

Future Climate, Hydrology, Vegetation, and Wildfire Projections for the Southern Sierra Nevada, California

A climate change science synthesis in support of Integrated Regional Water Management Planning

May 2014



EXECUTIVE SUMMARY

Broad scale changes in climate are already impacting local conditions across the West and are likely to continue and accelerate in the coming decades. Changes include the timing and availability of water, changes in tree and wildlife species, and changes in wildfire frequency and intensity.

Local communities will need to plan for such changes in order to continue to provide vital services to local residents and to support the economy. Integrating climate change science into water management planning is one step towards preparing people for climate change.

In support of Integrated Regional Water Management Planning for the Southern Sierra, we compiled climate change projections based on two global climate models, downscaled to reflect local conditions. We assumed the A2 “business-as-usual” emissions scenario. If emissions are reduced,

mid-century projections may be stabilized. If emissions continue unabated, late-century projections become highly likely.

In this report, we provide a review of historic and future expected trends in temperature, precipitation, snowpack, water deficit, runoff, vegetation, wildfire, and carbon storage in vegetation.

Overall, managers in the Southern Sierra can expect warmer temperatures, declining snowpack, a dramatic shift in timing for runoff, and shifts in major types of vegetation. With less certainty, changes in precipitation and wildfire patterns are also likely.

PROJECTIONS

Temperature – Average annual temperature in the Southern Sierra is expected to rise about 2° C (4° F) by mid-century and 3-4° C (5-7° F) by

late century. Summer temperatures are expected to rise slightly more (4-6° C; 7-13° F) than winter temperatures (3-4° C; 5-7° F) by the end of the century.

Precipitation – Precipitation projections were more variable than temperature projections, with both increases and decreases in precipitation possible throughout the year. Even with increases, however, drier conditions are expected due to greater evaporation and evapotranspiration.

Runoff – The hydrograph for runoff is expected to change dramatically, with greater runoff Jan-April, as precipitation increasingly falls as rain instead of snow, and lower runoff May-September. Variation between the two models resulted in uncertainty in projections, with annual average precipitation that may increase, decrease, or remain similar to historic levels.

Snowpack – Snowpack is expected to decline, on average, by about 75% by mid-century and 85% by late century. Both climate models showed high agreement on snowpack declines.

Climate water deficit – Climate water deficit is expected to increase by about 20% by mid-century and 40-50% by late century as increased temperatures, shifts from snow to rain, and higher evaporation lead to overall drier conditions across the Southern Sierra Nevada.

Vegetation – High elevation alpine zones are expected to become suitable

for subalpine vegetation over the next century. As subalpine shifts to higher elevations, an expansion of temperate evergreen needleleaf forest is expected. Temperate grasslands at lower elevations could convert to subtropical grasslands and shrublands over time. A time lag between changes in climate and changes in vegetation is highly likely and not included in the model projections, making vegetation projections highly uncertain.

Wildfire – When compared to the historic period (1961-1990), biomass consumed by wildfire is expected to double or triple by mid-century and triple or quadruple by late century. The area burned, however, is only expected to increase 20-65% by late century. A time lag between changes in climate and changes in vegetation is highly likely and not included in the model projections, making wildfire projections highly uncertain.

Carbon storage in vegetation – The two models showed, overall, increasing carbon storage in vegetation across the Southern Sierra. By late century, however, declines in carbon storage are possible, as are increases.



VULNERABILITIES

This climate science assessment provides information on potential climate change vulnerabilities for water-related resources of the Southern Sierra Nevada. Overall, the timing of water availability for storage and human consumption is highly vulnerable due to the projected seasonal changes in runoff. In addition, water quality is highly vulnerable based on the greater potential for drought, severe storms, wildfire, and lower late summer flows.

ADAPTATION STRATEGIES

Strategies that reduce the impacts of climate change by addressing specific goals and vulnerabilities will allow continued functioning of natural systems while also providing water resources for human populations. One of the primary impacts of climate change will be its exacerbating influence on existing stressors, which occur primarily through land management practices. As climate change progresses, reducing existing stressors will become increasingly necessary for retaining many of the services provided by functioning watersheds.

Some common adaptation strategies for reducing the vulnerabilities associated with water resources and watershed function include:

- Reduce water demand through conservation measures for residential and agricultural use
- Reduce water demand by changing the types of crops grown in the region
- Increase late summer flow through wetland and meadow restoration at higher elevations
- Increase water storage and flood abatement potential through watershed restoration activities, including, where appropriate, beaver reintroduction
- Reconnect floodplains
- Maintain water quality by reducing activities that lead to soils compaction and erosion, such as overgrazing, timber harvest, and roads
- Diversify local economy to become more resilient in the face of drought and water insecurity

