Fifth Oregon Climate Assessment

Oregon Climate Change Research Institute
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Introduction

Consistent with its charge under Oregon House Bill 3543, the Oregon Climate Change Research Institute (OCCRI) conducts a biennial assessment of the state of climate change science, including biological, physical, and social science, as it relates to Oregon and the likely effects of climate change on Oregon. This fifth Oregon Climate Assessment builds on previous assessments (Dello and Mote 2010; Dalton et al. 2013, 2017; Mote et al. 2019) by continuing to evaluate past and projected future changes in Oregon's climate and hydrology. This Assessment is structured with the goal of serving as a resource for the state's mitigation planning for natural hazards and implementation of the 2021 Oregon Climate Change Adaptation Framework.

The first section of this Assessment, *State of Climate Science*, reflects OCCRI's sustained appraisal of observed trends and future projections of temperature, precipitation, snowpack, and streamflow. New research and insights are consistent with previous key messages about projected changes in Oregon's climate, such as warmer temperatures, drier summers, wetter winters, heavier rains, less snowpack, and associated shifts in the timing and discharge of streamflow. *State of Climate Science* also summarizes the latest research related to simulations of future climate, including preliminary insights on the newest generation of global climate models, subseasonal to seasonal climate prediction, and attribution of extreme events.

The dependence of human communities on their surrounding natural, economic, and social environment is magnified by climate extremes and associated hazards (Guidotti et al. 2016, Martinez-Diaz et al. 2020). The second section of this Oregon Climate Assessment explores how climate change is expected to affect climate-related natural hazards, including extreme heat, drought, wildfire, floods, and coastal hazards, in support of Oregon's 2020 Natural Hazards Mitigation Plan. Furthermore, this Oregon Climate Assessment examines recent observed and projected changes in the physical and biological environment of marine and coastal systems in Oregon and the Northwest. Implicit in the Assessment's treatment of hazards is the fact that disasters may result either from single, major events or from recurrent events that individually are not extreme, but degrade a community's social and economic infrastructure (Field et al. 2012).

The third section of this Assessment addresses six sectors within which Oregon's 2021 Climate Change Adaptation Framework aggregates vulnerabilities and strategic responses: economy, natural world, built environment and infrastructure, public health, cultural heritage, and social systems. The Framework aims to guide state decisions about investment of resources as climate changes and to facilitate collaboration among state agencies. This Assessment dedicates a chapter each to five of the sectors. These chapters describe the latest research in climate science and climate adaptation that is relevant to the sector in Oregon. Economic aspects of climate change are integrated throughout chapters on other sectors rather than treated independently. The economic risks of gradual changes in climate and extreme climate-related events vary among regions. Additionally, given the distinct impacts of climate change on Tribal cultures, identities, histories, relations with other governments, and land-holding status, this Assessment emphasizes Tribal cultural heritage.

Both the Climate Change Adaptation Framework and this Assessment recognize that the myriad interactions and feedbacks among natural and human systems are complex and can be difficult to differentiate. Evidence from Oregon's natural hazards mitigation planning process, the climate science literature, and a sustained assessment process can help indicate the extent to which natural hazards may affect adaptation sectors, and inform selection of actions to maximize resilience.
Established and emerging understanding of observed and projected climate change in Oregon, and knowledge of the opportunities and risks that climate change poses to natural and human systems, may serve as a resource for actions including but not limited to planning for mitigation of climate-related natural hazards and implementation of Oregon's 2021 Climate Change Adaptation Framework.

**State of Climate Science**

**Temperature.** Oregon's annual average temperature increased by about 2.2°F per century since 1895. If greenhouse gas emissions continue at current levels, temperature in Oregon is projected to increase on average by 5°F by the 2050s and 8.2°F by the 2080s, with the greatest seasonal increases in summer.

**Precipitation.** Precipitation is projected to increase during winter and decrease during summer. The number and intensity of heavy precipitation events, particularly in winter, is projected to increase throughout the twenty-first century. Furthermore, as temperatures warm, the proportion of precipitation falling as rain rather than snow in Oregon is projected to increase, especially at lower to intermediate elevations in the Cascade Range.

**Snowpack and runoff.** Snowpack throughout Oregon, especially on the west slope of the Cascade Range, is accumulating more slowly, reaching lower peak values, and melting earlier. These trends are likely to continue, and may accelerate, as temperature increases. Concomitantly, runoff is expected to begin and peak earlier in the year, decline in summer, and increase in winter, but will vary geographically.

**Science advances.** In addition to simulations of future climate from the newest generation of global climate models, advances in climate science have improved the accuracy of climate forecasts one week to one month into the future. Also, it is becoming more feasible to estimate the extent to which human-caused climate change affects the likelihood of some types of extreme weather events.

**Climate-Related Natural Hazards**

**Extreme heat.** The frequency and magnitude of days that are warmer than 90°F is increasing across Oregon. During summer, relative increases in nighttime minimum temperatures have been greater than those in daytime maximum temperatures. The frequency, duration, and intensity of extreme heat events is expected to increase throughout the state during the twenty-first century.

**Drought.** Over the past 20 years, the incidence, extent, and severity of drought in the Northwest increased. These changes partially are attributable to human-caused climate change. As summers in Oregon continue to become warmer and drier, and mountain snowpack decreases, the frequency of droughts, particularly snow droughts such as those in 2014 and 2015, is likely to increase.

**Wildfire.** Wildfire dynamics are affected by climate change, past and contemporary land management and human activity, and expansion of non-native invasive grasses. From 1984 through 2018, annual area burned in Oregon increased considerably. Over the next 50 to 100 years, area burned and fire frequency are projected to increase substantially, initially east of the crest of the Cascade Range and then in the western Cascade Range. Over the long term, depending on how vegetation and fire weather shift with climatic changes and fuel and fire management, fire severity also may increase.

**Floods.** Flood magnitudes in Oregon are likely to increase. Heavy precipitation events are expected to become more intense because a warmer atmosphere can carry more moisture. Also, in a warmer climate, the relatively contribution to floods of rainfall will be greater than that of snowmelt. The consequence is larger flood peaks because, for a given amount of precipitation, the peaks of rainfall-driven floods tend to be larger than those of snowmelt-driven floods. Projected increases in wet-season precipitation also are likely to increase winter flood magnitude. Increases in regulated flows from the main stem of the Columbia River during winter appear likely to increase flood risk throughout the Columbia River reservoir system.

**Coastal hazards.** Sea-level rise, storminess, sediment supply, and human adaptation measures influence whether a given stretch of Oregon's coastline has eroded or built up in recent decades. Therefore,
predicting future shoreline change is challenging. As sea level rises, coastal storms and high tides are likely to increase the frequency and severity of flooding along Oregon's coastline. By the year 2050, relative sea level at Newport is very likely to rise between 0.6 and 1.8 feet, and at least one flood is likely to exceed four feet above mean high tide. Accounting for plausible, yet uncertain, estimates of Antarctic ice sheet melt suggests that sea level could rise 2.9 feet by the year 2050, with regular nuisance flooding occurring earlier.

**Marine and coastal change.** Off the Northwest coast, the open-ocean surface temperature increased by more than 1.2 ± 0.5°F since the year 1900, and is projected to increase by about another 5.0 ± 1.1°F by the year 2080. These changes in temperature have the potential to affect many other drivers of ocean change, such as by accelerating the rate of reduction in dissolved oxygen in the water and increasing the toxicity of harmful algal blooms. Ocean acidity also is projected to change by roughly 100–150%, resulting in a drop in open-ocean pH from 8.1 to 7.8. The change in pH is likely to affect shell formation in diverse species of commercial, recreational, and cultural value.

**Adaptation Sectors**

**Natural systems.** Climate change is affecting the timing of seasonal events in the life cycle of some plants and animals, and the viability of some species. Projected decreases in freshwater flows and connectivity are likely to decrease survival and growth of salmon. Projected increases in temperature and changes in precipitation also may have negative effects on some protected species. The ability of Oregon's species to adapt behaviorally, physically, or genetically to climate change in part depends on the speed of climate change, the level of other environmental stressors, and genetic diversity.

**Built environment.** Climate change is likely to stress Oregon's infrastructure. Projected increases in sea level and precipitation intensities are expected to strain levees, tide gates, and sewer and stormwater infrastructure. Droughts may diminish hydropower production and the effectiveness of water-supply infrastructure. Wildfires may threaten communities directly and indirectly via, for example, landslides and degraded water quality. Urban heat island effects are expected to increase summer electricity demand and risks of heat stress. Opportunities for mitigation and adaptation include wind and solar power, grid integration of electric transportation, and green infrastructure for resilience to flooding. Data-driven, science-based capital planning that engages stakeholders can help to realize these adaptations.

**Public health.** Racial and economic injustices have created disparities in health outcomes among populations in Oregon. Black, Indigenous, and People of Color; underinvested rural, Tribal, and low-income communities; the young and the old; and those with pre-existing conditions or disabilities are more likely to experience negative health effects of climate extremes. One in two households in Oregon spends 30% or more of their income on rent or a mortgage. These households are less likely to rebuild in the event of home loss or severe damage from an extreme weather event. Displacement and income loss associated with climate impacts will increase the risk of homelessness, food insecurity, and mental health effects.

**Tribal cultural resources.** Tribes may experience distinct impacts of climate change that relate to their cultures, identities, histories, relations with other governments, and land-holding status. Tribes throughout Oregon are using Traditional Knowledges to prepare for and increase their resilience to climate change. Priority topics include access to first foods, community health, changes in the distributions or status of native species, and wetland alterations. Tribal climate adaptation strategies also help to reassert treaty rights, advocate for equitable investment in civil infrastructure, and reestablish Tribal sovereignty.

**Social systems.** Social, political, and economic systems mediate the effects of climate change. The costs of adaptations to climate change in the agricultural sector likely will be passed on to consumers, exacerbating the existing challenges some communities face in obtaining affordable produce. Agricultural laborers’ incidence of heat-related illnesses and exposure to wildfire smoke are expected to increase as climate changes. In Oregon, 28% of agricultural workers are undocumented immigrants who may be unable or reluctant to seek health care.

The full Fifth Oregon Climate Assessment is available at blogs.oregonstate.edu/occri/oregon-climate-assessments/.