Society

- Population movements and development choices are among the societal changes that are making more Americans vulnerable to climate change impacts.

- Vulnerabilities to climate change impacts are greater for those who have few resources and few choices.
- Climate change will affect the tourism and recreation industries in ways that reduce opportunities for many activities that Americans hold dear.
- Cities, both their residents and their infrastructure, have unique vulnerabilities to climate change.
- The insurance industry is particularly vulnerable to increasing extreme weather events, but can also help society manage the risks.

Climate change will affect society through impacts on the necessities and comforts of life: water, food, energy, health, transportation, recreation, insurance, and so on. Many of these topics are dealt with in some detail later in this report. This section focuses on various aspects of society that tend to integrate the impacts of climate change in ways that significantly affect quality of life.

Because societies and their built environments have developed in concert with a relatively stable historical climate, most impacts of a rapidly changing climate will present challenges and the adaptation required will involve costs. Society is especially vulnerable to extremes, such as heat waves and floods, many of which are increasing as climate changes. And while there are likely to be some benefits and opportunities in the early stages of warming, as climate continues to change, negative impacts are projected to dominate.

It is also important to recognize that the impacts of climate change do not affect society in isolation, but rather in combination with the impacts of other human-induced stresses such as pollution and poverty. Climate change will affect different segments of society differently due to their varying exposures and capacities to adapt. Wealthier segments are likely to have greater technical and financial resources, making them capable of considerable adaptation, but this requires effective planning and investment.

Unequal adaptive capacity in the world as whole will also pose challenges to the United States, as poorer countries are disproportionately affected and the U.S. has to cope with the world beyond its borders.

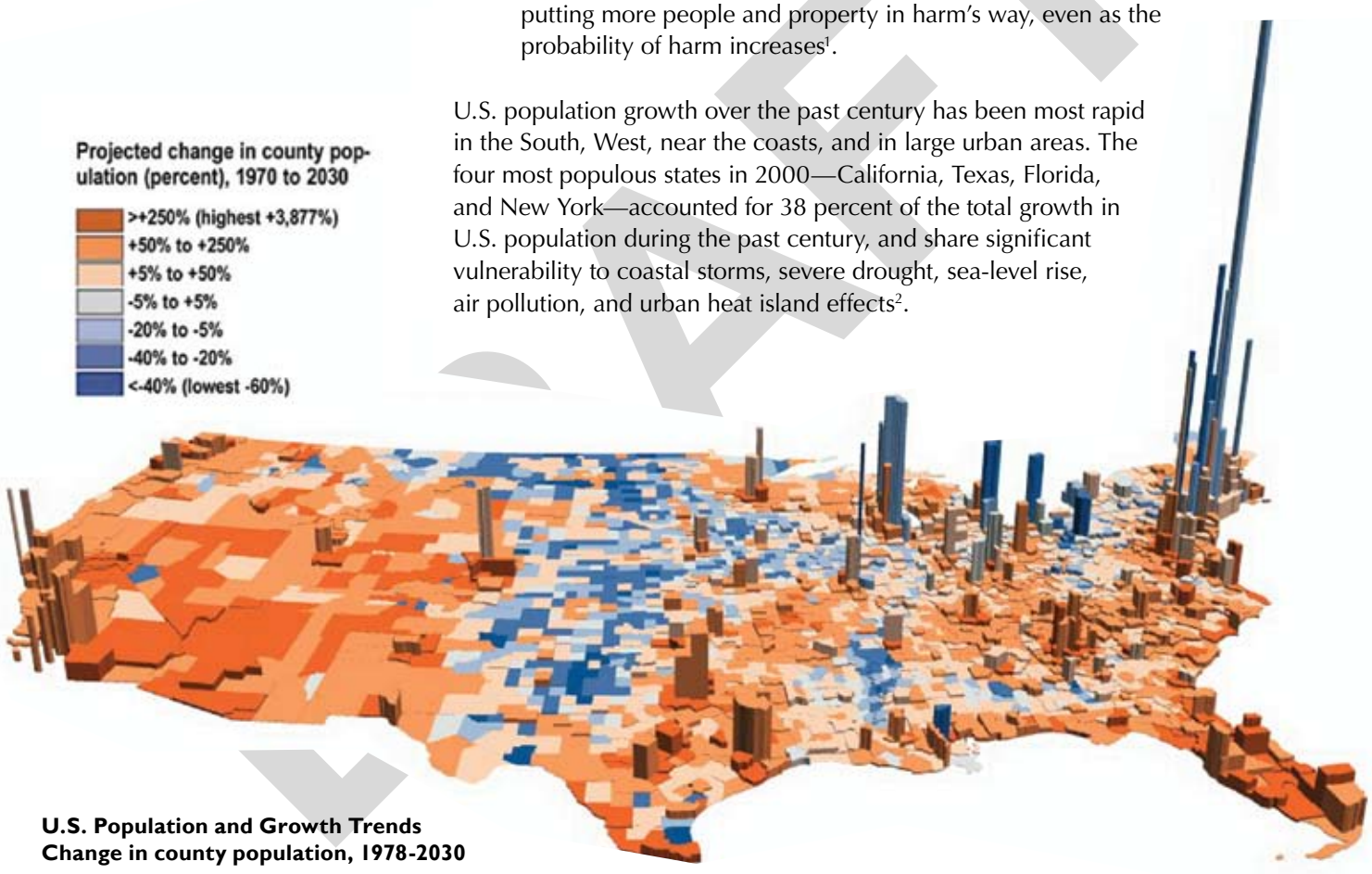
Population movements and development choices are among the societal changes that are making more Americans vulnerable to climate change impacts.

Climate change is interacting with changes in the U.S. population to affect all aspects of the human condition. As the challenges presented by population growth, an aging population, migration patterns, and urban and coastal development meet increasing changes in temperature, precipitation, sea levels, and extreme weather events, we can expect mounting impacts on many of the things we care about.

Climate change is interacting with changes in the U.S. population to affect all aspects of the human condition.

Overlaying projections of future climate change and its impacts on expected changes in U.S. population and development patterns reveals a critical insight: more Americans will be living in the areas that are most vulnerable to the effects of climate change. For example, the most rapidly growing area of the country is the mountainous West, a region projected to face more frequent and severe wildfires and have less available water, particularly during the high-demand period of summer. Similarly, the most rapidly growing coastal areas tend to be in regions most at risk due to hurricane activity, sea-level rise, and storm surge, putting more people and property in harm's way, even as the probability of harm increases[1].

U.S. population growth over the past century has been most rapid in the South, West, near the coasts, and in large urban areas. The four most populous states in 2000—California, Texas, Florida, and New York—accounted for 38 percent of the total growth in U.S. population during the past century, and share significant vulnerability to coastal storms, severe drought, sea-level rise, air pollution, and urban heat island effects[2].

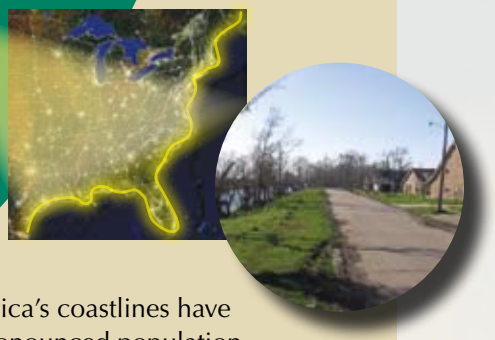


U.S. Population and Growth Trends
Change in county population, 1978-2030

Each block on the map illustrates one county in the United States The height of each block is proportional to that county's population density in the year 2000, so the volume of the block is proportional to the county's total population. The color of each block shows the county's projected change in population between 1970 and 2030, with shades of orange denoting increases and blue denoting decreases. The patterns of recent population change, with growth concentrated along the coasts, in cities, and in the South and West, are projected to continue[38].

Population movement to arid regions will stress water supplies, especially in the mountainous West, desert Southwest, and Great Plains. Overuse of rivers and streams in the West is common in dry regions with high agricultural irrigation demands, especially those along the eastern front of the Rocky Mountains in Colorado, in Southern California, and in the Central Valley of California. In the 40 years from 1960 to 2000, Colorado's population grew by 245 percent. Rapid population and economic growth in these dry regions has dramatically increased vulnerability to water shortages (see *Water* sector and *Southwest* region)[3]. The population of the mountain West (Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico) is projected to increase by 65 percent from 2000 to 2030.

Regional Spotlight: Atlantic and Gulf Coast Vulnerability



America's coastlines have seen pronounced population growth in recent decades: 53 percent of the U.S. population now lives in the 17 percent of the land in coastal areas. On the Atlantic and Gulf coasts where hurricane activity is prevalent, the land is sinking while sea level is rising, and human activities are exacerbating the loss of coastal wetlands that once helped buffer the coastline from erosion due to storms. The devastation caused by recent hurricanes highlights the vulnerability of these areas.

Many questions are raised by ongoing development patterns in the face of climate change. Will growth continue as projected in vulnerable areas, despite the risks? Will there be a retreat from the coastline as it becomes more difficult to insure vulnerable properties? Will there be the usual pressure for the government to insure properties that private insurers have rejected? How can the vulnerability of new development be minimized? How can we ensure that communities adopt measures to manage the significant changes that are projected in sea level, temperature, rainfall, and extreme weather events?

Development choices are based on what society wants to create: places to live, economies that provide employment, and resources that support environmental protection and community-based social activities. Development paths emerging from these choices affect the severity of climate change impacts, not only through changes in climate-related exposure and sensitivity, but also through changes in capacities to adapt. This also means that the future vulnerability of society will be influenced by choices of development paths. But not all development choices are created equal. Some, such as expanded urban development in coastal regions, can increase vulnerabilities to climate-related events, even without any change in climate. At the same time, it is important to consider whether climate change would make it more difficult for regions and communities to achieve their long-term development goals, and whether some development paths are better than others in reducing climate-related vulnerabilities and increasing capacities to adapt. While the atmosphere is changing above our heads, the ground is also shifting beneath our feet.

Vulnerabilities to climate change impacts are greater for those who have few resources and few choices.

Vulnerabilities to climate change depend not only on where people are but also on who they are. For example, the experience with Hurricane Katrina showed that effects of severe weather events are much greater on those in the population who have limited ability to get out of harm's way, such as the elderly and poor. Thus, those who have the least, often lose the most. And it is clear that people with access to financial resources, including insurance, have a greater capacity to adapt to and recover from adverse climate change effects than the poor. The fate of the poor can be permanent dislocation, leading to the loss of social relationships provided by their schools, churches, and neighborhoods.

In general, especially vulnerable groups include the very young, the very old, the sick, the poor, and the powerless. These groups represent a more significant portion of the total population in some regions and localities than others. Communities of the very poor or elderly are thus likely to be particularly vulnerable to climate change effects. Often such communities are in marginal locations, such as in river flood plains or low-lying coastal areas, increasing their risk.

There are also some activities that are particularly sensitive to changes in climate, and those whose livelihoods depend on such activities are especially vulnerable to the impacts of climate change. For example, maple syrup production is heavily reliant on climate and recent warming has altered the required temperature patterns, shifting production northward from New England into Canada (see *Northeast* region). Similarly, cranberries require a long winter chill period, which is shrinking as climate warms[4].

Spotlight on Alaska Coastal Villages at Risk

Dozens of villages on the Alaska coastline are threatened by a combination of impacts caused by warming. Sea level is rising, the reduction in sea ice leaves the coast more vulnerable to wave action from storms, and the thawing of coastal permafrost makes the coast more easily eroded. The people of these villages tend to live traditional lifestyles, meaning that they hunt, fish and gather much of their food. Warming is reducing the availability and accessibility of many of these food sources, such as seals that live on ice, and caribou whose migration patterns are sensitive to changes in climate.

A number of villages are now facing the prospect of having to abandon their ancestral homes and relocate to safer ground. The costs of such relocations are estimated in the hundreds of millions of dollars per village, and it is not clear who would pay these costs. A U.S. government study found that 184 villages on the coast and in low-lying areas along rivers are subject to increased flooding and erosion due to warming. These vulnerable populations face losing their communities, their livelihoods, and in some cases, their culture, which depends on traditional ways of collecting and sharing food[5].

Climate change will affect the tourism and recreation industries in ways that reduce opportunities for many activities that Americans hold dear.

Recreation and tourism play important roles in the economy and quality of life of many Americans. In regions including the West, Alaska, and the Islands, tourism and recreation are major job creators, bringing billions of dollars to regional economies. Across the nation, fishing, hunting, skiing, snowmobiling, diving, beach-going, and other outdoor activities make important economic contributions and are a part of family traditions that have value that goes beyond the financial.

A changing climate will mean reduced opportunities for many of the activities that Americans hold dear[6]. For example, coldwater fish species such as salmon and trout that are popular with fishermen will have reduced habitat in a warmer world, and coral reefs are already severely compromised. Hunting opportunities will change as animals' habitats shift and as relationships among species in natural communities are disrupted by their different responses to rapid climate change. In the arid Southwest, which is projected to get drier, declining reservoir levels will affect boaters, and streams that support sport fisheries are likely to decline.

Outdoor activities make important economic contributions and are a part of family traditions that have value that goes beyond the financial.

Examples of economic impacts include a projection that a 20 percent reduction in skiing days in the Northeast would cost the region about $800 million a year in lost revenue, and jeopardize the financial viability of some resorts[7]. A recent analysis projects that along the southern North Carolina coast, 14 of the 17 recreational beaches will be permanently underwater by 2080 as sea-level rise erodes the coastline all the way to the road. Lost opportunities for beach trips and fishing trips are projected to result in reduced recreational benefits totaling $3.9 billion in that state over the next 75 years[8].

There are opportunities for increases in some warm weather recreational options, but some of these options will be limited due to the increase in very hot weather.

Spotlight on Snowmobiling in the Northeast

Snowmobiling is the most vulnerable of the Northeast's economically important winter recreation activities, because, unlike the ski industry, it cannot be assisted by machine-made snow. Within the next several decades, snowmobiling opportunities are projected to become virtually nonexistent in Pennsylvania and much of New York state. By late in this century, the average season length for snowmobiling is projected to decline to just 13 days under a high-emissions scenario, an 80 percent decline below recent levels, and to 25 days under a low emissions scenario, a 57 percent decline. Only northern New Hampshire would retain a snowmobiling season longer than two months under a high emissions scenario.

Spotlight on Skiing in the West

The Mountain West is projected to see a continuation of the observed trend toward warmer winters and shorter snow seasons. Winter sports dependent on snow, including downhill skiing and snowboarding, cross-country skiing, snowshoeing, and snowmobiling are expected to see worsening conditions, potentially becoming unviable as soon as 2050 in some locations. Any significant shortening of the snow season is likely put some ski areas out of business. For example, a ski resort like Aspen is open for about 140 days; it takes the resort 100 days to break even and cover costs. If the season is compressed by a few dozen days, the resort can become unprofitable[9].

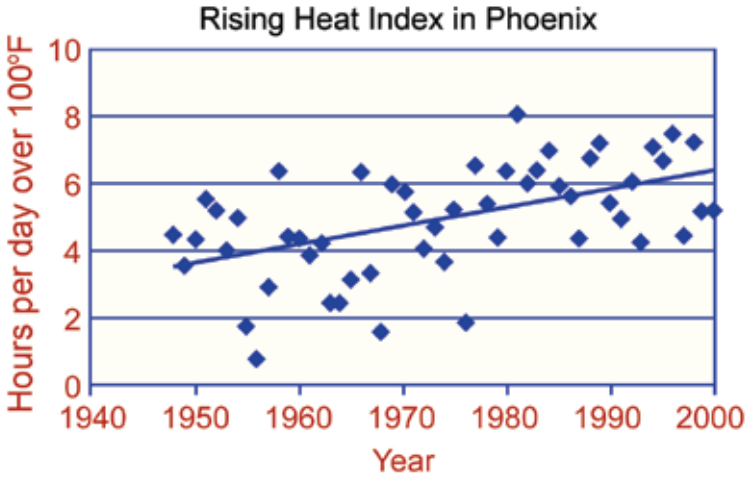
Cities, both their residents and their infrastructure, have unique vulnerabilities to climate change.

Over 80 percent of the U.S. population resides in urban areas. During recent decades, cities have become increasingly spread out, complex, and interconnected with regional and national economies[10]. Cities also have a host of social problems, including neighborhood degradation, traffic congestion, crime, poverty, and inequities in health and well-being[11]. Urban vulnerabilities to climate change are related to cities' economic activities, transportation, utility infrastructure, and residential populations. Climate-related changes including increased heat, air pollution, and extreme weather events will add further stress to existing problems.

Urban areas are among the most rapidly changing environments on Earth. As cities grow, they affect local climates. The urban heat island effect has raised average urban air temperatures by 2 to 5°F more than surrounding areas over the past 100 years, and by up to 20°F more at night[12]. Such temperature increases, on top of the general increase caused by human-induced warming, affect urban dwellers in many ways, influencing their health, comfort, energy costs, air quality, water quality and availability, and violent crime (which increases at high temperatures)[13,14].

The impacts of climate change on urban centers interact with and are compounded by cities' aging infrastructure, buildings, and populations, air pollution, and population growth. Their locations makes some cities more vulnerable than others. Cities are bellwethers of climate impacts, microcosms of the kinds of changes we can expect to see more widely in the future. For example, most cities already experience higher nighttime temperatures than surrounding areas due to the urban heat island effect. And some cities, particularly those in the western United States, are already facing the effects of drought on water availability.

The projected rise in extreme high temperatures combined with the urban heat island effect will increase stresses on urban residents. U.S. cities can expect to see longer, more frequent, and more intense heat waves, which will increase heat-related illness and death, and aggravate cardiovascular, respiratory, and other conditions (see *Human Health* sector). In Chicago's 1995 heat wave that resulted in over 700 deaths, most of the dead were elderly, inner-city poor, a group at increased risk of death due to heat stress. Climate projections suggest that the likelihood of a 1995-type heat wave will increase substantially over this century, with Chicago experiencing such heat waves three times per year under a high emissions scenario and every other year in a low emissions scenario (see *Midwest* region)[17].



The average number of hours per summer day in Phoenix that the Heat Index was over 100°F has doubled over the past 50 years. Hot days take a toll: Arizona's heat-related deaths are 13 times the national average[15].

More frequent heavy downpours and floods in urban areas will cause greater property damage, a heavier burden on emergency management, increased clean-up and rebuilding costs, and a growing financial toll on businesses and home owners. The Midwest floods of 2008 provide a recent vivid example of such tolls. Heavy downpours and floods can also overwhelm sewer and storm water systems. Typically, these systems have been engineered based on past frequency and intensity of rainfall, which are now increasing.

Coastal cities are at risk due to sea-level rise, storm surges, and increased hurricane intensity. Since most large U.S. cities are on coasts, rivers, or both, climate change will lead to increased flood potential. Cities such as New Orleans, Miami, and New York are particularly at risk, and would have difficulty coping with the sea-level rise projected under a high emissions scenario. The largest impacts are expected when sea-level rise, heavy river flows, high tides, and storms coincide[5]. Unfortunately, for many cities, current planning is based on the historical one-in-100 year event, and does not account for this same flood level occurring every 3 to 4 years as a result of the climate change projected over this century[18].

An increase in summer air conditioning use is projected to lead to a significant overall increase in electricity demand (see *Energy* sector). There is the potential for increased summer electricity blackouts such as those that have occurred in New York City and St. Louis. In southern California's cities, additional summer electricity demand will intensify conflicts between hydropower and flood-control objectives[18]. Unreliable electric power, as in minority neighborhoods during New York City's 1999 heatwave, can amplify concerns about health and environmental justice.

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Infrastructure designed to handle past variations in climate can instill a false confidence in its ability to handle future changes. Urban economies and infrastructure are likely to be affected by climate change in unforeseen ways, such as through rising expenses to city health systems to cope with increased summer hospital admissions due to excessive heat and poor air quality, and diversion of city funds from capital projects and social programs to cope with necessary emergency responses to extreme weather. Increased costs of repairs and maintenance are projected for transportation systems including roads, railways, and airports as they are negatively affected by heavy downpours and extreme heat (see *Transportation* sector). An increase in urban crime is associated with higher temperatures, thus requiring additional police presence.

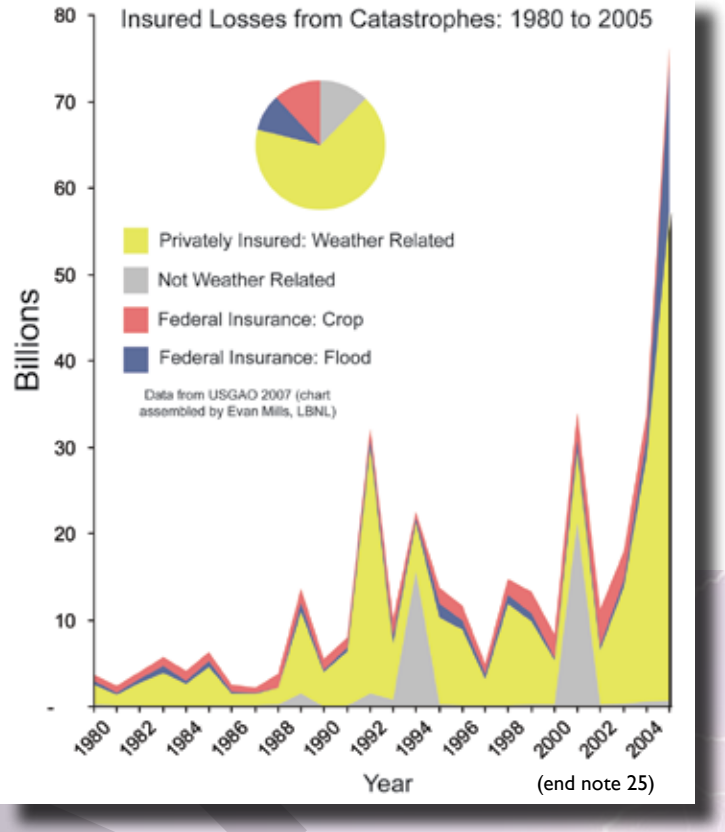
Adaptation Strategies

Cities concentrate the human activities that are largely responsible for heat-trapping emissions. The demands of urban residents are also associated with a much larger footprint on areas far removed from these population centers[19]. Cities thus have a large role to play in reducing heat-trapping emissions, and many are pursuing such actions. For example, over 700 cities have committed to the U.S. Mayors' Climate Protection Agreement to advance emissions reduction goals.

Urban areas also have considerable potential to adapt to climate change through technological, institutional, and behavioral changes. For example, a number of cities have programs in place to reduce heat-related illness and death (see *Human Health* sector). Choosing road materials that can handle higher temperatures is an adaptation option (see *Transportation* sector). The urban heat island effect compounds the effect of temperature increases due to global warming. Cities can reduce the heat load through reflective surfaces and green spaces. Some actions have multiple benefits. For example, increased planting of trees and other vegetation in cities has been shown to be associated with a reduction in crime[20], in addition to reducing local temperatures.

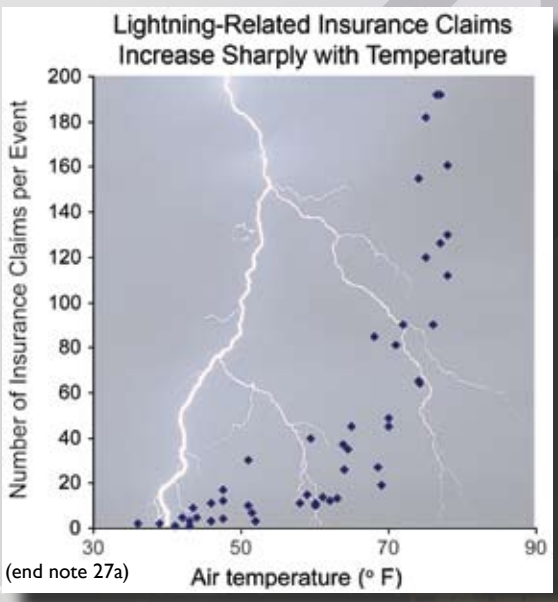
The insurance industry is particularly vulnerable to increasing extreme weather events, but can also help society manage the risks.

Most of the climate-change impacts described in this report have economic dimensions. A significant portion of these are channeled through the insurance sector, which serves as a risk-aggregating and risk-spreading vehicle for society and a window onto the myriad ways in which the costs of climate change will manifest. Government insurance programs for crops and flood absorb an additional layer of the overall risk.



Insurance provides peace of mind and financial security for many Americans. The highly weather-sensitive insurance industry (the world's largest at $4 trillion in yearly revenues as of 2006, about a quarter of which is from the United States) has been described as a lightning rod for the impacts of extreme weather events, serving as an integrator of impacts across all sectors of the economy and a messenger of these impacts through the terms and price signals it sends its customers[21]. Insurers provide comprehensive data on the costs of extreme weather events[22]. In an average year, about 90 percent of insured catastrophe losses worldwide are weather-related and the magnitude of these losses is growing. About half of all economic losses in the United States are insured; these are shown on the accompanying chart. Data on smaller-scale losses (many of which are weather-related) are significant but not included here[23].

Insurers also embody the increasing globalization of climate risks. Because large American companies operate around the world, they are exposed to climate impacts wherever they occur. In turn, most of the growth in the insurance industry is in emerging markets, which will increase U.S. insurers' exposure to risk.



It is a challenge to design insurance systems that properly price risks, reward loss-prevention, and do not inadvertently foster risk-taking (for example by repeatedly rebuilding flooded homes). Properly addressing these issues can correct market failures that have contributed to society's vulnerability to climate change. Yet, rising losses[24] are affecting the availability and affordability of insurance. Several million customers in the United States who can no longer find coverage in the private market have had to take refuge in state-mandated insurance pools, or go without insurance altogether.

While unwelcome, these insurer responses should come as no surprise to the extent that insurers are experiencing rising financial risks and communicating those to the rest of society through dramatic increases in prices, higher deductibles, and more exclusions. Private and federal insurers paid more than $320 billion in claims on weather-related losses in the United States from 1980 through 2005[25].

While major events like hurricanes grab headlines, the aggregate effect of smaller events including power outages, lightning strikes, and wildfires, account for 60 percent of total insured losses on average[21]. In the case of lightning, there is a strong correlation between higher temperatures and the severity of losses.[25??]

Weather-related losses are increasing much faster than population, inflation, and insurance penetration[27]. Damages from U.S. storms grew 60-fold to $6 billion a year between the 1950s and the 1990s[28] and there has been a seven percent annual increase in flood losses (corrected for inflation) since 1970[29]. These observations reinforce a recurring theme in this report: we can no longer use the past as the basis for planning for the future.

Virtually all segments of the insurance industry are vulnerable to the impacts of climate change: damage to onshore and offshore property and transportation infrastructure, crops and livestock, business and supply-chain interruptions, equipment breakdown, data loss, environmental liability, life, and health insurance. Risks to insurers and their customers include reduced periods of time between loss events, changing types and location of events, damages that increase exponentially with weather intensity, abrupt nonlinear changes, widespread simultaneous losses, and more events with multiple consequences. For example, the European heat wave of 2003 caused simultaneous impacts including enormous human death tolls and illness, wildfires, massive crop losses, and the curtailment of electric power plants and associated business interruptions due to high water temperatures or the lack of cooling water[31].

Insurers are also exposed to liability losses through legal claims from parties seeking compensation for the costs of climate change-related damages[32]. The assets that insurers' need to tap when paying losses (approximately $18 trillion worldwide) are also vulnerable to catastrophic losses.

Federal insurance exposures have grown substantially. For example, since 1980, the National Flood Insurance Program's exposure has quadrupled, nearing $1 trillion. Such escalating exposures to catastrophic weather events, coupled with private insurers' withdrawal from various markets are leaving the federal government at increased financial risk. For example, if the widespread Midwest floods of 1993 were to occur today, losses would be five times greater[33]. Following more than 250,000 flood claims in 2005 related to Hurricanes Katrina, Rita and Wilma, the National Flood Insurance Program would have gone bankrupt without being given the ability to borrow about $20 billion from the United States Treasury[34].

Insurers are emerging as partners in the scientific enterprise and the formulation of public policy and adaptation strategies[35]. Some have promoted adaptation by providing premium incentives for customers who fortify their properties, engaged in the process of determining building codes and land-use plans, and participated in the development and financing of new technologies and practices. Some insurers have also recognized that mitigation (emissions reduction) and adaptation can work hand in hand in a coordinated climate risk-management strategy[36,37].