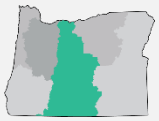

REGION 4

Observed & Projected Climate Changes

Air & Water Temperature

Observed	
Annual Air	• Mean annual temperature in south-central Oregon has increased by 0.05°C (0.09°F) per decade between 1895-2012.
Extreme Heat	• Increasing number of days >90°F (32°C) (e.g., 65 days/yr in 2021-2022 compared with 39.4 days/yr from 1951-2020 in The Dalles). • Increasing number of extremely warm nights (i.e., ≥65°F/18°C).
Streams	• August stream temperatures averaged 14.4°C (58°F) and ranged from 3.5°C (38.3°F) to 27.5°C (81.5°F) (1970-1999).
Projected by 2100	
Annual Air	• Mean annual temperature is projected to increase by 4.6-4.7°C (8.3-8.5°F).
Seasonal Air	• Warming is projected in all seasons, with the most warming in summer.

Extreme Heat	• Longer, more frequent, and more intense extreme heat events.
	• Increase in the annual number of days ≥90°F (32°C) by mid-century (+10 to +24 days) compared to 1971-2000.
	  ○ Bend: 12 days in 2020s; 26 days by 2050s.
	• Increased frequency and magnitude of days with an extreme heat index (temperature + humidity
	  ○ +22 to +36 days with a heat index of ≥90°F (32°C) relative to 1971-2000.

Streams	• Summer temperatures are projected to increase by an average of 1.3°C (2.3°F) in the 2040s and 2.2°C (4°F) in the 2080s. • Larger than average increases are projected to occur in the warmest streams at low elevations; smaller than average increases are projected for the coldest streams.

Precipitation & Drought

Observed	
Annual	• Annual precipitation has not changed since 1895, and interannual variability in precipitation is high.
Snowpack	• Annual peak SWE (snow-water equivalent; a measure of snow depth) has decreased significantly since 1980, with a concomitant increase in rain-on-snow events throughout the Cascades. • No significant decrease in April 1 SWE since 1980; Cascade Range snowpack during the past 40 years has been stable despite recent regional warming. • Snowmelt season is occurring 1-3 weeks earlier across the western US. • In the low-elevation eastern portions of the region, snow is already absent or ephemeral.
Drought	• Persistent and severe droughts have occurred in Oregon since 2000.
Projected by 2100	
Annual	• Models project minimal increase in precipitation (~6%) or no significant change.
Seasonal	• Models project an increase in seasonal amplitude of precipitation, with more precipitation in winter (Dec-Mar) and less during the growing season (Apr-Oct).

Extreme Precipitation	• Increase in frequency and intensity of floods due to stronger storms and a shift from snow to rain. • Increased intensity of atmospheric rivers and possible penetration further inland.
Snowpack	• In the low-elevation eastern portions of the region, warming temperatures will change average snow residence times (i.e., duration of snow) to a small degree, as snow is already absent or ephemeral. • At higher elevations in the southwestern portion of the region, the average residence time of snow projected to decline on the order of 3 to 4 weeks. • At higher elevations (i.e., crest and peaks of the Cascades) in the northwestern portion of the region, the average residence time of snow projected to decline on the order of 8 to 10 weeks. • At lower elevations (<2000 m/6500 ft) in the Oregon Cascades, snow residence time is expected to decrease by 7-8 weeks, with minimal snow remaining by April 1 at many sites. • Three to 4 times as much SWE loss in the Cascades as farther east in the region. • Annual mean snowfall in Deschutes County projected to decline from 7.4 ft (2.3 m) in 1981-2010 to 5.4 ft (1.6 m) in 2025-2049.
Drought	• Increased severity and duration of droughts. • Increased annual number of dry days in Bend: 186 in 1990s; 192 by 2050. • Under a high-emissions scenario, climatic water deficit (CWD; a measure of drought stress) is projected to double at most elevations.

Hydrology

Observed

Streamflows	• Spring, early summer, and late summer flows have been decreasing, and more annual flow has been occurring earlier in the water year.

Projected by 2100

Streamflows	• Small decreases in low flows are expected in areas where snow is not a large contributor to streamflow. • The largest reductions in summer streamflows are projected for the eastern slopes of the High Cascades, where earlier snowmelt timing will potentially result in summer streamflow losses of 40-60% by 2040 and 60-80% by 2080. • Reduced summer streamflow is also projected in the uplands of the Fremont-Winema National Forest, with projected reductions of 20-30% by the 2040s and 40-50% by the 2080s. • Summer streamflow is more likely to decrease 10-20% over the next 50 years in the Ochoco Mountains and Crooked River National Grassland. • Common floods are expected to increase in magnitude and extreme hydrologic events (e.g., those currently rated as having 100-year recurrence intervals) may become more frequent. • The eastern slopes of the Cascades are projected to have peak-flow increases of 20-40% by mid-century, with progressively more areas showing increased peak flows by 2080. • By 2080, other areas, including Fremont-Winema and Ochoco National Forests are projected to have increased peak flows of 20-30%. • Runoff timing is projected to occur 8-18 days earlier in the year relative to the 1980s baseline period. • Slight increase in the number of winter high-flow days (1-4 days). • Lake Abert, Middle Deschutes, Sprague, Summer Lake, Upper Crooked, and Upper Klamath Lake subbasins will likely experience substantial changes in bankfull flow (>30 percent increase in magnitude) by 2080.

Disturbances

Observed

Wildfire

- Fire season has increased significantly since the 1980s.
- The intensity and severity of fires in the last 3-4 decades has increased in shrub steppe and low- to mid-elevation dry forests and woodlands.

Projected by 2100

Wildfire

- Projected temperature increases will likely extend the length of the fire season.
- Increased frequency and extent of wildfire.
- Slight increases in fire suitability in higher-elevation forests along the Cascade Crest.
- Increased number of high fire danger days in summer and fall in Bend: 11 in 2020s; 15 by 2050s.
- Large increases in the number of summer days with high fire danger in the Cascade Range and Klamath Mountains.
- Increased average size of fires on the east slope of the Cascade Range.
- Increased proportion of forests in which conditions are consistent with large wildfires (>100 acres/40 ha); largest projected increases in Klamath Mountains and eastern Cascade Range.

Insects & Pathogens

- Increased frequency and extent of insect and disease outbreaks.

Information from the following references and the citations therein:

1. Halofsky, J.E., D.L. Peterson, and R.A. Gravenmier, eds. 2022. Climate change vulnerability and adaptation in the Columbia River Gorge National Scenic Area, Mount Hood National Forest, and Willamette National Forest. Gen. Tech. Rep. PNW-GTR-1001. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. 469 p.
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3. Dalton, M. and E. Fleishman, eds. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University. 183 p.
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