# WEST

The West has a variable climate,diverse topography and ecosystems,an increasing human population,and a rapidly growing and changing economy. Western landscapes range from the coastal areas of California to the deserts of the Southwest to the alpine meadows of the Rocky and Sierra Nevada Mountains. Since 1950,the region's population has quadrupled,with most people now living in urban areas. Thus,once predominantly rural states are now among the most urban in the country. The economy of the West has been transformed from one dominated by agriculture and resource extraction to one dominated by government,manufacturing,and services. National parks attract tourists from around the world. The region has a slightly greater share of its economy in sectors that are sensitive to climate than the nation as a whole; these include agriculture,mining,construction,and tourism,which currently represent one-eighth of the region's economy.

As a result of population growth and development,the region faces multiple stresses. Among these are air quality problems,urbanization,and wildfires. Perhaps the greatest challenge,however, is water, which is typically consumed far from where it originates. Competition for water among agricultural,urban, power consumption, recreational,environmental,and other uses is intense,with water supplies already oversubscribed in many areas.

## KEY ISSUES

- **Changes in Water Resources**
- **Changes in Natural Ecosystems**
- **Effects on Agriculture and Ranching**
- **Shifts in Tourism and Recreation**

## Observed Climate Trends

The climate of the West varies strongly across the region and over time. Historically, the region has experienced exceptionally wet and dry periods. During the 20th century, temperatures in the West have risen 2-5ºF (1-3ºC). The region has generally had increases in precipitation,with increases in some areas greater than 50%. However, a few areas,such as Arizona,have become drier and experienced more droughts. The length of the snow season decreased by 16 days from 1951 to 1996 in California and Nevada. Extreme precipitation events have increased.

*The Hadley and Canadian models suggest increased precipitation during winter, especially over California, where runoff is projected to double by the 2090s.*

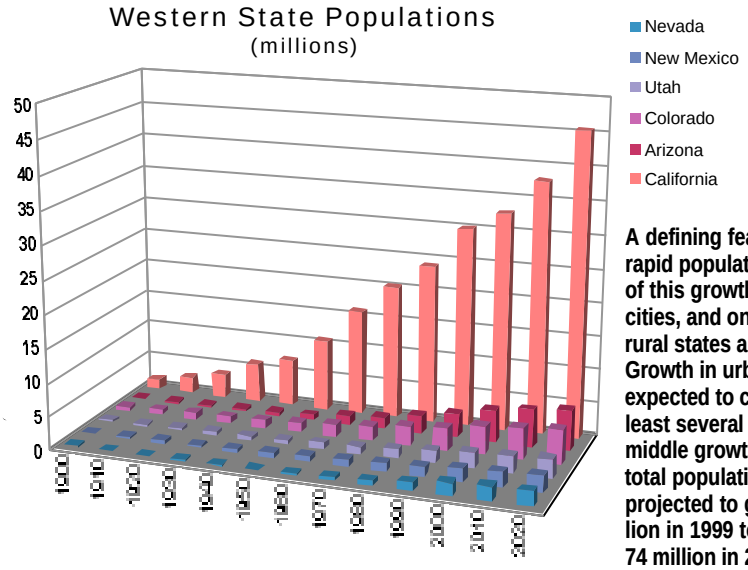
## The Oakland Fire and Response

Climate change is likely to increase fire frequency in the West. However, as shown by the response to the Oakland fire, there is substantial potential to reduce the risk of urban fires. On October 20, 1991, a small brush fire started in the hills above Oakland, California. Fire-conducive conditions, including high winds, unseasonably high temperatures, large stores of fuel in the form of dead plant parts, housing developments with dense and flamable vegetation, and low humidity, enabled the fire to spread rapidly. Before the fire was brought under control, it covered 1,600 acres, killed 25 people, consumed 3,229 structures and damaged another 2,992, and caused an estimated $2 billion in damage.

In response to this and other recent severe wildfires, the State developed the California Fire Plan to address pre-fire management prescriptions and improved response capabilities. Fire-prevention methods include fire-resistant construction standards for roofing and other materials, changes in zoning, and hazard reduction near structures such as vegetation clearing and management. Improved response capabilities

## Scenarios of Future Climate

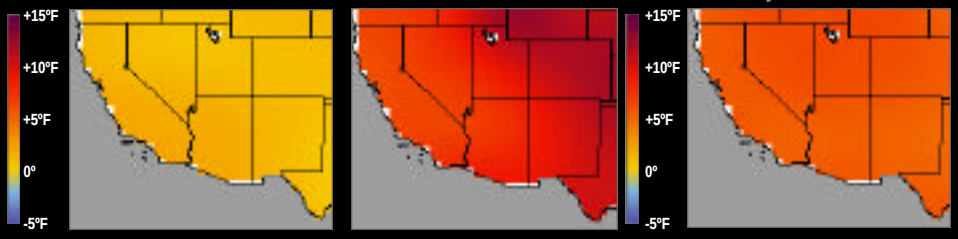
The two models used in this Assessment project annual average temperature increases from 3 to over 4ºF (2ºC) by the 2030s and 8-11ºF (4.5-6ºC) by the 2090s. The models project increased precipitation during winter, especially over California, where runoff is projected to double by the 2090s. In these climate scenarios, some areas of the Rocky Mountains are projected to get drier. Both models project more extreme wet and dry years. Due to uncertainties about regional precipitation, the possibility of a drier climate was also considered.




**A defining feature of the West is rapid population growth. Much of this growth has occurred in cities, and once predominantly rural states are now urbanized. Growth in urban areas is expected to continue for at least several decades. In the middle growth scenario the total population of the West is projected to grow from 48 million in 1999 to between 60 and 74 million in 2025.**

### Temperature Change - 20th & 21st Centuries

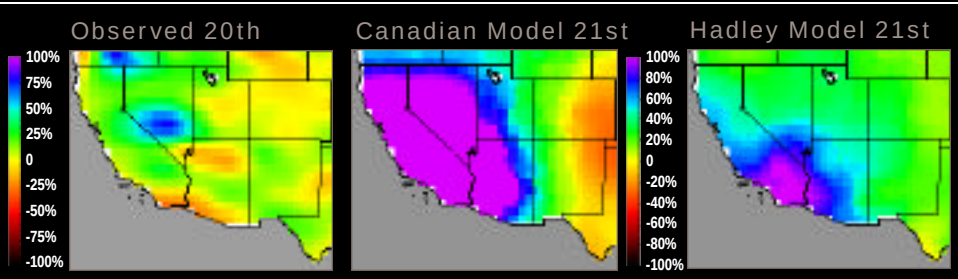
**The west has warmed by about 2-5ºF over the 20th century.**




**Temperatures in the West are projected to rise substantially in both models. The Canadian scenario projects increases of 8-11ºF for Colorado, New Mexico, and Utah, while California is projected to warm by about 5ºF by both models.**

### Precipitation Change - 20th & 21st Centuries

**Much of the west has had increases of precipitation, but with some decreases in Arizona and the Central Rockies.**




**Both models project substantially increased rainfall, especially in California, Nevada, and Arizona.**

include better neighborhood access for firefighting equipment and adequate nearby water supplies. In addition, very high fire hazard severity zones were identified. The State requires construction ordinances for structures in these zones, including roof specifications and a minimum vegetation clearance around structures. Much of the area burned in the Oakland Hills fire has since been rebuilt according to these standards.

Studies have found that fire protection programs that included prevention elements reduced the losses from wildfires by anywhere from 50 to 80%. Results indicate that prevention strategies can aid in fuels management, control fire behavior, reduce the physical impact of fire on natural resources, improve forest health, and reduce the cost and losses due to wildfires.

# WEST KEY ISSUES

## Changes in Water Resources

The West's water resources are sensitive to climate change. The semiarid West is dependent upon a vast system of engineered water storage and transport,such as along the Colorado River, and is governed by complex water rights laws. Much of the water supply comes from snowmelt,and higher temperatures will very likely reduce the snowpack and alter the amount and timing of peak flows. In some places,it is likely that current reservoir systems will be inadequate to control earlier spring runoff and maintain supplies for the summer, but more research is necessary to identify which systems are most vulnerable.It is also possible that demand will increase.

In a wetter climate,the potential for flooding will increase when precipitation comes in more intense events or where total precipitation increases substantially. It is possible that more precipitation would also create additional water supplies, reduce demand, and ease competition among competing uses.Greater runoff would likely increase hydropower production and ease some water quality problems, although it is also possible that there would be more non-point source pollution.

In contrast,a drier climate is likely to decrease supplies and increase demand for such uses as agriculture, urban needs,and power production, thus making water supplies much tighter. Native Americans,among others,are exercising their rights to water, and may do so to a greater extent,further tightening supplies.

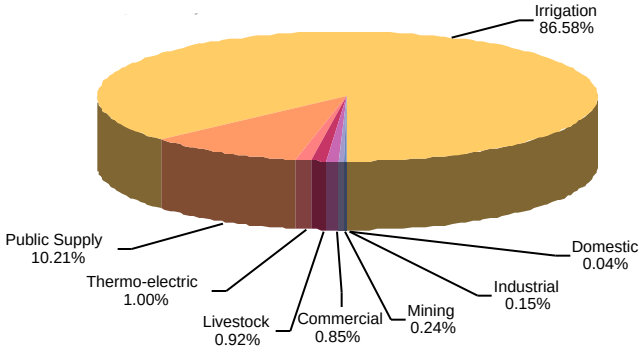
Adaptations: Improved technology, planting of less water-demanding crops,pricing water at replacement cost,and other conservation efforts can help reduce demand. Flexibility to transfer water across basins and water users,and to integrate the use of surface and groundwater, can also serve as adaptation strategies for water managers under conditions of scarcity. Environmental and cost constraints will be an important consideration in building additional flood control or storage facilities.

## Changes in Natural Ecosystems

Under the Hadley and Canadian scenarios, vegetation models suggest an increase in plant growth, a reduction in desert areas,and a shift toward more woodlands and forests in many parts of the West. However, a less positive $CO_2$ fertilization effect than assumed in the models,increase in fires,and persistence of other stresses such as air pollution,are important sources of uncertainty. It is possible that continued increases in temperature and leveling off of the $CO_2$ fertilization effect would result in an eventual decline in forest productivity. A drier climate would also likely reduce forest productivity.

The diverse topography coupled with landscape fragmentation and other development pressures in the West will likely make it difficult for many species to adapt to climate change by migrating. It is likely that some ecosystems,such as alpine ecosystems,will disappear entirely from some places in the region.On the other hand it is possible that mountains may enable some species to adapt by permitting their migration to higher elevations.

### Relative Consumptive Water Use in the West

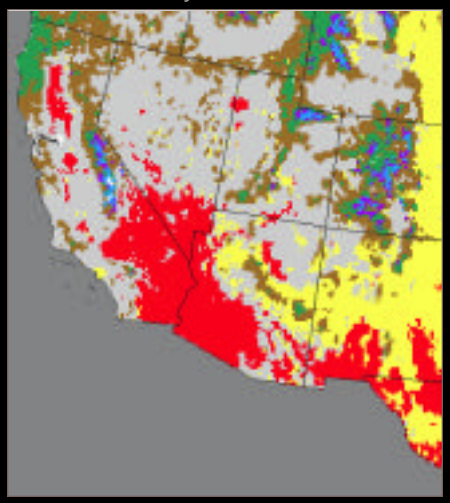



**In 1995, 87% of the water used in the West was for irrigation. However, water use for irrigation has declined slightly since 1980, while municipal uses have grown.**

### Ecosystem Models

**Climate change is projected to cause major changes in vegetation distribution during the 21st century. Overall, the model scenarios project increases in grasslands, woodlands, and forests in the West, and a loss of desert vegetation. The far left map shows potential vegetation types in the West (the vegetation that would naturally flourish in the absence of human activity given today's climate), while the two maps on the right show model-projected scenarios for future vegetation shifts in the face of climate change.**

Current Ecosystems



Non-native invasive species have already stressed many Western ecosystems and are likely to make adaptation to climate change much more difficult for native species. Climate change is also likely to increase fire frequency. As long as year-to-year variation in precipitation remains high, fire risk is likely to increase whether the region gets wetter or drier. This is because fuel loads tend to increase in wet years as a result of increased plant productivity and are consumed by fire in dry years. In addition, rising sea levels will threaten many coastal wetlands, such as those in the San Francisco Bay area,and the diversity of species they support.

Adaptations: Devising strategies to reduce negative climate change impacts on natural ecosystems and biodiversity is particularly challenging. Improved management of urban development can help reduce habitat fragmentation. The creation of migration corridors to help some species migrate to more suitable locations has been suggested,but its effectiveness is not known. Controlled burns and restricting building in fire prone areas are among the strategies for reducing fire risks.

## Effects on Agriculture and Ranching

Higher $CO_2$ concentrations and increased precipitation are likely to increase crop yields and decrease water demands,while milder winter temperatures are likely to lengthen the growing season and result in a northward shift in cropping areas.

There is the possibility that higher temperatures will also negatively affect crops by increasing heat stress, weeds,pests,and pathogens. There is a possibility that increased flooding will reduce crop production.

Fruit and nut crops,which come from perennial plants,are 32% of the value of the West's crop production, with a third of that from grapes.Since fruit and nut plants can take decades to get established, relocating such crops as an adaptive response to climate change is very likely to be more difficult than relocating annual crops.

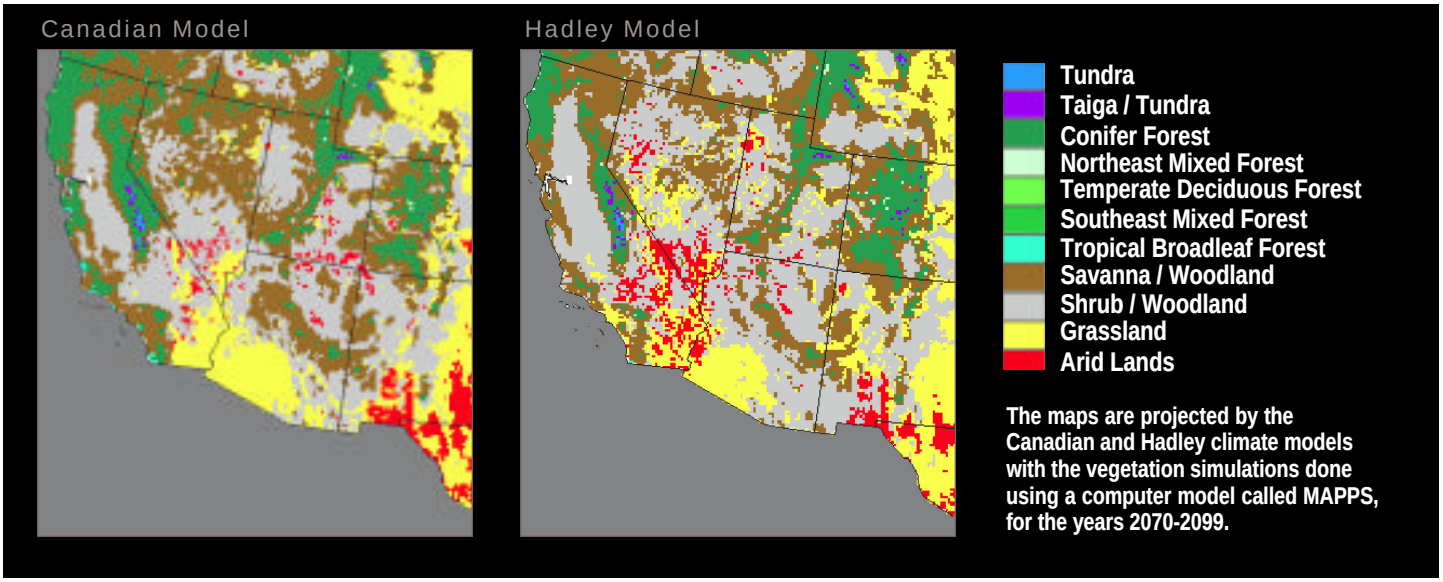
In the ranching industry, there is a possibility that higher temperatures and increased precipitation will increase forage production and lengthen the growing and grazing season.There is also a possibility that flooding and increased incidence of animal disease will adversely affect ranching.

Adaptations: Increasing crop diversity can improve the likelihood that some crops will fare well under variable conditions,while switching to less water-demanding crops and improving irrigation efficiency would conserve water. Improved weather forecasting could aid farmers in selecting crops,timing planting and harvesting,and increasing irrigation efficiency, and aid ranchers in timing cattle sales and breeding,and in improving range management.

## Shifts in Tourism and Recreation

Tourism,a growing component of the Western economy, is strongly oriented to the outdoors and sensitive to climate. Higher temperatures are likely to mean a longer season for summer activities such as backpacking,but a shorter season for winter activities,such as skiing. Ski areas at low elevations will be at risk from a shortening of the snow season and rising snowlines. There is a possibility that increases in precipitation will provide more water for sports,but some chance that there will be less water available for summer recreation and that recreation days will be limited by heat. Changes in the distribution and abundance of vegetation, fish,and wildlife will also affect recreation.

Adaptations: Strategies for tourism and recreation involve diversification of income sources. The larger, better-capitalized resorts have adapted their facilities to support winter and summer activities. These options,however, might not be available to smaller, less well-capitalized resorts.




The maps are projected by the Canadian and Hadley climate models with the vegetation simulations done using a computer model called MAPPS, for the years 2070-2099.