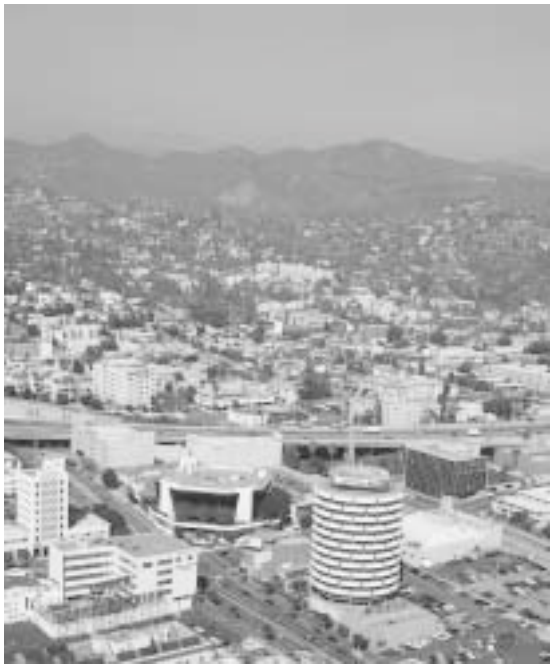
Los Angeles and Smog

Even before the automobile, there was smog in the Los Angeles basin because of its geography. The mountains that ring the city trap and hold VOCs and NO_x, which combine to form smog. Smog is at its worst in the summer and creates acid rain in the winter, harming animals, vegetation, and water quality.

Seeing the yellow-brown skies of Los Angeles, it is hard to believe air quality is improving, but it is. Between 1974 and 1996, Stage 1 smog alerts were reduced by 94%. But even the "new improved" version of Los Angeles air still ranks among the worst air in the nation. Therefore, EPA has designated this region an extreme ground-level ozone non-attainment area, which threatens the health of all 15 million residents.[57]

In January 2003, air quality officials reported that they had underestimated by 30% the smog-forming emissions from cars, trucks and other sources, and thus California may be facing penalties under the Clean Air Act by 2010. The Clean Air Act requires states to maintain healthy air quality. Although the state made progress in reducing ozone for two decades, efforts have not kept pace with growth and development. Stepping up the pace of ozone reduction to meet the 2010 requirements could mean new restrictions on growth and highway construction plus greater demand for more fuel-efficient cars. The state Air Resources Board released a draft of the 2003 clean air plan at the end of January, followed by public hearings.[58]

About 70% of Los Angeles smog comes from mobile sources: not just the 11 million cars and trucks in this area, but also agricultural equipment, construction equipment, and gasoline-powered lawn and garden equipment.[59] California still suffers from decisions made over 50 years ago under pressure from the auto and petrochemical industries to replace electric transit systems in 100 cities with gasoline or diesel buses, which increased toxic emissions.[60] Carmakers and the petroleum industry continue to lobby hard against emission controls and public transit.



The Clean Air Act was enacted more than three decades ago; yet enforcement remains a challenge. In 1999, for example, Los Angeles settled a lawsuit with environmental groups to implement the 1994 State Implementation Plan, designed to reduce air pollution in the South Coast area. The groups filed suit against state and federal agencies for violating the Clean Air Act, charging that the agencies failed to implement the State Implementation Plan, which was designed to reduce NO_x and VOCs by more than 77 tons per day.[61] Measures proposed in the State Implementation Plan to achieve these reductions in emissions include tougher standards for buses and gasoline trucks, gasoline station vapor recovery equipment, and new regulations for consumer products such as SUVs, marine vessels, and motorcycles.[62]

oxygen, carbon monoxide displaces oxygen from the blood, thereby reducing the amount of oxygen being delivered to the tissues. The low-level exposures that occur in urban settings affect the most oxygen-sensitive organs of the body, the heart and the brain. Pregnant women or anyone with heart or lung disease cannot tolerate reduced levels of oxygen. Low ambient levels of

carbon monoxide may cause headache, confusion, shortness of breath, and fatigue, even in a healthy person.

Transportation accounted for about 75% of carbon monoxide emissions nationwide in 1997, more than half coming from the exhaust of cars and trucks. In cities, car exhaust contributes as much as 95% of all carbon monoxide emissions, creating high concentrations of carbon monoxide in areas congested with heavy traffic. Nationally, average carbon monoxide levels have decreased since 1988.

Pollens and natural allergens

Pollens and fungal spores may increase with climate change, exacerbating their adverse effects on sensitive individuals. Higher temperatures and added precipitation could increase fungal growth, exacerbating asthma and other respiratory conditions.[63] Warmer temperatures may also lengthen the allergy season.[64] Some plants such as birch trees increase their pollen production and the allergen content of the pollen with increasing temperatures.[65]

How Climate Change Could Affect Water in California

"…in a very real and frightening sense, pollution of groundwater is pollution of water everywhere."[66]

—RACHEL CARSON, SILENT SPRING

Most of California's rainfall and runoff from the Sierra Nevada snow pack occurs in the north. The majority of the population and most of the irrigated agriculture are in the Central Valley and the southern part of the state. California's survival depends on an elaborate system of reservoirs, canals, pumps, and pipelines that move water around the state to meet the conflicting demands of agriculture, wildlife, and urban communities.

Although climate change could increase total precipitation, it could alter precipitation patterns. This could mean more rain earlier in the year and less snow, shrinking the Sierra snow-pack, which acts as a natural reservoir, holding water through the winter and releasing it gradually in spring and summer when demand peaks. More rain and less snow also increases the likelihood of both floods and droughts.[67]

More rain and less snow will affect both the water supply and water quality in the state. At current rates, 70% of surface water supplies and 11% of ground water supplies go to urban centers.[68] A smaller snow pack means less surface and groundwater earlier in the year, intensifying California's legendary water wars as agriculture, environmental, and urban communities compete for scarce water resources. Unless precipitation increases, the increased evaporation caused by warmer temperatures would likely reduce groundwater supplies.[69] Floods will increase contamination of surface water supplies, and droughts will cause pollutants in the water to become more concentrated.

Changes in Water Supply

Scientists predict that climate change will create water shortages across the West within the next 25-50 years. No state will feel the pain more than California, whose insatiable demand for water is outstripping dependable supplies. Population growth and climate change threaten to worsen the situation.

A recent study indicates that both the Sacramento and Colorado rivers will have less water available for irrigation, cities, and hydropower (see sidebar). Researchers forecast that reservoir levels will drop by one-third and releases of water by 17%, resulting in a 40% decrease in hydropower generation. Less fresh water in the Sacramento Delta will mean increased salinity, harming the ecosystem.[710] The evidence indicates that California will face a water supply deficit of between two and eight million acre-feet. [71] (An acre-foot of water is enough to meet the annual needs of one to two households).

Colorado River: Sharing the Resources

The Colorado River is a unique water source that poses complex water management problems. Arizona, California, Nevada, New Mexico, Utah, Colorado, Wyoming, and Mexico all share the river's resources.[76] For the past 29 years, California has consumed more than its allotted share of water from the Colorado River because other Southwestern states did not need their full share.[77] Population growth and development have changed the situation, however, and other states now are demanding their full allotment.

California failed to submit a plan that would encourage increased efficiency in water use and transfers of large volumes from agricultural to urban areas to the U.S. Department of Interior. Therefore, the Department of Interior initiated a 7% cutback on California's allotment for 2003, affecting Imperial Valley farmers and diverting 200,000 acre-feet to urban San Diego. The Imperial Irrigation District has filed suit in federal court to block the Department of Interior from cutting water to Imperial Valley farmers. That litigation may take months or years to resolve.[78] Meanwhile, as climate change further influences water supply, and as a growing population increases demand for water, conservation techniques and efficiency programs will prove extremely important in protecting water sources.

California agriculture accounts for 43% of the total annual ground and surface water use in the state. Environmental uses (maintaining the health of rivers and wetlands and holding back salt water incursion) account for 46% of water use and urban areas 11%.[72] Warmer temperatures and more frequent droughts will eventually lead to an increased demand for agricultural irrigation when water supply is at its lowest. At least 87% of California farms are irrigated. [73]

More than any other sector of California's economy, agriculture is directly influenced by temperature and rainfall. Thus changes in climate pose a major concern for growers and workers in this $25 billion industry as well as anyone who relies on food products grown in the state. Agriculture supports 1.1 million jobs in California, about 7.4% of all employment.[74]

Water Quality and the Health of Californians

Changes in precipitation, temperature, humidity, salinity, and wind have a measurable effect on water quality.[75]

Droughts and floods

Climate change will likely increase both droughts and floods, not only leading to water contamination but to illness, injury, and destruction of important ecosystems. Droughts reduce water supply through evaporation, thereby increasing concentration of contaminants in the water that remains. Droughts also force overdrafts of aquifers, creating conflict over priorities for groundwater use. Floods wash contaminants off of fields, roadways, and industrial sites, and can cause overflows of sewage drains, water treatment centers, and agricultural lagoons, infiltrating surface supplies. Waterborne diseases can result from both flooding and drought, which can encourage the proliferation of organisms that influence gastrointestinal health.

During droughts, low stream flow can cause substances such as salt and toxic chemicals like mercury to concentrate, leading to more polluted waters. One of the most potent neurotoxins known, mercury is emitted into the air by power plants and incinerators and also dumped directly into fresh and ocean water as industrial and municipal waste. In the water, mercury converts to methyl mercury, and is bioaccumulated in the bodies of fish at 10,000 to 100,000 times the concentrations in water.

Mercury is especially harmful to the developing fetus that may suffer irreversible neurological damage, including lower intelligence levels, impaired hearing, poor coordination, and delayed motor and verbal skills.[79] High doses of methyl mercury have been implicated in causing cerebral palsy and mental retardation.[80] Since 1991, the Institute of Medicine has advised pregnant women and women of childbearing age to avoid swordfish because of high levels of mercury contamination. In 2001, the Food and Drug Administration echoed this warning, not only on swordfish but also to shark, king mackerel, and tilefish. In July 2002, a Food and Drug Administration Advisory committee recommended that tuna be added to the advisory.[81] Consequently, women who are pregnant, or may become pregnant, have been advised to check with their doctor about which fish and how much fish is safe to consume. In January 2003, California's attorney general sued five major grocery chains for violation of Proposition 65, demanding that they warn consumers about the high levels of mercury in tuna, swordfish, and shark.[82]

Thirty fish consumption advisories related to mercury contamination were issued in California in 2001 specific to particular bodies of water, and 18% of river miles were under

advisory. The entire San Francisco Bay is currently under an advisory for levels of mercury.[83]

Nationwide, floods are the leading cause of death from drowning and account for 40% of all injuries resulting from natural disasters.[84] Fatalities and property damage from floods have increased in the past 25 years. Studies suggest this is largely due to the fact that more people are living and working in buildings in higher risk coastal and floodplain areas, subjecting lives and property to greater exposure.[85]

California has suffered repeated flood disasters with tremendous loss of life and property. For example, floods from the winter storms of 1995 caused $1.8 billion in damages. During the El Niño years of 1997 and 1998, floods wreaked havoc throughout the nine-county San Francisco Bay Area and in the Central Valley, with hundreds of people forced to leave their homes. Statewide, El Niño resulted in at least 17 deaths, 29 major injuries, and caused more than $700 million in damage to public and private property.[86] Thirty-five counties were declared federal disaster areas. Ninety miles north of San Francisco, Clear Lake reached its highest level since 1909, flooding the town of Lakeport.[87]

Harmful algal blooms

Poisonous algae blooms in the spring or fall can also cause health problems by contaminating fish and shellfish. Nationally, such harmful algal blooms are increasing and expanding throughout the U.S., and climate change may increase their occurrence and severity due to an increase in temperature. These harmful algae can stain water red—thus are called "red tides."[88]

The largest, most widespread red tide found off the California coast since 1902 occurred in 1995, and extended from Mexico's upper Baja peninsula to Monterey Bay. Researchers found that urea from urban waste and agricultural runoff may play a major role in triggering or sustaining algal blooms.[89] Scientists at the Marine Mammal Center reported that another major hazardous algal bloom in 1998 killed more than 50 sea lions along the central California coast and caused seizures in others, while sickening other marine mammals and sea birds.[90, 91]

Red tides and other algal blooms affect human health when people consume or otherwise contact fish and shellfish from infected waters. Both raw or cooked shellfish and other fish can poison humans, sometimes leading to irreversible dementia, paralysis, or even death.[92, 93]

How Climate Change Could Affect Extreme Weather Events

Extreme weather may take a heavy toll on the health of Californians, the health of fragile ecosystems, and the health of the economy. As a coastal state, California is vulnerable to rising sea levels. The impact of droughts and floods on California's water quality was discussed earlier, but both droughts and floods can lead to other damage, including landslides, dust storms, and forest fires.

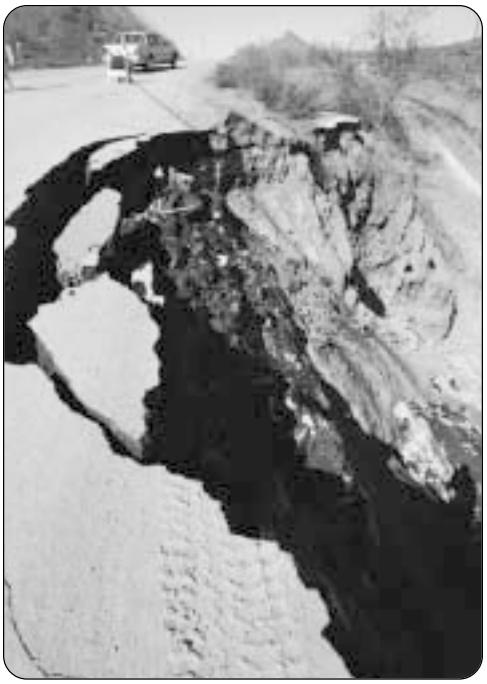
Sea Level Rise

California's more than 1,800 miles of coastline[94] and 194,000 miles of rivers[95] are vulnerable to changes caused by climate change. Sea levels could rise as much as three feet over the next century, inundating the San Francisco Bay Area and the coastline south of Santa Barbara. Beachfront homes and harbors may be lost to erosion; beaches could flood; and aquifers could suffer from saltwater intrusion. Due to the nature of the coastal cliffs, Big Sur and Mendocino are not as vulnerable.[96]

Landslides (Debris Flows), Dust Storms, and Forest Fires

"Debris flows amass in stream valleys and more or less resemble fresh concrete. They consist of water mixed with a good deal of solid material, most of which is above sand size. Some of it is Chevrolet size. Boulders bigger than cars ride long distances in debris flows. Boulders grouped like fish eggs pour downhill in debris flows."

JOHN MCPHEE, THE CONTROL OF NATURE[97]



Landslides, dust storms, and forest fires are frequent and naturally occurring events in California. While not directly caused by climate change, they are triggered by climatic events that may become more frequent as the climate changes. Changes in precipitation patterns could play a key role.

California and most of the Pacific Northwest are at risk for landslides every year. Landslides include falling rocks and slabs of bedrock breaking free and falling, rolling, or bouncing through the air to the ground below at speeds of up to 10 ft/sec. Earthquakes or rainstorms often trigger these events. More than 100 Californians have been killed by debris flows during the past 25 years.[98]

The El Niño winter storms of 1997 and 1998 caused landslides throughout California, particularly along the coast. Landslides are costly: damage from the 1997-1998 El Niño-related landslides in the 10 San Francisco area counties exceeded more than $140 million.[99] Annually, landslides cost the state of California $100 million in structural damage.[100]

Dust storms in dry desert areas could be influenced by climate change, worsening air quality. Imperial County, home to the Salton Sea, has some of the state's worst air pollution problems due to its dry, desert climate and its location on the U.S.-Mexico border. As global temperatures rise and the Sonora desert warms, the rate of evaporation in the Salton Sea could increase, encouraging the development of a toxic dustbowl. The exposed sea bed of the Salton Sea increases particulate pollution as dust containing arsenic, selenium, and cadmium becomes airborne.[101]

An equally toxic dust bowl lies in the Owens Valley, 200 miles north of Los Angeles, an early victim of California's water wars that resulted in the Owens

River being diverted into the Los Angeles region, leaving the Owens lakebed high and dry, swirling with white dust containing particles of nickel, cadmium and arsenic.[102] According to the EPA, the dry Owens lakebed is the single largest source of particulate matter in the U.S.[103] In 1997, the City of Los Angeles agreed to implement dust control measures, which required limited diversion of Owens River water to the lakebed. These measures are scheduled for completion by 2007.

The dry conditions caused by climate change could increase the frequency of forest fires, which affect human health by increasing airborne particulates and exposing communities and firefighters to dangerous conditions. Forest fires may set up conditions for landslides and dust storms by burning brush that helps keep soil in place.

Heat, Health, and California

Climate change is expected to increase average temperatures worldwide between 2.5–10.4° F by 2100. California will not be immune. The state already is becoming hotter and drier. Between 1899 and 1995, the average temperature in Fresno has increased from 61.9°F to 63.3°F, and precipitation has decreased as much as 20% in many parts of the state.[104] The numbers of very hot days and nights in California have increased during the past 50 years.[105]

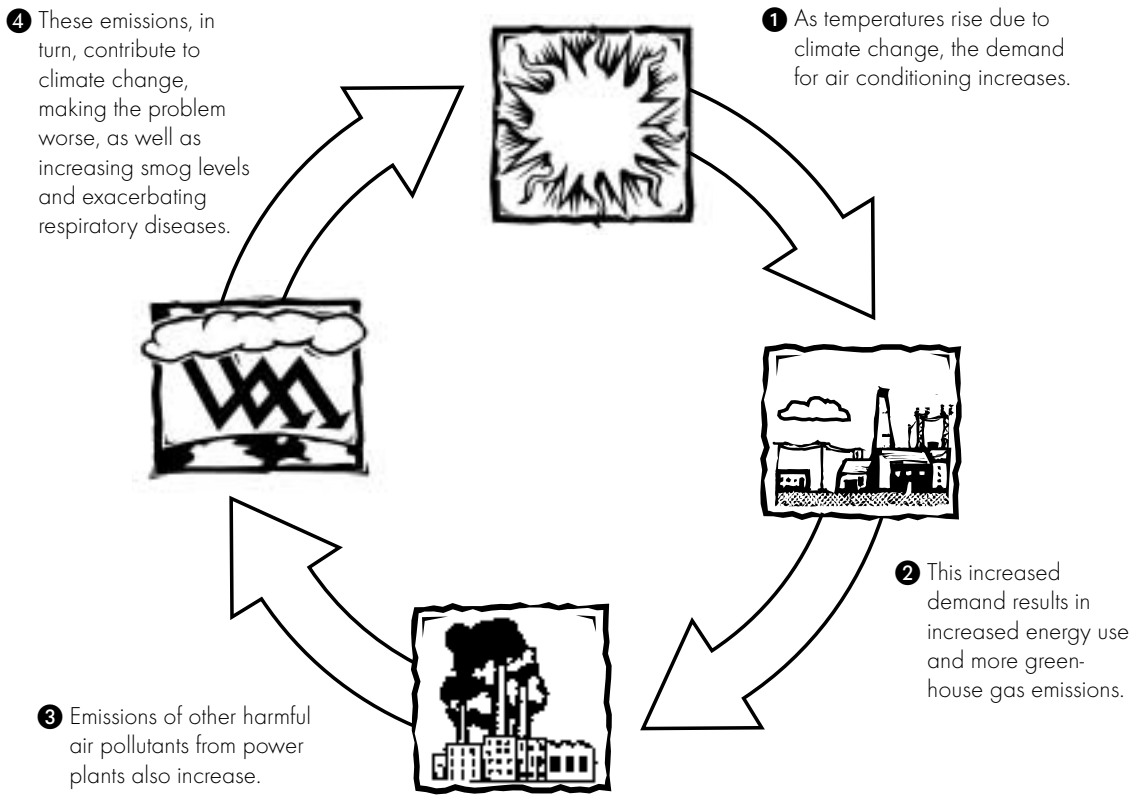
Heat waves that accompany overall rises in temperature are not a new phenomenon in California and can severely affect human health. In fact, during the 1990s, San Francisco had the highest number of four-day heat waves nationwide, with 49, and Los Angeles had 29.[106] These heat stresses are related to changes in average temperatures, not to the absolute temperatures themselves. When San Francisco temperatures rise to 80°F, from an average of 65° F, the impact can be comparable to temperatures rising from 95° to 110° in the Southwest.

Heat stress, heart attacks and stroke can occur during oppressive heat waves, causing a significant increase in the number of deaths per day for the general population.[107] When a person overheats, the heart tries to pump harder and faster to dissipate the heat. Heat stress may also cause the blood clot more easily.[108] Following a record-breaking five-day heat wave in 1995 in Chicago, the number of deaths increased by 85%, accompanied by an increase in hospital admissions.[109] Some of the deaths were from heatstroke, but most were from common conditions such as heart attacks, stroke, and respiratory diseases, exacerbated by the heat. Those particularly affected were people with existing conditions who were socially isolated and had no access to air conditioning.[110]

Residents of urban areas are at greater risk of heatstroke and other heat-related causes of mortality because buildings and roads absorb heat during the day and release the heat during the night. This phenomenon, known as the "heat island effect," keeps nighttime temperatures high and prevents nighttime relief from the heat.[111] This may be a particular problem for Los Angeles and San Diego, but also for cities like Sacramento.

Warmer winter temperatures may slightly decrease wintertime mortality rates. Although daily mortality is usually higher in winter, most winter deaths result from causes that do not vary much with temperature, such as

FIGURE 10
Air Conditioning: The Vicious Cycle



respiratory infections. Thus, even with warmer winter temperatures, overall weather-related mortality is expected to increase.[112]

Increased Risk of Vector-borne Diseases

Diseases caused when an infected insect bites a human or other animal were once common in the U.S. Until the mid-1900s, malaria was endemic in the U.S., and epidemics of mosquito-borne diseases such as yellow fever occurred regularly during the summer. By the mid-20th century, however, changing agricultural practices, improved housing and sanitation, and mosquito control had largely eradicated these diseases.[113]

Diseases that may be transmitted to humans from wild birds or mammals via mosquitoes, ticks, and fleas, however, continue to circulate in the U.S. Most of them exhibit distinct seasonal patterns, and are sensitive to rainfall, temperature, and other variables.

In many parts of the world, climate change is helping to expand breeding grounds and livable areas for mosquitoes and other insect vectors that carry diseases. Warmer temperatures can speed the maturation of some insects, as

well as the development of the disease within the insect itself, making it easier for some insects to transmit disease to humans.[114] Evidence suggests that outbreaks of some vector-borne diseases, such as encephalitis and West Nile virus may follow periods of extended droughts.[115]

University of Florida scientists have determined that Asian Tiger mosquitoes, which carry tropical diseases, could spread widely as the earth warms, disrupting ecosystems.[116] Warmer regions of North and South America already harbor this small, aggressive species, which feeds on humans, livestock, and wildlife. In the tropics, the Asian Tiger mosquito carries dengue fever, which is usually not fatal. However a severe hemorrhagic form of the disease infects hundreds of thousands each year and kills about 5% of those infected.

The expanded range of the Asian Tiger mosquito may be just the beginning. Biologists have documented the northward migration of insects and marine life along the Pacific Coast, which they attribute to global climate change. The consensus is that the warming of the earth may bring conditions that will increase the range of insects, thus spreading vector-borne disease farther north.

In the U.S, many factors determine whether vector-borne diseases will re-emerge as a result of climate change. Higher standards of living, less time spent outdoors in the daytime, window and door screens, air conditioning, better mosquito control, and better public health infrastructure may help keep these diseases from becoming an unmanageable problem in most parts of the U.S.[117] It is important to strengthen and maintain surveillance system for vector-borne diseases. Three insect-borne diseases, which have emerged or re-emerged in the U.S. recently, will be discussed here: West Nile virus, dengue, and malaria.

West Nile virus

The first cases of West Nile virus to appear in the U.S. were reported in New York City in the summer of 1999, when more than 60 people became ill and 7 died. By January 2003, more than 3,955 cases had been reported nationwide with 252 fatalities.[118] Though most of the cases were concentrated in Illinois, Ohio, and Michigan, the rapid expansion of West Nile virus across the U.S., including California, indicates that the disease is now permanently established in the Western hemisphere.[119] Some scientists believe it is a harbinger of other diseases previously thought of as "exotic" in the U.S., and which may become more widespread with climate change.

It is still unknown how West Nile—a strain of encephalitis normally found in the warmer climates of Africa, West Asia, and the Middle East—has spread, especially to New York City. The primary carrier of the disease is an urban-dwelling mosquito (*Culex pipiens)*, which typically breeds in the foul water of city drains and catch basins. The virus can infect humans, birds, mosquitoes, horses, and other mammals.

In most cases, West Nile virus is a mild disease, characterized by flu-like symptoms that last a few days. But more severe infection can result in encephalitis, meningitis, or meningoencephalitis, causing inflammation of the brain or the membrane around the brain. Fatality rates from severe infections

range from 3-15%, with the highest rates among the elderly. West Nile virus first arrived in California in 2002. As of November 2002, only one case of West Nile Virus had been reported in California with no deaths.[120]

Dengue

Dengue is a mosquito-born infection that usually results in flu-like symptoms such as fever, headaches, and joint pain. It can, however, develop into dengue hemorrhagic fever, which causes hemorrhaging, liver enlargement, circulatory failure and, in some cases, death.

Predominant in areas where household water storage and inadequate solid waste disposal services prevail, dengue is second only to malaria in the number of people infected worldwide. Since 1994, epidemics of dengue have increased substantially in the Caribbean, Mexico, and South and Central America.

There is concern that dengue may be introduced to the U.S. from neighboring countries, especially through the southern border, as indicated by the fact that since 1981, dengue fever has moved from South America to the Texas/Mexico border.[121] Dengue fever has thus become a potential threat to public health in these border areas, particularly South Texas.[122] If disease surveillance systems are not strengthened and maintained, vector-borne diseases such as dengue fever could become a problem in California, especially in the southern border region.

Malaria

Throughout most of U.S. history, malaria has been endemic in the southern U.S. But following mosquito-control efforts and increased urbanization, malaria was thought to be virtually eradicated in the U.S. Over the past 10 years, however, locally acquired malaria has been documented on a small scale. Initially, most of the documented cases were among farm workers in Southern California, with large number of immigrants from malaria-endemic areas.

In 2000, the CDC reported 1,402 cases of malaria in the U.S., including 194 cases in California. The majority of cases diagnosed in the U.S. have been imported from regions of the world where malaria transmission is common. More than 89% of infected individuals exhibited symptoms after arrival into the U.S.[123]

Pesticides: Good Mosquito Control?

Pesticides may seem like a tempting solution for Californians to eliminate mosquitoes and other insects in and around their home. However all pesticides are inherently toxic and therefore are not risk-free to humans, especially to babies and young children.[124] In 1999, there were almost 60,000 pesticide-related incidents reported to poison control centers nationally; almost half of those were in children less than six years old.[125]

Pesticides are harmful to humans, wildlife, and natural ecosystems and should only be used as a last resort, by professionals, and only in limited quantities when public health is significantly threatened, and there are no safer alternatives to application. Ecosystems that are already stressed by pesticide poisoning and other forms of pollution may be more readily destroyed by the additional stress of climate change.

How Climate Change Could Affect Vulnerable People And Regions

Many of the health risks posed by climate change will be most felt by vulnerable populations including infants, children, the elderly, the sick and the poor.[126] These populations are least able to adjust to changes in their environment and most susceptible to conditions such as high temperatures and poor air quality. Of California's 34 million people, 10% are over age 65 and more than 25% are children.[127] Thus, more than a third of the state's population is at particular risk to the adverse effects of climate change.

Children

There are 8.5 million children in California, who will be especially vulnerable to climate change effects such as air pollution and heat stress, largely because:

- Their immune systems are not fully developed, increasing their susceptibility to the harmful effects of pollution.
- They breathe more rapidly and take in more air for their size than do adults. Pound for pound, children breathe 50% more air than do adults, thus inhaling a greater percentage of pollution.
- Infants and children drink more water, juice, milk and other liquids in proportion to their size than adults do. Infants consume 3-5 oz/kg/day. For adults, this translates to 30 12-oz. cans of beverage per day.
- Infants have larger surface are for absorption relative to weight, and the skin of newborns is more permeable.
- Children spend more time outdoors than adults do, swimming in lakes, ponds, and streams, exposed to harmful UV rays, polluted air, and possibly contaminated water. Such exercise increases the penetration of pollutants into the lungs, making adverse health effects more likely.
- Children live and play closer to ground level. Dust and chemicals settle on floors, carpet, playgrounds, and grass, and may be more concentrated at ground level.
- Today's children will have a heavier lifetime exposure to air pollution, UV rays, and a longer time to develop diseases with a long latency such as cancer, than do those born in 1960.[128]

Elderly

The 3.4 million elderly in California are in many ways as vulnerable as the young, largely due to progressive loss of function.

- Older people are less able to disperse heat through the body's physiological mechanism, making them more vulnerable to heat waves.
- They are less able to perceive changes in temperature, and thus take measures to avoid effects.
- They are more likely to have underlying illnesses, especially cerebrovascular, cardiovascular, and respiratory conditions, which are worsened by air pollution
- Declining immune system function makes the elderly more susceptible to infectious diseases.
- They are more likely to be taking medications that may contribute to heatstroke.
- Mobility problems may impair their ability to respond to emergencies.

Immunocompromised

People with diseases that suppress the immune system, such as cancer and HIV/AIDs, and people who have had organ transplants, with immunosuppressive medications, have greater susceptibility to infections. As mentioned earlier, those with cerebrovascular, cardiovascular, and respiratory conditions are especially susceptible to heat stress and air pollution.

The poor

Immigrant and poor populations are also at risk as they are often without adequate resources to control their environment with appliances such as air conditioners, or to seek medical attention. For example, death during heat waves in the U.S. is primarily an urban phenomenon that disproportionately affects areas with low-income populations[129] Nearly 20% of Californians—6,800,000 people—have no health insurance coverage, including more than one million children who live in poverty.[130] Persons living below the poverty line represent 10.6% of the California population, compared with the national average of 9.2%.[131]

The poor may be more vulnerable to climate change due to:

- Less access to air-conditioning during heat waves
- Reduced awareness of the potential dangers of heat due to lack of access to media such as newspapers and television.
- Residence in urban areas, where the "heat island" effect actually increases warming and the consequent effects of heat.
- Poor nutrition and crowding that may increase susceptibility to infectious diseases.
- Lack of health insurance that limits access to health care.

California's geographic, economic, and ethnic diversity mean that the local effects of climate change will vary throughout the state. For example, people who live in regions with the most polluted air already suffer health effects that will only worsen as the world grows warmer.

Central Valley

Farm workers in California's Central Valley (the San Joaquin Valley) may be at a higher risk of harm from air pollution than the general population. Although all residents of the Valley are exposed to polluted air, farm worker families in this region face additional problems, all of which threaten health: occupational exposure to pesticides, lack of access to health care, contaminated drinking water, and poor quality housing.

Air pollution in the Central Valley now rivals the legendary smog of Los Angeles. Agricultural pesticides, smog from the San Francisco Bay Area, exhaust from huge diesel engines used to run irrigation pumps and other agricultural equipment, and waste from poultry, dairy, and livestock factory farms combine to make the air in the Central Valley some of the dirtiest, most hazardous air in the nation.[132] In November 2002, the EPA officially classified the Valley's ozone non-attainment status as "severe."[133]

Farms in the Central Valley used over 120 million pounds of pesticides in 1999—more than anywhere else in the U.S.[134] Some of these pesticides become airborne, mixing with other pollutants and entering human respiratory systems. Although farm workers and their children have the highest exposures, everyone in the area is affected. More than 7,000 children in Fresno alone suffer from asthma, which is the leading cause of hospitalization of young children in California.[135]

Unlike the other 49 states whose agricultural industries were required to comply with the Clean Air Act, California state law has exempted agriculture. However, a lawsuit filed by health and environmental groups in 2002[136] forced the EPA to call for a change in state law to remove that exemption.[137] A 10-bill package of legislation has been introduced in the California State Senate to end the exemption (SB700-709) and reduce pollution in the Central Valley.[138] Unless those bills become law by the end of 2003, the EPA will impose sanctions on the San Joaquin Valley Air Pollution Control District and assume responsibility for issuing operating permits to agricultural sources of air pollutants in California whenever required by the Clean Air Act.

Sempra Power

San Diego-based Sempra Energy is building a new 600-megawatt natural gas-fired power plant in Mexicali. The plant will provide electric power to San Diego, Los Angeles, and perhaps even to Northern California and will be regulated under Mexican law. The plant will produce significant amounts of carbon monoxide, NO_x, and particulate matter affecting the health of both Mexicans and Californians. In California, residents of Imperial County, an area with a struggling economy and a 72% Latino population, will be affected disproportionately.

Sempra's fossil fuel energy plan is not the only solution to increased energy needs. The Imperial County/Mexicali region has great potential for renewable resources such as wind, solar, and geothermal power, and there are energy companies willing to build these types of facilities in the San Diego/Imperial area. California needs to take advantage of this opportunity to demand that their energy come from cleaner energy alternatives that are most protective of human health.

U.S./Mexico border

The U.S.-Mexico border stretches for nearly 2,000 miles, encompassing 10 U.S. and Mexican states including California.[139] The California counties of San Diego and Imperial, plus the municipalities of Tijuana, Tecate, and Mexicali, account for almost half of the population along this border.[140]

Political developments during the last few decades have fostered industrial growth along the border. New factories, increased congestion, and higher population density have made it more difficult for people to obtain clean water, sanitation, and other services, and these problems could worsen if climate change further influences water supply and quality.

Although poverty levels in border communities in California/Baja California are significantly lower than along the rest of the border, Imperial County is the poorest county in California. Latinos make up 72% of the population.[141] The poverty rate there is 10.6%, compared with the national rate of 9.2%. The poverty rate for Imperial County families with children under 18 is 19% compared with 13.6% for the same group nationally.[142] Imperial County also has the highest hospitalization rates for childhood asthma cases in the state.[143]

Currently 12% of the border population does not have access to potable water, and 30% do not have wastewater treatment services available. Industrial, agricultural, and human wastes flow into rivers and present dangerous health risks. Portions of the Colorado River, including its tributaries, are heavily polluted with raw sewage, toxic chemicals, and trash. These conditions have amplified health problems such as gastrointestinal infections, asthma, and tuberculosis in the border communities. Dwindling resources and a burgeoning population exacerbate the threats posed by industry.[144]

Toxic air emissions threaten human health no matter which side of the border they come from. However, environmental regulations are less stringent in Mexico than in the U.S. for power plants as well as for vehicles. In addition, the regulations that do exist are less tightly enforced.[145] New power plants being built in Mexico will supply power to California and add to emissions of NO_x, carbon monoxide, CO_2, and particulate matter in Mexicali and Imperial County, a region with existing air pollution problems. Both Imperial and San Diego counties have been classified by EPA as non-attainment areas for ozone since 1992; Imperial also has a non-attainment status for particulate matter.[146]

The new plants are being built 10 miles from Calexico, California.[147] This situation raises concerns about U.S. companies building plants in Mexico to power U.S. cities without having to comply with U.S. emissions regulations. Emissions from vehicles are also a concern. Long lines of idling cars and trucks at border ports contribute to particulate pollution.

As the climate changes, health hazards along the border could multiply. Having public health surveillance systems in place to monitor disease and environmental quality will be essential to help us adapt to these changes. However, differing methods of disease surveillance between the U.S. and Mexico could prove problematic. The U.S. relies on a laboratory-based approach to monitoring disease, whereas Mexico utilizes a more clinical approach, due in part to limited laboratory equipment. These differing methods impede precise, accurate identification and comparison of health hazards and the diseases they cause. This inconsistency makes remediation difficult.

California's Progress in Confronting Climate Change

"Responding to climate change need not be an additional burden but can, in fact, promote economic development, ensure energy and economic security, and improve public health and safety."[148]

—CALIFORNIA ENERGY COMMISSION

Climate change, some of which might already be irreversible, requires an urgent effort to minimize further and escalating damage. California's unique position of being a leader in national environmental legislation and environmental innovations places a significant responsibility on the state to take necessary actions. This section outlines many of the solutions that can help reduce or eliminate air pollution, slow the rate of climate change and reduce its negative impacts on California. Most importantly, the amount of CO_2 and other greenhouse gases released into the atmosphere must be drastically reduced. Technology already exists to lessen our dependence on fossil fuels, such as coal and oil, which produce CO_2 when they are burned. By demanding that government and industry invest in and use renewable sources of energy, the amount of CO_2 production can be reduced. Technology also exists to clean up the power plants that help generate

The Precautionary Principle

The public health community, legislators, ethicists, and environmentalists often refer to "the precautionary principle" when dealing with climate change issues. The term's definition states, "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context, the proponent of an activity, rather than the public, should bear the burden of proof."[149]

The precautionary principle has four main components:

1. Communities have a duty and a right to take anticipatory action to prevent harm.
2. The burden of proof of the harmlessness of a new technology, process, activity, or chemical is the responsibility of the proponents, not the public.
3. Communities have an obligation to discuss and to explore a full range of alternatives to the hazards posed.
4. Decisions must be open, informed, and democratic.

California's electricity, which would immediately reduce CO_2 and other greenhouse gas emissions. For example, 40 of the 93 power plants in California's Great Basin (Los Angeles, Riverside, Orange, and San Bernardino counties) have no pollution controls.[150]

Motor vehicles are responsible for 37% of CO_2 emissions in California.[151] Technology already exists to produce cars with greater fuel economy. A limited number of these vehicles are already on the market, but industry and the government must be pressured to accelerate investment in these technologies and produce more vehicles that are environmentally responsible, while making a major shift to affordable, dependable, and clean mass transit.

Although vested interests continue to debate the consequences of climate change, we must take precautionary action, as a society, to avoid those consequences. This means applying the precautionary principle in shaping public policy that will slow climate change by reducing our consumption of fossil fuels.

Clearing the air in California and slowing the rate of climate change demands several approaches. These approaches include increasing our use of renewable energy sources, decreasing our use of fossil fuels, improving energy efficiency, improving and expanding mass transportation, and restricting urban sprawl. In addition, we need to protect vulnerable populations and ecosystems against further harm.

Renewable Energy

"Creating a new energy economy is not a question of science; neither is it a question of technology. Armies of inventors and engineers, fascinated by the challenges of energy, have already supplied us with the devices and designs we need…They need only to be taken to the level of mass production and deployed throughout the world."[152]

—ROSS GELBSPAN, THE HEAT IS ON

California was an early leader in renewable energy, beginning in the 1970s, but lost that leadership position to Europeans. A recent poll conducted by the Public Policy Institute of California showed that 85% of the state's residents favor a policy that requires doubling the use of renewable energy over the next decade.[153] California now has an opportunity to recapture a competitive advantage in this growth industry and create jobs and revenue.

The four major sources of power in California are natural gas, hydroelectricity, nuclear, and coal

California's Commitment to Renewables

In 2002, California passed a renewables portfolio standard law mandating that utilities acquire 20% of their electricity from renewable sources by 2017, doubling the contribution of renewables to California's supply of electricity. The 20% increase is to be largely met by 2012 and completely met by 2017. The new law requires that California utilities and other sellers of electricity must increase by 1% each year the share of their electricity from renewable sources including wind, solar, biomass, and geothermal. This legislation will reduce the state's reliance on natural gas and help retire older fossil fuel fired power plants.

As of 2001, only 12.5% percent of the state's electricity was produced from renewable sources.[154]

- Geothermal: 5.1%
- Biomass/Waste: 2.6%
- Wind: 1.5%
- Solar: 0.4%
- Small hydro (<30 megawatts) 2.9%

providing 88.5% of the state's electricity.[155] California is a leader in seeking alternatives to fossil fuel power such as wind, solar, and biomass energy. Though a small fraction of the total generation mix, these renewable sources hold great promise for the future in decreasing pollution and protecting health. Advanced technology for fuel cells and solar photovoltaic cells are emerging as important sources of energy with a potential opportunity for both in-state use and export.

Legislation passed in 1997 established a statewide renewable energy policy by providing $540 million collected from Southern California Edison, Pacific Gas and Electric Company, and San Diego Gas and Electric over four years to support existing, new, and emerging technologies from 1998 to 2001.

FIGURE 11
California's Renewable Potential

Source: Energy Information Administration

Wind energy

Most of California's wind turbines are located in three primary regions: Altamont Pass (east of San Francisco), Tehachapi (south of Bakersfield), and San Gorgonio (near Palm Springs, east of Los Angeles). In 2000, wind energy produced more than enough energy to light a city the size of San Francisco. According to the Electric Power Research Institute, the cost of producing wind energy has decreased nearly four-fold since 1980. The California Energy Commission estimates that newer technologies can reduce the cost of wind energy to 2.5 cents per kilowatt/hour, making it fully competitive in the state's deregulated electricity market. Many regions in California have predictable strong winds with great potential for wind energy development. These include not only many coastal areas but also the Imperial and Salinas Valleys and the Delta.[156]

Once the world leader in wind energy, California has lost that role to Europe, where wind energy installation

has expanded by about 40% annually for the past six years. According to European Wind Energy Association, wind energy projects produce enough electricity to meet the domestic needs of 5 million people. By 2010, wind energy is expected to produce 60,000 megawatts, which would provide electricity for about 75 million people.[157]

Regaining California's leadership in wind energy production would not only reduce air pollution in California but also create badly needed jobs. In the early 1990s, wind energy created an estimated 1,200 direct jobs in California and 4,000 indirect jobs.[158]

Wind energy has other advantages including:

- Inexhaustible supply: there is enough potential wind energy in the U.S. to power the entire country.
- Easily expandable: Additional turbines can add capacity as needed.
- Quick installation.
- Price is not affected by fuel price increases or supply disruptions.
- Attractive federal and state tax credit for wind generation.

Wind energy is not without controversy. Potential issues include

- The need for large tracts of land on or just below ridgelines. Simultaneous land use for agriculture or cattle grazing is possible; however, the turbines may interfere with views.
- Avian mortality and disturbances to wildlife habitats. Wind turbines have been redesigned to address these issues, with longer blades that turn more slowly, which are easier for birds to see and avoid. Pylons are now solid tubes, rather than the latticework structure that larger birds used for nesting sites.
- Noise. Wind turbines generate both audible and low frequency sound waves.
- Grass or brush fires caused by shorts in the electrical cables, in the unlikely event that they become stretched or twisted when the turbines turn.

Solar (photovoltaic) energy

Less than 1% of California's electricity comes from solar power, and most of that is owned not by utilities, but by municipalities, businesses, and individual consumers. This use of this technology has tremendous potential for expansion, particularly in the warmest regions of the state. Although solar power is an intermittent resource, depending entirely on the amount of sun shining on the solar cells, it can provide energy reserves when they are most needed—during heat waves. Solar power offers the following advantages:

- Provides dependable summer peak capacity in California.
- Reduces the run-time of existing high-polluting, fossil fuel burning plants.
- Reduces the number of new gas generation plants needed.
- Improves the reserve capacities of the transmission and distribution system.

- Operates in conjunction with energy efficiency measures, reducing system peak load more than either could alone.
- Further reduces total power plant emissions.
- Provides a valuable energy option if natural gas prices fluctuate.[159]

The cost of photovoltaic cells has come down by a factor of 10 since 1980.[160] However, it is still more expensive per kilowatt-hour than any other form of power generation. Local generation and use of electric power avoids transmission losses and further reduces the cost.

Big Business Making a Difference

Toyota Motor Sales is going solar in their national headquarters in Torrance, California by installing the largest commercial solar rooftop electric system in North America. The 501-kilowatt solar system can generate enough electricity in the daytime to power more than 500 homes. This investment in on-site solar generation will lower Toyota's operating costs and reduce its purchase of peak electricity. Over the 25-year lifetime of this system, the solar-generated electricity will reduce emissions of NO_x by more than 5,000 tons and CO_2 by 12,300 tons, which is equivalent to planting 853,000 trees or eliminating 54 million miles of driving.[163]

Businesses and consumers who had invested in solar power were the only ones who avoided blackouts and catastrophic utility bills during the energy crisis of 2001. Cities in California and elsewhere are taking a cue from that example and investing in rooftop solar for municipal infrastructure. San Francisco voted for solar power in November 2001, approving clean energy bonds that will enable the city to purchase up to 60 megawatts of solar panels. In the fall of 2002, Berkeley followed suit, approving bonds for the purchase of 185 kilowatts of solar panels for government buildings. Going solar is estimated to save Berkeley exposure to more than three million pounds of CO_2, 79 pounds of sulfur dioxide, and 133 pounds of NO_x over the next eight years. In addition, for every megawatt of solar panels produced, 35.5 jobs are created.[161] Cities as large as San Diego and as small as Santa Cruz and Oroville are also exploring the use of solar power to reduce energy costs and clear the air.

The Sacramento Municipal Utility District is a national leader in the installation of grid-connected photovoltaic systems. By January 2002, Sacramento had reached the 10-megawatt milestone in solar electric power installations, enough to meet the annual needs of more than 3,300 homes. The power generated from the photovoltaic installations is net metered, so that customers are paid for electricity they generate but do not use. Net metering can cause the customer's meter to spin backward in some cases. The utility has also joined with local homebuilders to incorporate photovoltaic energy roofs in new home subdivisions.

Interface, Inc., installed a 128-kilowatt industrial solar power array that will generate the electricity needed to manufacture tufted carpet at its facility in the City of Industry. Daily performance of the solar array is monitored and presented on a public website.[162] The

company began their program of on-site generation and purchase of clean energy power in 1998, and now also has smaller solar arrays in their facilities in Georgia, North Carolina, and Holland.

Increasing Energy Efficiency

The state of California ranked second in the U.S. in amount of total energy consumed in 1999 but 48th in amount consumed per person. This proves that California energy consumption standards are already some of the most efficient in this nation of inefficient users. However, our standards are still low compared to European standards, so we have a lot of room for improvement, even in using existing technologies.[164]

Cleaner power plants

Aging power plants, mostly coal burners, exempted from the Clean Air Act are the worst polluters in the U.S. Although California has no coal-burning plants, power plants fueled by natural gas also create pollution. Through the New Source Review program in the Clean Air Act, regulations require that any upgrades or expansion of these plants also must include upgraded pollution controls. However, Congress voted late last year to eliminate that requirement in the new Clean Air Act regulations, which do not mandate any reductions in CO_2 emissions.

If this country is to significantly decrease air pollution and greenhouse gases, old power plants will need to be cleaned up to modern standards or shut down. Senator James Jeffords (I-VT) introduced a bill passed in 2002 by the Senate Environment and Public Works committee that would achieve reduction in NO_x, sulfur dioxide, CO_2, and mercury, the four main pollutants from power plants. This bill did not reach the Senate floor; therefore, Senators Jeffords, Collins (R-ME), and Lieberman (D-CT) reintroduced the bill in the 108th Congress. Similar legislation has been introduced in the Senate and House of Representatives; however, this legislation ignores the climate change-causing CO_2. Clean air legislation is needed nationally to reduce the four major power plant pollutants to prevent unnecessary deaths.

Tougher fuel economy standards

Cars and light trucks consume 40% of the oil used in the U.S. and create 20% of the CO_2 pollution nationwide. Increasing the fuel efficiency of these vehicles is the biggest single step we can take to reduce the consumption of fossil fuels and CO_2 emissions and slow the rate of climate change

Corporate average fuel economy (CAFE) standards set the minimum mile per gallon (mpg) requirements that fleets of cars and light trucks must achieve. Original CAFE standards, set in 1975, were a victory for the environment, for human health, and for the American consumer in money saved. However, as technology has improved in the last quarter century, CAFE standards have remained stagnant. In fact, the overall fuel economy of new cars and trucks sold in the U.S. in 2001 dropped to the lowest level since 1980 due to dramatic increases in sales of SUVs and minivans with poor fuel economy.[165]

New Legislation Regulating Automobile Greenhouse Gas Emissions Challenged by Washington and Carmakers

In July 2002, California lawmakers took automobile regulations a step further by passing legislation limiting the amount of CO_2 that automobiles may discharge into the atmosphere.[167] The new standards will aim for a "maximum feasible reduction" of CO_2 emissions and will be set by 2005. All automobiles sold in the state must comply by 2009. The standards will apply to all noncommercial passenger vehicles, including light-duty trucks like SUVs.[168]

Opponents of the bill, primarily the auto and oil industries, claim that the law will limit consumer choice, drive up prices, and deprive Californians of their SUVs and light trucks, which currently account for 47% of vehicle sales in the state. However, the bill prohibits regulations such as limits on vehicle weight, bans on the sale of certain vehicles, restrictions on speed limits or miles driven, or additional fees or taxes on vehicles or fuel. Instead, legislators believe the new standards will provide consumers with the same popular styles of vehicles while encouraging technological advancement and creating new jobs within the auto industry.

Greenhouse gas emissions from California alone account for only a small percentage of worldwide emissions. However, the state has the fifth largest economy in the world and makes up 10% of the nation's market for automobiles. With this legislation, California has done what the U.S. Congress has been unable to do, pass stricter controls on fuel economy standards that will decrease U.S. greenhouse gas emissions.

Defending and maintaining these new higher standards, even though they only pertain to California, would spur industry innovation, given the guaranteed market for the product. Since it is not often cost effective to produce different models of cars and trucks for different regions, automakers here and abroad may choose to simplify production by making all models confirm to California standards.

This landmark legislation is being challenged in the courts by the Bush administration and automakers.[169] They are also challenging the 1967 federal law giving California the unique authority to set its own auto emissions standards. The administration argued that the state Air Resources Board's latest rules violate the federal government's exclusive authority to regulate fuel efficiency. However, the Board rules do not specify mpg standards; instead, the rules require that manufacturers sell a certain percentage of fuel-efficient hybrid vehicles powered by a combination of gasoline and electricity.

General Motors and Daimler Chrysler convinced a federal judge in Fresno to issue an injunction delaying enforcement of the new rules until the 2005 model year. The state, with the support of environmental organizations, has asked the appeals court to overturn the injunction.

Lower fuel economy standards mean more gasoline consumed and more emissions released. According to the EPA, the average fuel economy of the new fleet of cars for 2003 is 6% lower than it was 15 years ago. Only 4% of the 2003 fleet gets more than 30 miles per gallon. Current CAFE standards are 27.5 mpg for cars and 20.5 mpg for light trucks (including pick-ups, SUVs, and minivans). Toughening CAFE standards would dramatically reduce pollution levels. New fuel efficiency standards of 40 mpg for cars and light trucks are estimated to cut CO_2 pollution by 345 million tons per year.[166]

Improving vehicle efficiency will not compromise automobile safety. Safety is primarily a function of good design and good technology. These types of improvements, made since the mid-1970s, have nearly doubled fuel economy while cutting fatality rates by more than half. Contrary to popular belief, SUVs are not generally safer than passenger cars. Heavier than regular cars, SUVs ride higher, creating a high propensity for rollover. The Insurance Institute for

Highway Safety has reported that in many accidents, SUVs lead to higher fatality rates than smaller cars.

Technology available today makes it possible to increase fuel economy and save lives. In fact, the National Academy of Sciences concluded that fuel economy could be increased to 37 mpg without any reduction in vehicle size or weight. They found that CAFE standards can be improved through the use of aluminum or high-strength, lighter weight steel bodies, better tires and tire maintenance, and innovations in aerodynamic design.

Until CAFE standards are toughened, individuals and fleet owners can spare the air and save money by choosing from the hybrid vehicles already available from Toyota and Honda, with fuel efficiency up to 50 mpg or better. Another alternative is to choose the most fuel-efficient gasoline powered car one can afford that meets one's needs. Many current models exceed 30-mpg standards and cost significantly less than their hybrid counterparts.

California has long led the country in addressing clean air and the environment. It is the only state allowed to set its own automobile emissions regulations, an exception that dates back to 1967 when the Air Resources Board was formed to address the issue of smog in Los Angeles. Consequently, the state has been on the cutting edge of enacting environmental legislation concerning automobiles and has some of the strictest tailpipe emission standards in the country.

Alternative fuel vehicles

California is unique in its embrace of alternative fuel vehicles. No other state has created the infrastructure necessary for electric and natural gas vehicles to be used by individual consumers. Refueling sites for electric, natural gas, hydrogen, and methanol are available.[170] In addition, drivers in alternative fuel vehicles may find the commute a little faster, because low emission vehicles are allowed to use HOV lanes, regardless of the number of passengers.

Other alternatives may be available in the not-too-distant future. French entrepreneur Guy Nègre has developed a "zero pollution" car that runs on compressed air at one-tenth the cost of a gasoline-powered car.[171] Other alternative vehicles are being developed by various manufacturers.[172, 173]

Electric vehicles

Electric cars are one alternative to gasoline-powered vehicles, particularly for short-distance city driving. To be truly energy efficient, however, the electricity used should be generated by a renewable source, not fossil fuels. The engineering problems with battery capacity make an electric vehicle little more than a traveling battery.

Electric cars have caught on with some California consumers, particularly in Northern California cities. Despite owner enthusiasm and waiting lists for the vehicles, Ford, General Motors, and Honda are discontinuing their electric vehicle program, claiming there is no market. Owners disagree, suggesting that carmakers are scrapping these environmentally friendly vehicles in favor of highly profitable, gas-guzzling SUVs.

Los Angeles now has the largest fleet of electric vehicles in the nation, property of the U.S. Postal Service.[174] Used as delivery vehicles, this fleet increases the postal service's total number of electric vehicles to nearly 600 nationwide.

Natural gas vehicles

In October 2002, California air quality, transportation, and energy officials joined with private sector representatives to form the California Natural Gas Vehicle Partnership and announced the goal of having 600,000 new natural gas powered vehicles on the state's roads in 10 years. These would include passenger cars, pickup trucks, and small service vehicles, as well as large vans, transit shuttles and buses, refuse haulers, school buses, and large service trucks. If these goals are fully met by the tenth year of the program, statewide emissions of NO_x would be reduced by nearly 6,000 tons each year.[175]

Natural gas vehicles are available from leading carmakers, including American Honda, Chrysler, Ford, General Motors, John Deere, and Cummins Westport and are viewed as a bridge between traditional gasoline-powered vehicles and zero emission fuel cell (hydrogen) powered vehicles.[176]

Fuel cell vehicles

In December 2002, Los Angeles took delivery of a Honda FCX, the first of five fuel cell cars to be leased by the City for the next two years.[177] The hydrogen-powered Honda FCX is the only fuel cell vehicle certified by the California Air Resources Board and the EPA for everyday commercial use. The FCX is certified as a Zero Emission Vehicle and uses hydrogen supplied to a fuel cell "stack" to generate electricity that powers its electric motor. Honda has contracted with Air Products and Chemicals, Inc., based in Allentown Pennsylvania, to provide the hydrogen fuel and refueling infrastructure. The FCX accelerates much like a Honda Civic (up to 80 horsepower), and water vapor is the only exhaust. It seats up to four people and can go 170 miles without refueling. Honda plans to lease up to 30 fuel cell cars in California and Japan over the next two or three years. However, the company has no plans for mass-market sales to individuals. Other major automakers are engaged in hydrogen or fuel cell research. How soon the vehicles will be available for the public is an open question. But even on a clear day, for Los Angeles and other California cities, it cannot come too soon.

In his 2003 State of the Union address, President Bush introduced a new five-year, $1.2 billion FreedomCar and Fuel Initiative, raising public awareness of the need for a transition from fossil fuel energy to renewables such as hydrogen. This announcement marked the first time significant federal funding has been aimed at moving toward a hydrogen economy. While the FreedomCar initiative may help build public support for a transition to renewable energies, it has several shortcomings. The plan does not support

bridge technologies or policies to phase in the transition, such as stricter fuel-efficiency standards, tax incentives for hybrid-engine cars, and expanded use of alternative fuels such as ethanol. Instead, the Bush initiative diverts funding from other programs. Only $720 million of the promised $1.2 billion is new money. The remaining 40% is funding redirected from existing renewable-energy and energy-efficiency programs.[178]

Case Study: Olympic Games and Asthma

A study conducted during the 1996 Olympics in Atlanta, Georgia, offers powerful evidence that auto emissions have an impact on asthma attacks. During the 17 days of the Olympics, downtown Atlanta was closed to private traffic forcing people to use the 24-hour public transit system. This move not only cleared the air significantly of air pollution, but also was associated with the reduction of acute asthma attacks among Atlanta's children by an estimated 40%.[183]

Increasing Mass Transportation

California's long love affair with the car has spawned thousands of miles of freeways throughout the state, now clogged by more than 23 million vehicles, each contributing a share of toxic pollution. But the ardor for the auto is cooling, as two-hour commutes and record congestion become the norm for many Californians. Freeway delays cost as much as $2.8 billion a year in lost time and excess fuel consumption.[179] The public wants and needs alternatives, and mass transit systems are enjoying new popularity.

In 1998 and 1999, over 115 million passengers used urban rail transit (light rail) statewide. Between 1999 and 2000, transit trips increased by 20 to 30 million statewide. Annual growth among California's 29 largest transit systems is estimated to be as high as 5%.[180] And for more than three years in a row, transit use in California has grown faster than driving.

Not all transit systems have mirrored the statewide growth pattern. Ridership has fallen in some individual systems due to fare increases and/or reduced service cuts.[181] For example, AC Transit in Alameda and Contra Costa counties has lost nearly a third of its riders since 1982 due to fare increases resulting from federal budget cuts. Riders on the Los Angeles MTA bus system declined by 13% after it raised fares from 50 cents a ride to $1.35.

High-speed Rail: Connecting California to the Future

High-speed rail, considered to be one of the largest infrastructure plans in the U.S., is vital to helping California succeed with smart, responsible growth. A high-speed rail system will provide a fast, affordable option for traveling between southern and northern California. Californians could travel from Los Angeles to San Francisco in 2.5 hours, connecting L.A.'s Union Station to San Francisco's Transbay Terminal, with extensions as far as San Diego and Sacramento proposed for the future. This 700 mile high-speed passenger train would reduce pollution caused from automobiles and air travel and would eliminates typical weather-related aviation delays. This high-speed train would serve vast sections of California, providing the entire state with a true public transportation network.

Californians will be given the opportunity to voice their support of high-speed rail with a bond measure in November 2004. The high-speed rail bond would partially fund the construction of the system; the remainder is expected to be paid from federal funds.

Many California cities offer a variety of transit options from cable cars to buses to light rail systems. The BART (Bay Area Rapid Transit) will soon extend to the San Francisco airport, an extension expected to replace 10,000 automobile trips to the airport each day.[182]

For commuters without a convenient public transit option, several alternatives to the private vehicle are available. Current initiatives, such as rideshare programs and HOV lanes, began in the 1970s during the oil embargo to save costs on gasoline. Currently an average of 2,518 people per hour commute via high-speed HOV lanes in California.[184] Sacramento, San Diego, and San Francisco all have ride share programs. The lowest emission transportation options include bicycling, walking, and telecommuting.

More mass transit and fewer cars can make a difference in your health. The city of Atlanta, Georgia discovered that during the 1996 Olympics. (see sidebar)

City/Regional Planning

"It is not just a social equity goal, but also a health goal, to have communities where rich and poor can live where there is good public transportation, accessible parks, sidewalks, and public areas."[185]

—RICHARD JACKSON, MD, MPH, CENTERS FOR DISEASE CONTROL AND PREVENTION

Suburban sprawl plays a major role in air pollution and climate change in California. Metropolitan areas have expanded into the countryside many times faster than the population has grown, encroaching on farmlands more suitable for growing crops and forcing many people to commute long distances to work, shopping centers, and recreational locations. Few conveniences are within walking distance, so the only choice is to drive. In the 1980s, motor vehicle miles traveled grew more than four times faster than the driving-age population and many times faster than the population at large.[186]

More driving and less walking have not only fouled the air, but also fattened the waistlines of Californians, leading to an epidemic of obesity and diabetes. Halting sprawl and revitalizing urban areas through better city and regional planning, commonly called "smart growth," will help clear the air and protect public health.

In October 2000, the Quality Growth and Smart Investments Act (AB2140) became law.[187] This innovative legislation encourages alternative growth scenarios in the development of 20-year transportation plans in each of the state's 43 regional transportation-planning agencies. It also establishes a core set of performance indicators related to safety, congestion, potholes, and public transit that each region must track and establishes a standardized method of financial reporting to show the public and local officials how their money is being spent.

This smart growth legislation requires each region to develop models of alternative growth rather than assuming certain types of growth and development will occur and then committing funds to provide the necessary infrastructure to serve that growth. Emphasizing compact growth that makes more efficient use of existing infrastructure, these models hold the potential for reduced traffic, decreased travel times, preservation of open space, reduced emissions, and greatly reduced infrastructure costs.

Cities throughout California are beginning to implement smart growth principles by providing more housing choices that are close to public transit

and affordable for people of all income levels. The Los Angeles City Council voted to spend $2.4 billion to revamp the core downtown area and build 13,000 housing units that would include low-income housing as well as more luxurious apartment complexes, offices, shops, grocery stores, movie theaters, and other entertainment venues. San Francisco's Mission Bay project is another example of urban reuse/revitalization that has converted former industrial land to housing, offices, parks, and a new biotechnology campus for the University of California.

This new project will include 6,000 homes and apartments, 1,700 of which will be for low- to moderate-income families.[188]

The smart growth approach is based on the following principles:

- Provide incentives for compact growth that includes amenities such as bike paths and neighborhood parks as population density increases.
- Preserve and enhance existing pedestrian and transit-oriented neighborhoods.
- Create mixed-use zone districts that encourage residential, commercial and office use on the same site.[189]

Greening Government and Business

"A revolution is occurring across a fairly large range of industry…Early adopters of profitable climate protection will derive decisive competitive advantage."[190]

—ROCKY MOUNTAIN INSTITUTE

Local governments can save money by making their facilities more energy efficient, particularly if financial incentives are available from utilities. The City of San Diego Environmental Services Department renovated a three-story, 73,000 square foot office building and cut energy consumption by 70%. Changes included replacing the entire heating, ventilating, and air conditioning system with a high efficiency system and installing high-efficiency window films, fluorescent lamps, fixtures, and daylight and occupancy sensors. The project qualified for financing by San Diego Gas and Electric, so all high-performance energy efficiency measures were financed by the utility. This turned a two- to three-year payback into an instant payback. The City estimates that the renovation saves about $80,000 annually.[191]

Protecting Vulnerable Populations and Resources

Making the transition to renewable energy sources may affect employment, housing, transit and health. Those most affected must be protected during the transitions.

Policymakers can ease some of the burden felt by lower income populations by supporting and implementing policies that hold polluters responsible for cleaning up the environment, rather than the federal government or the individual taxpayer. Revenue needs to be invested into easing the transition to a cleaner energy economy that will help to curb climate change by decreasing CO_2 emissions.[192]

Preventing Heat-Related Health Problems

Installing early warning systems, which advise the public and public health officials that dangerously hot weather is coming, can allow communities to prepare for heat waves. Such systems are already in place in Philadelphia, for example. "When the system predicts a heat wave, Philadelphia officials distribute media advisories, activate telephone hotlines, alert neighborhood volunteers, open air-conditioned shelters, expand outreach to the homeless, and coordinate efforts with local utilities" to protect vulnerable populations.[193] Similar early warning systems could be set up in California communities.

During recent deadly heat waves, mortality rates have been lower in cities with historically hot summers. This decreased number of deaths may be attributable to habit as these populations are more acclimated to heat and housing is better designed for extreme temperatures.[194] Many potential negative effects of heat could be averted if public housing, when built or retrofitted to meet new earthquake safety standards, could be fitted with adequate ventilation systems, proper insulation, and up-to-date and efficient air-cooling systems that could be easily controlled by the elderly.

Planting trees and vegetation in cities would also alleviate some of the "heat island" effect as trees create shade and absorb some of the heat trapped by the urban landscape. The choice of trees is important since some types of trees, such as eucalyptus and weeping willows, emit large amounts of volatile organic compounds (VOCs) that can increase smog levels. Deciduous trees are ideal because they provide shade in summer and but do not block the heat from winter sun.

Improving Public Health Infrastructure

Although the standard of living and health care infrastructure reduce the risk of epidemics from insect-borne diseases in the United States, the risk may increase as the climate warms and changes in precipitation and weather patterns occur. It would be prudent to continue to improve public health infrastructure, by strengthening and maintaining surveillance programs. Further research into how climate change affects disease is also needed to better understand how to reduce the risk.

Conclusion

"When fifty-one of the one hundred biggest economies on earth are corporations, not countries, only governments come close to having enough strength to enforce real limits on the behavior of the marketplace and the giant corporations who are its most powerful players."[195]

—MARK HERTSGARD, EARTH ODYSSEY: AROUND THE WORLD IN SEARCH OF OUR ENVIRONMENTAL FUTURE

Air pollution and climate change will only become more difficult to manage the longer we wait to take action. Every day we delay adopting policies that address the problems, we put human health and the environment more at risk. California is better positioned than any other state in the nation to lead the way

in finding clean energy solutions. The time for action is now. The number one priority is to lower the use of fossil fuels. Simply stated, that means beginning a transition to cleaner energy. These alternative energy sources are clean, safe, renewable, and available or within our reach. An economy based on cleaner fuels will help California prosper, gain its freedom from fossil fuels, and improve human health and quality of life.

What You Can Do

Each of us, as citizens and health professionals, has a role to play in what needs to be done. Our future and our quality of life depend on the actions we take now (Refer to Responsible Actions Insert for individual actions that can be taken to reduce climate change). In addition to these individual actions, health professionals can talk about these issues with colleagues, and catalyze action on the local and state level.

Resolutions

One such action available to health professionals is passage of resolutions through their professional organizations. The California Medical Association has adopted two important resolutions. These resolutions assert a powerful voice in the community and provide language and reasoning to elected officials looking for ways to help protect public health locally. Support these and any future resolutions on climate change and demand similar action on the national level.

Resolution 105-02

Air Pollution, Energy And Health

RESOLVED: That CMA encourage the State of California to develop a mechanism to ensure that the cleanest power generating units, including renewably fueled units, run first and most often, while encouraging all health care facilities to use the cleanest available technologies for emergency power generation; and be it further

RESOLVED: That CMA encourage the State of California to fully explore and quantify the health costs of air pollution in developing energy policies, aimed at offsetting the cost of retiring old power plants and replacing them with renewable energy sources, and for transforming the transportation infrastructure to ease the introduction of clean, alternative vehicles into the market; and be it further

RESOLVED: That CMA encourage the State of California to explore strategies to fund petroleum demand reduction strategies, to clean up and mitigate transportation and petroleum- related air and water pollution, and to support new, clean transportation technologies and infrastructure planning.

ACTION: Adopted as amended
Assigned to: Center for Medical Policy and Economics Priority: Medium

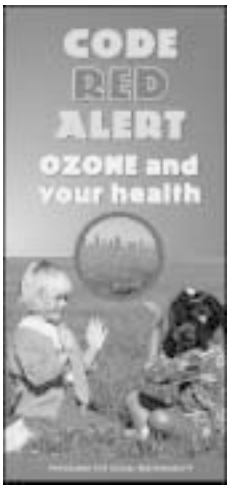
Resolution 106-02

Climate Change and Human Health

RESOLVED: That CMA strongly urge the President of the United States to take proactive steps to curb greenhouse emissions and work with other nations to address the increasing dangers of global climate change by committing to binding reduction targets for emissions; and be it further

RESOLVED: That this matter be referred for national action.

ACTION: Adopted as amended
Assigned to: Center for Medical Policy and Economics; California Delegation to the AMA Priority: Low



Patient Education Brochures on Climate Change

Developing patient brochures or distributing those made by others may help your patients prevent an asthma attack on a high ozone day or avoid mercury poisoning in their newborn. While the big picture of how air pollution and energy choices affect climate change and your patients' health may not fit in a handy, easy-to-read brochure, tips on how to prevent these effects individually may help reduce hospital visits and medical treatment in the long run. PSR created *Code Red Alert: Ozone and Your Health* to provide patients information about the effects of ozone on human health. To order copies please visit the PSR website at www.psr.org.

Where Physicians for Social Responsibility (PSR) Stands

Physicians for Social Responsibility (PSR), the active conscience of American medicine and the U.S. affiliate of International Physicians for the Prevention of Nuclear War, uses its members' expertise, 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 climate change—just as all scientific measurement is uncertain—we are moved to action for several compelling reasons. First, the overwhelming consensus among climate scientists is that the earth's temperature is increasing, and humans are largely responsible. Human-caused climate change may, in the future, change the environment in ways potentially harmful to human health. Second, just like businesses, governments, and responsible individuals, PSR feels the need to act decisively in the face of uncertainty to protect human welfare.

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

NOTES:

1. Zandonella, C. UC Berkeley researchers trace ancient migration of Valley Fever from Texas to South America. UC Berkeley press release 4/2/2001.
2. Amezzrican Lung Association. 2002. Available: www.lungusa.org/air2001/analysis02.html Accessed 3/11/03.
3. U.S. EPA. 2003. Global Warming Site: What is the Problem? Available: http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html Accessed: 3/11/03.
4. Prather M et al. Radiative Forcing of Climate Change Chapter; Climate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, 1995.
5. Houghton J. Global Warming: The Complete Briefing. Cambridge: Cambridge University Press, 1997.
6. International Council for Local Environmental Initiatives. 1993. Energy Fact Sheet: Greenhouse Gases. Available: http://www.iclei.org/efacts/greengas.htm Accessed: 3/11/03.
7. U.S. EPA. 2003. Global Warming Site: Emissions. Available: http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissionsindividual.html Accessed: 3/11/03.
8. Intergovernmental Panel on Climate Change. Summary for Policymakers to Climate Change 2001: Synthesis Report of the IPCC third Assessment Report. Wembley, UK, 2001.
9. Ibid.
10. Clarkson, J. Greenhouse Gas Emissions. In University of Texas Press, ed. The Impact of Global Warming on Texas: A Report of the Task Force on Climate Change in Texas. Austin, 1995, 50–67.
11. Clarkson J, Wilson JD, and Roeseler W. 1995. Urban Areas. In University of Texas Press, ed The Impact of Global Warming. pp. 168–186.
12. Karl TR, Knight RW, Easterling DR, et al. 1996. Indices of climate change for the U.S., Bull. Am. Meterol Soc. 77:279–303.
13. Karl TR, et al. 1995. Trends in high-frequency climate variability in the twentieth century. Nature 377:217–220.
14. Energy Information Administration. 2000. Emission of Greenhouse Gases in the United States 1999. Executive Summary. Available: http://www.eia.doe.gov/oiaf/1605/ggrpt/ Accessed: 3/11/03.
15. U.S. EPA. 2003. Global Warming Site: What is the Problem? Available: http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html Accessed: 3/11/03.
16. National Assessment of Climate Change. Climate Change Impacts on the United States, 12. Available: http://www.gcrio.org/NationalAssessment/overpdf/2IntroB.pdf Accessed: 3/11/03.
17. National Academy of Sciences. 2001. Climate Change Science: An Analysis of Some Key Questions. Washington D.C.: National Academy Press. Available: http://books.nap.edu/books/0309075742/html/2.html#pagetop Accessed: 3/11/03.
18. Intergovernmental Panel on Climate Change: Third Assessment Report, Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change. 2001. Available: http://www.ipcc.ch Accessed: 3/11/03.
19. California Public Interest Research Group. 2002. Campaign for Clean Energy Solutions. Available: http://www.calpirg.org/CA.asp?id2=2286&id3=CA&id4=CAIB&. Accessed: 3/11/03.
20. Ibid.
21. Fischlowitz-Roberts B. 2002. Air pollution fatalities now exceed traffic fatalities by 3 to 1. Earth Policy Institute. Available: www.earth-policy.org/Updates/Update17.htm Accessed 3/11/03.
22. California Energy Commission. 2001. California Energy Facts. Available: www.energy.ca.gov/html/calif_energy_facts.html Accessed: 3/11/03.
23. Wilkinson R and Rounds T. 1998. Climate Change and Variability in California: White Paper for the California Regional Assessment. National Center for Ecological Analysis and Synthesis, Santa Barbara, California. Research Paper No. 4. Available: http://www.nceas.ucsb.edu/papers/climate.pdf Accessed 3/11/03.
24. California Air Resources Board. 2002. California's Air Quality History: Key Events. http://www.arb.ca.gov/html/brochure/history.htm Accessed: October 2002.
25. California Energy Commission. 2001. California Energy Facts. Available: www.energy.ca.gov/html/calif_energy_facts.html Accessed: 3/11/03.
26. U.S. EPA. 1994. Environmental Fact Sheet, Air Toxics from Motor Vehicles. EPA 400-F-92-004, p. 2. Washington, D.C.: U.S. Environmental Protection Agency.
27. California Energy Commission. 2002. Consumer Energy Center Transportation Website. Available: www.consumerenergycenter.org/vehicles/default.php Accessed: 3/11/03.

28. California Energy Commission. 2001. California Energy Facts. Available: www.energy.ca.gov/html/calif_energy_facts.html Accessed: 3/11/03.

29. California Energy Commission. 2002. Climate change and its impacts on California. Sacramento, CA: California Energy Commission. Available: www.energy.ca.gov/global_climate_change/index.html Accessed 3/11/03.

30. Cifuentes L. Assessing the Health Benefits of Urban Air Pollution Reductions Associated with Climate Change Mitigation (2000–2020). Environmental Health Perspectives 109 suppl 3:419–25 (2001).

31. Department of Health Services State of California. 2002. Advance Report: California Vital Statistics 1999. Available: http://www.dhs.ca.gov/hisp/chs/OHIR/Publication/Highlights/Advance/AdvanceReport99.doc Accessed: 3/11/03.

32. Dockery DW et al. An Association Between Air Pollution and Mortality in Six U.S. Cities. New England Journal of Medicine 329:1753–59 (1993).

33. Spellman FRR, Whiting NE. Environmental Science and Technology: Concepts and Applications. Rockville, MD: Government Institutes, 1999.

34. U.S. EPA. 2002. U.S. EPA Greenbook: Nonattainment Status for Each County By Year. Available: http://www.epa.gov/oar/oaqps/greenbk/ancl.html Accessed 3/11/03.

35. U.S. EPA. 1997. Climate Change and California. EPA 230-F-97-008e. Washington, D.C.: U. S. Environmental Protection Agency.

36. U.S. EPA. 1997. Ozone: Good up high, bad nearby. EPA/451/K-97-002. Available: http://www.epa.gov/oar/oaqps/gooduphigh/#depletion Accessed 3/11/03.

37. Ibid.

38. Brown ER, Meng YY, Babey SH, Malcolm E. 2002. Asthma in California in 2001: High Rates Affect Most Population Groups. California Health Interview Survey: Making California's Voices Heard on Health. Available: http://www.chis.ucla.edu/asthma052002.html Accessed 3/11/03.

39. Weisel CP. Relationship Between Summertime Ambient Ozone Levels and Emergency Department Visits for Asthma in Central New Jersey. Environmental Health Perspectives 103 Suppl 2:97–102 (1995).

40. California Health Interview Survey. 2002. Landmark California Health Study Reports That Asthma Is A Major Issue For Californians. UCLA. Available: www.healthpolicy.ucla.edu/chis/050702.html Accessed: 3/11/03.

41. Hoerling M., Hurrell J Xu T. Tropical Origins for Recent North Atlantic Climate Change. Science 92, 290-292. 2001.

42. Ibid.

43. McConnell, R, Berhane, K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM. 2002. Asthma in exercising children exposed to ozone: a cohort study. The Lancet 359 (9304): 386–391.

44. Bernard SM et al. The Potential Impacts of Climate Variability and Change on Air Pollution-Related Health Effects in the United States. Environmental Health Perspectives 109 Suppl 2:199–209 (2001).

45. U.S. EPA. 1997. National Air Pollutant Emission Trends Update: 1970–1996. Washington D.C.: U.S. EPA.

46. Bernard SM et al. The Potential Impacts of Climate Variability and Change on Air Pollution-Related Health Effects in the United States. Environmental Health Perspectives 109 Suppl 2:199–209 (2001).

47. Samoli E et al. Investigating Regional Differences in Short-Term Effects of Air Pollution on Daily Mortality in the APHEA Project: A Sensitivity Analysis for Controlling Long-Term Trends and Seasonality. Environmental Health Perspectives 109; 4: 349–53 (2001).

48. Bascom R et al. State of the Art: Health Effects of Outdoor Air Pollution, Part 1&2. American Journal of Respiratory and Critical Care Medicine 153:3–50; 477–98 (1996).

49. U.S. EPA. 2002. U.S. EPA Greenbook: Nonattainment Status for Each County By Year. Available: http://www.epa.gov/oar/oaqps/greenbk/ancl.html Accessed 3/11/03.

50. Bascom R et al. State of the Art: Health Effects of Outdoor Air Pollution, Part 1&2. American Journal of Respiratory and Critical Care Medicine 153:3–50; 477–98 (1996).

51. Dockery DW et al. An Association Between Air Pollution and Mortality in Six U.S. Cities. New England Journal of Medicine 329:1753–59 (1993).

52. Seaton A et al. Particulate Air Pollution and Acute Health Effects. The Lancet 345:176–8 (1995).

53. Committee on the Medical Effects of Air Pollutants: Statement on Long-Term Effects of Particles on Mortality. 2001. London, England: Department of Health. Available: http://www.doh.gov.uk/comeap/longtermeffects.pdf Accessed 3/11/03.

54. Peters A et al. Increased Particulate Air Pollution and the Triggering of Myocardial Infarction. Circulation 103; 23:2810 (2001).

55. Woodruff TJ et al. The Relationship Between Selected Causes of Postneonatal Infant Mortality and Particulate Air Pollution in the United States. Environmental Health Perspectives 105: 608–12 (1997).

56. Borrell P. Tropospheric Chemistry. Encyclopedia of Ecology and Environmental Management. Oxford: Blackwell Science, 1998.

57. California Air Resources Board. 2002. California's Air Quality History: Key Events. Available: http://www.arb.ca.gov/html/brochure/history.htm Accessed 3/11/03.

58. Polakovic G. 2003. Smog-forming emissions badly underestimated, officials say. Los Angeles Times. 16 January 2003.

59. South Coast Air Quality Management District . Dirty Air Brochure. Available: http://www.aqmd.gov/forstudents/Dirty_Air_Brochure.htm Accessed 3/11/03.

60. California Air Resources Board. 2002. California's Air Quality History: Key Events. Available: http://www.arb.ca.gov/html/brochure/history.htm Accessed 3/11/03.

61. Coalition for Clean Air. 1999. ARB settles Clean Air Act lawsuit with environmental groups: Emission reductions promised in 1994 SIP plan will be restored. Available: http://www.coalitionforcleanair.org/cca/press_detail.cfm?PressID=5 Accessed 3/11/03.

62. Ibid.

63. Beggs PJ & Curson PH. An Integrated Environmental Asthma Model. Archives of Environmental Health 50; 2:87–94 (1995).

64. Balbus JM & Wilson ML. Human Health and Global Climate Change: A Review of Potential Impacts in the United States. Arlington, VA: Pew Center on Global Climate Change, 2000.

65. Ahlholm JU et al. Genetic and Environmental Factors Affecting the Allergenicity of Birch (*Betula pubescens* ssp. *czerepanovii* [Orl.] Hamet-Ahti) Pollen. Clinical and Experimental Allergy 28:1384–88 (1998).

66. Carson R. 1962. Silent Spring. New York: Houghton Mifflin, 42.

67. US EPA, Climate Change and California. 1997. EPA 230-F-97-008e.

68. California Department of Water Resources. 2002. State Water Project. Available: http://wwwdwr.water.ca.gov/nav.html?topic=State_Water_Project Accessed: 3/11/03.

69. U.S. EPA. 1997. Climate Change and California. EPA 230-F-97-008e. Washington, D.C.: U. S. Environmental Protection Agency.

70. Barnett TP, Malone R, Pennelll W, Stammer D, Semtner A, and Washington W. 2003. ACPI project overview and summary. Climatic Change. In review.

71. California Futures Network. 2002. News from California's Smart Growth Movement. Available: http://www.calfutures.org/whoweare.html Accessed 3/11/03.

72. University of California Agricultural Issues Center. 2000. The Measure of California Agriculture 2000. Available: http://aic.ucdavis.edu/pubs/summarycards.pdf Accessed 3/11/03.

73. U.S. EPA. 1997. Climate Change and California. EPA 230-F-97-008e. Washington, D.C.: U. S. Environmental Protection Agency.

74. University of California Agricultural Issues Center. 2000. The Measure of California Agriculture 2000. Available: http://aic.ucdavis.edu/pubs/summarycards.pdf Accessed 3/11/03.

75. National Assessment Synthesis Team, Climate Change Impacts on the U.S. The Potential Consequences of Climate Variability and Change, Overview: Human Health, 2000.

76. Arizona Department of Water Resources. Arizona's Water Supplies and Water Demands. Available: www.water.az.gov/azwaterinfo/statewide/supplyde.html Accessed: 3/11/03.

77. National Assessment Synthesis Team. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Washington D.C.: US Global Change Research Program, 2000.

78. Perry T. 2003. Irrigation district sues to keep share of river water. Los Angeles Times, 11 January 2003. Available: www.latimes.com/

79. Toxicological Effects of Methylmercury, p. 4. 2000. National Academy of Sciences Commission on Life Sciences. Washington, D.C.: National Academy Press.

80. Meyers GJ & Davidson PW. Prenatal Methylmercury Exposure and Children; Neurolgic, Developmental and Behavioral Research. Environmental Health Perspectives 106 Suppl 3:841–7 (1998).

81. U.S. FDA. 2001. Consumer Advisory: An Important Message for Pregnant Woomen and Women of Childbearing Age Who May Become Pregnant About the Risks of Mercury in Fish. Rockville, MD: Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration. Available: http://vm.cfsan.fda.gov/~dms/admehg.html Accessed 3/11/03.

82. Llanos M. 2003. California sues grocers over mercury in fish. MSNBC, January 22. Available: www.msnbc.com/news/862660.asp Accessed 3/11/03.

83. U.S. EPA. 2002. Update: National Listing of Fish and Wildlife Advisories. Available: http://www.epa.gov/waterscience/fish/advisories/factsheet.pdf Accessed: 3/11/03.

84. Greenough G, McGeehin M, Bernard SM, Trtanj J, Riad J, Engelberg D. The Potential Impacts of Climate Variability and Change on Health Impacts of Extreme Weather Events in the United States. Environmental Health Perspectives 109:191–198 (2001).

85. Kunkel KE, Pielke RA Jr, Changnon SA. Temporal Fluctuations in Weather and Climate Extremes that Cause Economic and Human Health Impacts: A Review. Bulletin of the American Meteorological Society 80:1077–1098 (1999).

86. U.S. FEMA. 1999. El Ni_o: Gone but not forgotten. Washington, D.C.: Region IX, Federal Emergency Management Agency. Available: www.fema.gov/regions/ix/1999/r9_03.shtm Accessed 3/11/03.

87. U.S. NCDC. 1998. California Flooding and Florida Tornadoes, February, 1998. Asheville, N.C.: National Climate Data Center. National Oceanographic and Atmospheric Administration. Available: www.ncdc.noaa.gov/oa/reports/febstorm/february98storms.html Accessed 3/11/03.

88. Woods Hole Oceanographic Institution. 2001. Harmful Algal Blooms in Your Region. Available: http://www.redtide.whoi.edu/hab/HABdistribution/habexpand.html Accessed: 3/11/03.

89. Kudela RM and Cochlan WP. 2000. Nitrogen and carbon uptake kinetics and the influence of irradiance for a red tide bloom off southern California. Aquatic Microbial Ecology 21:31–47.

90. The Marine Mammal Center. 2000. Harmful algae bloom detected in the Monterey Bay National Marine Sanctuary. Available: www.tmmc.org/learning/comm/com_archive/algal_bloom.asp Accessed 3/11/03.

91. Scholin CA, et al. 2000. Mortality of Sea Lions Along the Central California Coast Linked to a Toxic Diatom Bloom. Nature 403:80–84.

92. The Marine Mammal Center. 2000. Harmful algae bloom detected in the Monterey Bay National Marine Sanctuary. Available: www.tmmc.org/learning/comm/com_archive/algal_bloom.asp Accessed: 3/11/03.

93. Scholin CA, et al. Mortality of Sea Lions Along the Central California Coast Linked to a Toxic Diatom Bloom. Nature 403:80–84 (2000).

94. Resources Agency of California. 1997. California's Ocean Resources; Policies for Shoreline Erosion Protection (Appendix I). Available: http://elib.cs.berkeley.edu/cgi-bin/doc_home?elib_id=1947&search=Miles+of+coastline Accessed 3/11/03.

95. Friends of the River. 2001. Potential Wild and Scenic Rivers in California: A Statewide Inventory, p. 5. Sacramento, CA: Friends of the River. http://www.friendsoftheriver.org Accessed 3/11/03.

96. National Assessment Synthesis Team, Climate Change Impacts on the U.S. The Potential Consequences of Climate Variability and Change, Overview: Human Health, 2000.

97. McPhee J. 1989. The Control of Nature, p. 185. New York: Farrar, Straus & Giroux.

98. California Geological Survey. 2002. CGS Note 33 — Hazards from "Mudslides"…Debris Avalanches and Debris Flows in Hillsides and Wildfire Areas. Available: www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_33/index.htm Accessed 3/11/03.

99. U.S.G.S. 1999, Landslides will continue to impact U.S. — Tumbling Rocks Cost Collars and Lives. Denver, CO: U.S. Geological Survey. U.S. Department of the Interior. Available: http:www.usgs.gov/public/press/public_affairs/press-releases/pr851m.html Accessed 3/11/03.

100. Louis AM. 1998.L andslide insurance offered but many ineligible to buy policies. San Francisco Chronicle, February 6. Available: http://sorrel.humboldt.edu/~geodept/geology700/landslides_floods/landslide_insurance.html Accessed 3/11/03.

101. American Lung Association of Sand Diego and Imperial County. 2002. Imperial County Issues. Available: http://www.lungsandiego.org/environment/article_imperial_issues.asp Accessed: 3/11/03.

102. The Owens Valley Land Grab. Available: www.usc.edu/isd/archives/la/scandals/owens.html Accessed 3/11/03.

103. U. S. EPA Reclassification of Moderate PM-10 Nonattainment Areas to Serious Areas — Part II. 1993. Owens Valley, California. Federal Register 58:05. January 8, 1993. 58 FR 3334.

104. U.S. EPA. 1997. Climate Change and California. EPA 230-F-97-008e. Washington, D.C.: U. S. Environmental Protection Agency.

105. Ozone Action and Physicians for Social Responsibility. 2000. Heat Waves and Hot Nights: A report by Ozone Action and Physicians for Social Responsibility, released July 26, 2000, analyzing NOAA weather data from 1948–1999 for trends in heat index and the frequency of heat waves in 171 U.S. cities. Washington D.C.

106. Ibid.

107. Kalkstein LS,Greene JS. 1997. An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change. Environmental Health Perspectives 105: 84–93.

108. Kilbourne EM. Illness Due to Thermal Extremes Chapter. In Public Health & Preventive Medicine, Stamford, CT: Appleton & Lange, 1998.

109. CDC. 1996. Heat-related mortality—Chicago, July 1995. Morbidity and Mortality Weekly Report 44:577–579. Atlanta, GA: U.S. Centers for Disease Control and Prevention (cited in McGeehin).

110. Semenza JC et al. Heat-related deaths during the July 1995 heat wave in Chicago. The New England Journal of Medicine 335:84–90 (1996).

111. Kilbourne EM. Illness Due to Thermal Extremes Chapter. In Public Health & Preventive Medicine, Stamford, CT: Appleton & Lange, 1998

112. Kalkstein LS & Greene JS. An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change. Environmental Health Perspectives 105:84–93 (1997).

113. Gubler DJ. 1998. Resurgent vector-borne diseases as a global health problem. Emerging Infectious Diseases 4(3). Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: http://www.cdc.gov/ncidod/eid/vol4no3/gubler.htm Accessed 3/11/03.

114. World Health Organization. 1996. Climate Change and Human Health. Geneva.

115. Epstein and DeFilippo. 2001. West Nile virus and drought. Global Change and Human Health.

116. Alto, B & Juliano, S. 2001. Beyond Pesticides Tech Report. Journal of Entymology. 38:4.

117. Kilbourne EM. Illness Due to Thermal Extremes. In: Public Health & Preventive Medicine (Wallace RB, ed). Stamford, CT: Appleton & Lange, 607–17 (1999).

118. U.S. CDC. 2003. West Nile Virus Update: Current Case Count. Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: http://www.cdc.gov/od/oc/media/wncount.htm Accessed 3/11/03.

119. U.S. CDC. 2003. Overview: Questions and Answers About West Nile Virus. Division of Vector-Borne Infectious Diseases. Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: (http://www.cdc.gov/ncidod/dvbid/westnile/qa/overview.htm Accessed 3/11/03.

120. U.S. CDC. 2003. West Nile Virus Update: Current Case Count. Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: http://www.cdc.gov/od/oc/media/wncount.htm Accessed 3/11/03.

121. U.S. CDC. 2001. Map: American countries with laboratory confirmed hemorrhagic fever, prior to 1981 and from 1981 to 1997. Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: http://www.cdc.gov/ncidod/dvbid/dengue/map-dengue-1981–1997.htm Accessed 3/11/03.

122. American Society for Microbiology. 1998. Dengue fever: A public health problem along the Texas-Mexico border.

123. U.S. CDC. 2002. Malarial Surveillance — United States, 2000. Morbidity and Mortality Weekly Report 51(ss-5):9–21. Atlanta, GA: U.S. Centers for Disease Control and Prevention. Available: http://www.cdc.gov/mmwr/ Accessed 3/11/03.

124. Moses M. 1998. Pesticides. In Maxcy KF, Rosenau MJ, Last JM, Wallace RB (Eds.), Public Health and Preventive Medicine, 14th edition. New York: McGraw-Hill Professional, 593.

125. The 1999 Toxic Exposure Surveillance System Annual Report. The American Journal of Emergency Medicine 18;5: 517–74.

126. Longstreth J. 1999. Public health consequences of global climate change in the United States—Some regions may suffer disproportionately. Environmental Health Perspectives 107 Suppl 1: 169–179.

127. U.S. Census Bureau. 2001. California People Quick Facts. Washington D.C. Available: http://www.fedstats.gov/qf/states/06000.html Accessed 3/11/03.

128. Lorin, M. Overview of Environmental Threats to Children's Health. 2003. 11-1-0002. Ref Type: Conference Proceeding

129. Longstreth J. 1999. Public health consequences of global climate change in the United States—Some regions may suffer disproportionately. Environmental Health Perspectives 107 Suppl 1:169–179.

130. U.S. Census Bureau. 2002. Low Income Uninsured Children by State: 1999, 2000, and 2001. Available: http://www.census.gov/hhes/www/hlthins.html Accessed 3/11/03.

131. U. S. Census Bureau. 2000. DP-3. Profile of Selected Economic Characteristics: 2000. Washington, D.C.: U.S. Census Bureau. http://www.factfinder.census.gov/ Accessed 3/11/03.

132. Natural Resources Defense Council. 2002. Public health and environmental coalition sues EPA for allowing corporate agriculture in California to evade Clean Air Act. Available: http://www.nrdc.org/media/pressReleases/020204.asp Accessed 3/11/03.

133. U.S. EPA. 2002. U.S. EPA Greenbook: Nonattainment Status for Each County By Year. Available: http://www.epa.gov/oar/oaqps/greenbk/ancl.html Accessed 3/11/03.

134. U.S.D.A. 1999. Environmental Exposures to Agrochemicals in the Sierra Nevada Mountain Range. Washington, D.C.: U.S. Department of Agriculture, Agricultural Research Service.

135. Earthjustice. 2002. Big agriculture in California will be required to obey Clean Air Act. Available: www.earthjustice.org/news/print.html?ID=370 Accessed 3/11/03.

136. Natural Resources Defense Council. 2002. Public health and environmental coalition sues EPA for allowing corporate agriculture in California to evade Clean Air Act. Available: http://www.nrdc.org/media/pressReleases/020204.asp Accessed 3/11/03.

137. U.S. EPA. 2003. San Joaquin Valley New Source Review Rules. Washington, D.C.: U.S. Environmental Protection Agency. Available: www.epa.gov/region09/air/sjvalleynsr/index.html Accessed 3/11/03.

138. San Francisco Chronicle. 2003. Bringing back blue skies. Editorial, March 9. Available: www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2003/03/09/ED7380.DTL Accessed 3/11/03.

139. Zanobetti A et al. Are There Sensitive Subgroups for the Effects of Airborne Particles? Environmental Health Perspectives 108;9: 841–5 (2000).

140. US Environmental Protection Agency; Mexico's Secretariat for Environment, Natural Resources and Fisheries. 1998. US-Mexico Border Environmental Indicators 1997. Washington D.C.

141. U. S. Census Bureau. QT-PL. Race, Hispanic or Laltino, and Age: 2000. Washington, D.C.: U.S. Census Bureau. http://factfinder.census.gov/ Accessed 3/11/03.

142. U. S. Census Bureau. 2000. DP-3. Profile of Selected Economic Characteristics: 2000. Washington, D.C.: U.S. Census Bureau. http://factfinder.census.gov/ Accessed 3/11/03.

143. American Lung Association of San Diego and Imperial Counties, www.lungsandiego.org/environment/article_imperial_issues.asp Accessed 3/11/03.

144. Spix C et al. Short-Term Effects of Air Pollution on Hospital Admissions of Respiratory Diseases in Europe: A Quantitative Summary of APHEA Study Results. Archives of Environmental Health 53;1: 54–64 (1998).

145. Ibid.

146. U.S. EPA. 2002. U.S. EPA Greenbook: Nonattainment Status for Each County By Year. Washington, D.C.: U.S. Environmental Protection Agency. Available: http://www.epa.gov/oar/oaqps/greenbk/ancl.html Accessed 3/11/03.

147. Lindquist D. 2003. Mexico weighing offshore LNG sites. San Diego Union Tribune, January 16 2003. Available: http://www.signonsandiego.com/news/business/20030116-9999_1b16lng.html Accessed 3/11/03.

148. California Energy Commission. 2002. Climate change and its impacts on California. Sacramento, CA: California Energy Commission. Available: www.energy.ca.gov/global_climate_change/index.html Accessed 3/11/03.

149. Tickner J. 1997. Precautionary Principle. The Networker, The Newsletter of the Science and Environmental Health Net 2;34. Available: http://www.pmac.net/precaut.htm Accessed: 3/11/03.

150. Polakovic G. 2001. AQMD moves to overhaul power plant emission rules. Los Angeles Times, January 20.

151. California Energy Commission, Public Interest Energy Research Staff Report. 2002. Inventory of California Greenhouse Gas Emissions and Sinks: 1990–1999, p. 8. http://www.energy.ca.gov/pier Accessed 3/11/03.

152. Gelbspan R. 1997. The Heat Is On. Reading, MA: Addison Wesley Publishing Company. 13.

153. Public Policy Institute of California. 2002 PPIC Statewide Survey: Special Survey on Californians and the Environment, p. 15 Available: http://www.ppic.org/content/pubs/S_602MBS.pdf Accessed: 3/13/03.

154. California Energy Commission. 2002. 2001 Net System Power Calculation, p. 4.

155. California Energy Commission. 2002. California Electrical Energy Generation, 1983 to 2001. Available: http://www.energy.ca.gov/electricity/ELECTRICITY_GEN_1983-2001.XLS Accessed: 3/11/03.

156. California Energy Commission. 2002. California Wind Resource Maps 2002. Available: http://www.energy.ca.gov/maps/wind.html Accessed 3/11/03.

157. European Wind Energy Association. 2002. Wind Energy in Europe. Available: http://www.ewea.org/src/Europe.htm Accessed 3/11/03.

158. California Energy Commission. 2002. Wind Energy in California. Available: http://www.energy.ca.gov/wind/overview.html Accessed 3/11/03.

159. Herig C. 2001. Using Photovoltaics to Preserve California's Electricity Capacity Reserves. Golden, CO: National Renewable Energy Laboratory NREL/BR-520-31179.

160. Romm JJ. 1999. Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions, p. 136. Washington, D.C.: Island Press.

161. Power Shift. Power Shift helps Berkeley go solar. July 13, 2002. http://www.shiftpower.org/newswire_detail.php?id=99 Accessed 3/11/03.

162. Interface, Inc. 2002. Renewable Energy Strategies. www.interfacesustainability.com/globclim.html Accessed 3/11/03.

163. U.S. DOE. 2002. What's New in Alternative Fuels. Alternative Fuels Data Center. Washington D.C.: U.S. Department of Energy. Available:. http://www.afdc.doe.gov/whatsnew.shtml Accessed 3/11/03.

164. California Energy Commission. 2001. California Energy Facts. Available: www.energy.ca.gov/html/calif_energy_facts.html Accessed: 3/11/03.

165. Bradsher K. 2001. Fuel Economy for New Cars Is at Lowest Level Since '80. The New York Times May 18, 2001.

166. Sierra Club Global Warming and Energy Program. The Biggest Single Step to Curbing Global Warming and Saving Oil. Washington D.C. (2000).

167. Booth W. 2002. California Takes Lead on Auto Emissions. Washington Post July 22, 2002. Available: http://www.washingtonpost.com

168. California Assembly. Vehicular emissions: greenhouse gases. AB 1493. Bill Text. 2002. Available: http://www.leginfo.ca.gov/pub/01-02/bill/asm/ab_1451-1500/ab_1493_bill_20021209_status.html Accessed 3/11/03.

169. Egelko G. 2002. Bush hits state's emission rules; He backs carmakers in lawsuit. San Francisco Chronicle, October 10, 2002. Available: http://www.sfgate.com/cgi-bin/article.cgi?file+/c/a/2002/10/10/MN162632.DTL Accessed 3/11/03.

170. Clean Car Maps. 2002. Mapquest. Available: http://www.cleancarmaps.com/cgi-bin/mqinterconnect?link=find Accessed 3/11/03.

171. Moteur Developpment International. 2002. The Air Car: Lifestyle, Economy, Ecology. Available: http://www.theaircar.com Accessed 3/11/03.

172. Hypercar, Inc. 2002. On the Road to a Sustainable Tomorrow. Available: http://www.hypercar.com Accessed 3/11/03.

173. How to Reduce the Environmental Impacts of Transportation? 2002. Snowmass, CO: Rocky Mountain Institute. Available: http://www.rmi.org/sitepages/pid18/php Accessed 3/11/03.

174. U.S. DOE. 2002. What's New in Alternative Fuels. Alternative Fuels Data Center. Washington D.C.: U.S. Department of Energy. Available: http://www.afdc.doe.gov Accessed 3/11/03.

175. California Natural Gas Vehicle Partnership. 2002. California Leaders Set Goals to Deploy More Natural Gas Vehicles. Available: http://www.cngvp.org Accessed 3/11/03.

176. Ibid.

177. City of Los Angeles Takes Delivery of First Fuel Cell Car. 2002. The New York Times, December 2, 2002.

178. Griscom A. 2003. Tough cell: What can we learn from Bush's FreedomCAR plan? Grist Magazine, February 26. Available: http://gristmagazine.com/powers/powers022603.asp Accessed 3/11/03.

179. Financing Our Transportation System. 2000. Sacramento, CA: California Legislative Analysts Office. Cited in California Transit Facts, Environmental Media Services.

180. Environmental Media Services. 2001. Californians Flock to Public Transit in Record Numbers. Available: http://www.ems.org/cal_transportation/zz.stpp.01.04.16.html Accessed 3/11/03.

181. Surface Transportation Policy Project. 2001. Public Transit Spending and Trends in California Ridership. Available: http://www.transact.org/Ca/public_transport3.htm Accessed 3/11/03.

182. San Francisco Bay Area Rapid Transit District. 2002. Bart SFO Extension: Project Features. Available: http://www.bart.gov/about/sfo/aboutSFOHistory_2.asp Accessed 3/11/03.

183. Friedman, M.S., Powell, K.E., Hutwagner, L., Graham, LM, Teague, W.G. 2001. Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma. Journal of the American Medical Association 285 (7): 897–905.

184. California Energy Commission. 2002. Consumer Energy Center: Transportation Choices. Available: www.consumerenergycenter.org/transportation Accessed: 3/11/03.

185. Jackson R. 2001. What Olmsted Knew. Western City, March. Available: www.westerncity.com/Mar01Olmsted.htm Accessed 3/11/03.

186. Natural Resources Defense Council. 1999. Paving Paradise: Sprawl and the Environment. Available: www.nrdc.org/cities/smartgrowth/rpave.asp Accessed 3/11/03.

187. California Assembly. AB 2140: The Quality Growth and Smart Investments Act of 2000. 2000. Surface Transportation Policy Project. Available: http://www.transact.org/Ca/smart_growth1.htm Accessed 3/11/03.

188. California Futures Network. 2002. News from California's Smart Growth Movement. Available: http://www.calfutures.org Accessed 3/11/03.

189. Fresno Growth Alternatives Alliance. 1998. A Landscape of Choice: Strategies for Improving Patterns of Community Growth. Available: http://www.transact.org/Ca/smart_growth.htm Accessed 3/11/03.

190. Rocky Mountain Institute. 2003. Profitable climate protection for businesses. Snowmass, CO: Rocky Mountain Institute. Available: www.rmi.org/siteipages/pid126.php Accessed 3/11/03.

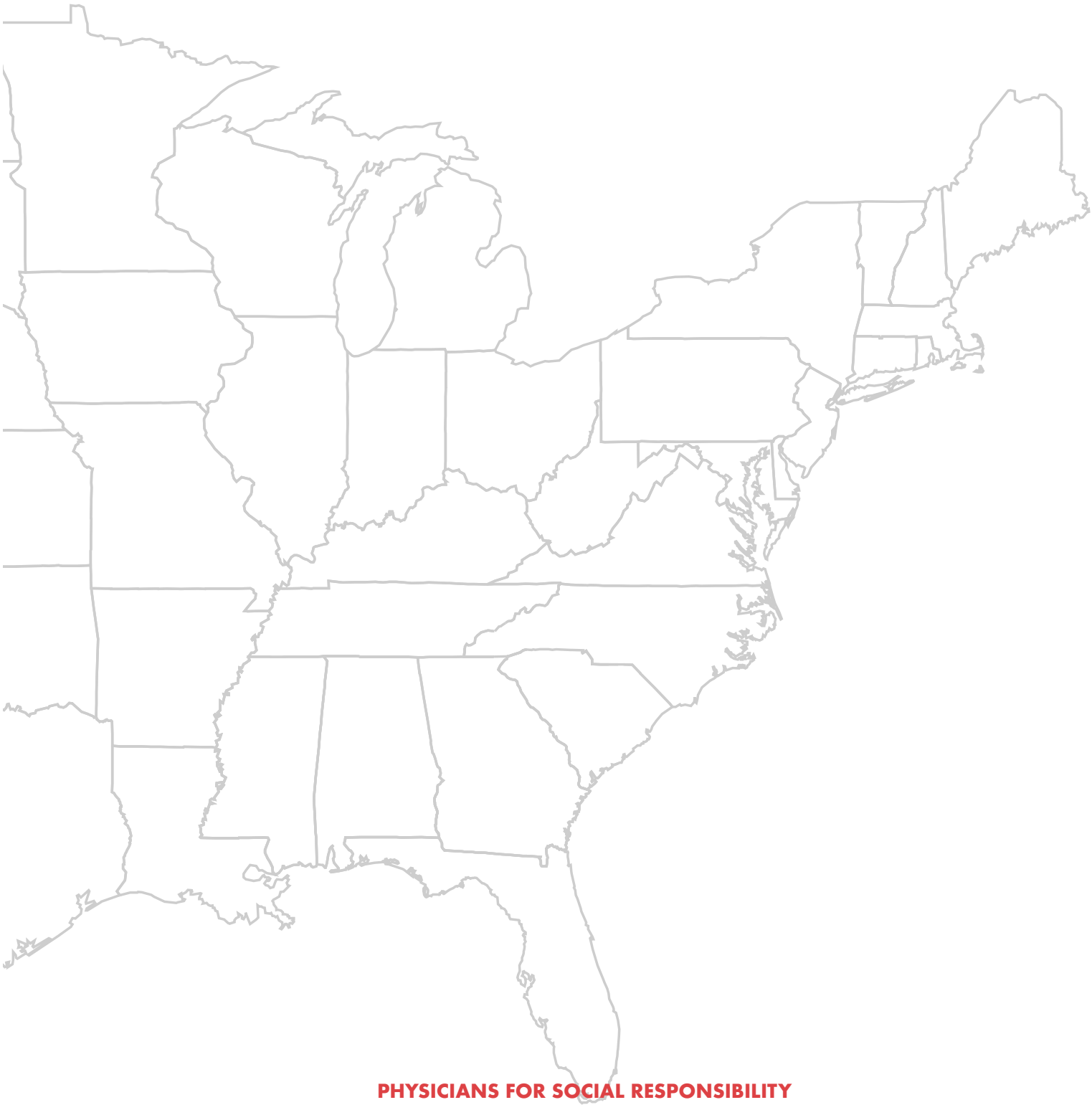
191. Romm JJ. 1999. Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions, pp 51–52. Washington D.C. Island Press.

192. Miller A with Brown P. 2000. A Fair Climate for All. Climate Change Issue Brief. Redefining Progress. Available: http://ww.redefiningprogress.org.

193. Forum. Predicting Heat Worldwide. Environmental Health Perspectives 107:A238^A240 (1999).

194. Kalkstein LS & Greene JS. An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change. Environmental Health Perspectives 105:84-93 (1997).

195. Hertzgaard M. 1998, Earth Odyssey: Around the World in Search of Our Environmental Future. New York: Broadway Books, 279.



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