Climate Trends Primer:
Lane County, Oregon

May 2021

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More information about this project and a pdf of this report can be downloaded at:
http://www.climatewise.org/projects

Photos (clockwise from upper left): Willamette River in Eugene by Rick Obst, Waxcap mushrooms in Hult City Park by David Geitgey Sierralupe, and Florence Oregon by tjflex2.

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Cape Creek Bridge by Bonnie Moreland

Climate change is affecting communities and natural resources around the globe. The overall conditions that residents of Lane County experience will continue to change in coming decades. In 50 years, for example, Eugene will be similar to today's Sacramento (6.6° F hotter and 40% drier)[1]. These changes are expected to have dramatic impacts on the residents of Lane County.

TABLE OF CONTENTS

Some of the climate risks Lane County is facing include loss of snowpack and water storage, larger extreme storms and more flooding, larger wildfires, increasing incidence of heat waves, disease outbreaks, and dramatic declines of fish, wildlife, and plant species.

Like all communities, Lane County needs to be prepared for impacts and take action to protect people, property, and nature from climate-related risks. This document is intended to inform residents and decision makers in Lane County about expected changes in climate in the coming decades. The projections and trends presented in this primer are based on the latest available scientific information, with all sources listed at the end of this document.

What Climate Change Means for Lane County:

Climate Projections

- 4-7° F warmer by 2050s; 7-10° F warmer by 2080s
- 47-69% less snowfall by 2050s; 67-85% less by 2080s
- 31 more days per year over 90° F by 2050s; 58 more by 2080s
- 19-49% more drought stress by 2050s; 32-59% more by 2080s

Land, Air, and Water

- Lower water availability, especially in summer months
- Degradation of wetlands, riparian areas, and meadows
- Further declines in salmon populations
- Loss of marine life due to warmer and more acidic water
- Declining biological diversity and loss of high elevation species

Social and Economic

- Increasing risk of property loss from wildfire
- Water supplies stressed from snowpack declines, drought, and increasing demand
- Declines in timber production
- More prevalent disease affecting people and livestock
- Increasing stress to emergency response systems and personnel
- Infrastructure damage from sea level rise

Potential Benefits

- Lower demand for home energy for heating in colder months
- Longer growing season for some agricultural operations


Blue River, Oregon before Holiday Farm Fire 2020 by George Beverly Jr.


Blue River, Oregon during/after Holiday Farm Fire 2020 by George Beverly Jr.

Introduction

The marina in Florence by Michael Wyther-Jones

Climate change is affecting communities around the globe, but the impacts and opportunities for action occur locally. The speed and magnitude of change are expected to increase rapidly in coming decades, especially if greenhouse gas emissions are not reduced quickly. Local communities need to be prepared for impacts and take action to protect property, people, and the natural world. Preparing for climate change in order to reduce impacts is called climate change ***adaptation***. Reducing emissions in order to prevent the most catastrophic impacts of climate change is called climate change ***mitigation***. Both are needed.

This climate trends primer provides an overview of historic climate trends and projected future change in conditions throughout Lane County. It is intended to inform the development of a climate change vulnerability assessment and adaptation plan for the people and resources of the region.

Lane County Climate Change Snapshot[2]

HISTORICAL CHANGES

- Avg. temp. +1° F
- Precipitation –6%
- Frost free period 1 week longer
- Snowpack declines of 15-30% throughout West

MID-CENTURY (2050s) PROJECTIONS

- Avg. temp. +4-7° F
- Summer temp +5-9° F
- Precipitation –6% to +10%
- Drought stress +19 to 49%
- Frost free period +43 to +85 days longer
- Snowfall –47 to –69%
- Days over 90° F in Eugene +31 per year

LATE-CENTURY (2080s) PROJECTIONS

- Avg. temp +7-10° F
- Summer temp +7-14° F
- Precipitation –4% to +12%
- Drought stress +32 to 59%
- Frost free period +79 to +126 days longer
- Snowfall –67 to –85%
- Days over 90° F in Eugene +58 per year
- Days over 100° F in Eugene +21 per year
- Very large wildfires increase in likelihood by 281%

Climate Change Data and Models

The Earth's climate is regulated by a layer of gases commonly referred to as greenhouse gases for their role in trapping heat and keeping the earth at a livable temperature. These gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and water vapor (H_2O). CO_2 plays an especially large role due to its long residence time and relative abundance. The atmospheric concentration of CO_2 in the atmosphere has risen from 280 to over 410 parts per million (ppm) in the past century, driven largely by fossil fuel combustion, deforestation, and other human activity. CO_2 levels are about 46% higher now than prior to the industrial revolution. Information from ice cores provides us a glimpse into CO_2 levels over hundreds of thousands of years. This data shows us that CO_2 has fluctuated between about 175 and 300ppm over the last 800,000 years. The current level of 400ppm is far above anything detected in the ice core analyses. As CO_2 has fluctuated in the past, it has tracked closely with changes in temperature, and we can expect this relationship to hold in the future as CO_2 and other greenhouse gases continue to increase.

The Intergovernmental Panel on Climate Change (IPCC), which is made up of thousands of leading scientists from around the world, has compiled a suite of 22+ global climate models (GCMs) from different institutions with which to assess future trends. These models were created independently and vary substantially in their output. In addition, there are different potential "pathways" for future greenhouse gas concentrations (called Regional Concentration Pathways, or RCPs), which assume different rates of continued greenhouse gas emissions.

Downtown Eugene by Rick Obst

All models have uncertainty because complex processes are simplified, and assumptions are made about how the earth's processes work. Thus, different models show different trajectories in future climate, creating uncertainty in the projections. The uncertainty is similar to that associated with other types of models that we use every day to make decisions about the future, including economic models, population growth models, and environmental models. In the case of climate change, however, most uncertainty stems from human behavior (will we or will we not reduce emissions?) rather than the modeling process itself.

Data on future trends in this report are primarily compiled from an "ensemble" or average across many GCMs, which have been adjusted from the global scale (course scale) to local scales (fine scale) using fine scale climatological data that reflects variation across the local landscape. When ensembles are used, it is important to understand the range of variation among the different models in the ensemble, as it can be quite great. In general, precipitation projections are associated with higher uncertainty (i.e. more variation among models) while temperature projections are associated with lower uncertainty. Also, short- to medium-term projections have less uncertainty than longer-term projections.

Lane County Climate Trends

Lane County, like the rest of Oregon, has already experienced substantial warming and other climate impacts. In order to present climate change projections specifically for Lane County, this primer provides downscaled climate data from the ClimateNA portal[2]. in the form of maps and graphs. In addition, historical weather station data and snowpack modeling were downloaded from www.climatetoolbox.org.

Temperature – Lane County has warmed about 1° F compared to the baseline average (1961-90). Over the last 40 years, Lane County has warmed by about 0.2° F per decade (Fig. 1).

Lane County is projected to warm by 4-7° F by the 2050s and 7-10° F by the 2080s if emissions are not quickly and aggressively reduced at global scales. If emissions are reduced, warming could be limited to 3-5° F by the 2050s and 4-6° F by the 2080s (Fig. 2).

Summers are expected to warm more than winters in Lane County. The number of very hot days is expected to increase substantially in coming decades. For example, in Eugene the number of days above 90° F could increase by more than a month, on average, by the 2050s. By the 2080s, they could increase by more than 2 months on average. The number of days over 100° F, previously extremely rare, could occur, on average, 21 days per year (Fig. 3).

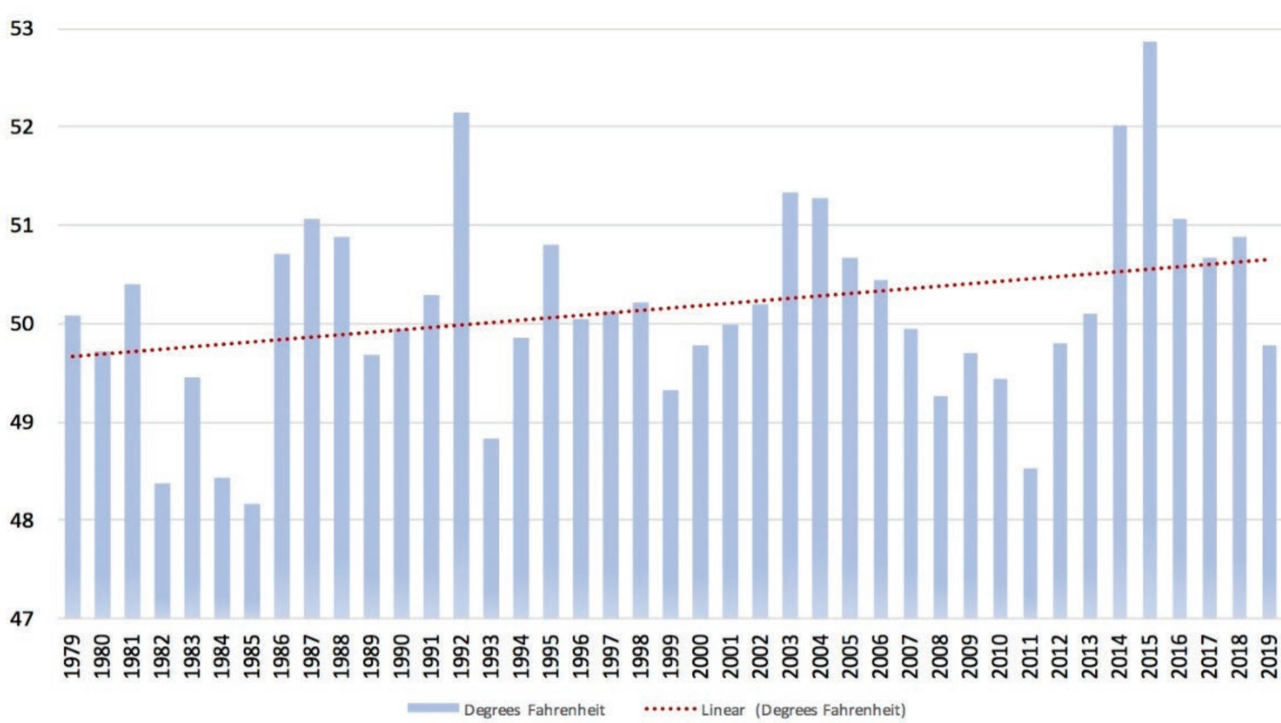

Figure 1. Average annual temperature (in degrees Fahrenheit) from 1979-2019 across Lane County. Data from www.climatetoolbox.com.

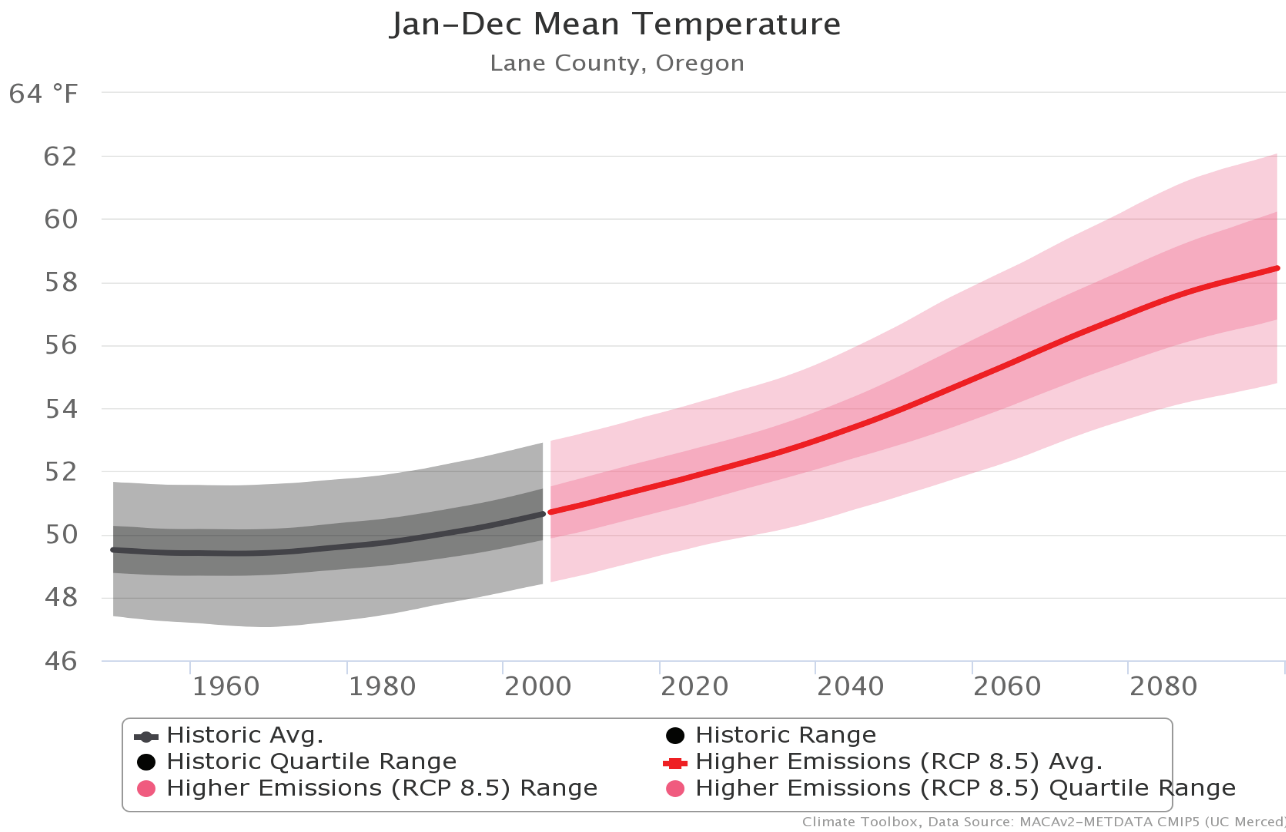

Figure 2. Average annual temperature across Lane County from 1940-2000 (observed) and projected out to 2100 (modeled). Graph from www.climatetoolbox.com.

Figure 3. Average number of days per year in Eugene over 90° F and 100° F, assuming continued higher emissions. Graphic from www.climatetoolbox.com.

Urban Heat Islands – Urban areas are at even higher risk from climate change. Infrastructure such as buildings and roads absorb and re-emit the sun's heat more than areas that have more trees and rivers[3]. The loss of canopy cover and use of asphalt and other man-made materials that trap heat can cause urban areas to be 10-20 degrees warmer than surrounding rural areas during a heat wave.[4] In August 2016, temperature measurements were taken throughout the city of Eugene, indicating that downtown Eugene, West 11th Ave., and Eugene's industrial areas are hottest (Fig. 4). Springfield's hot spots included Gateway St. and Harlow Rd. Temperatures in late afternoon varied by as much as 14° F.

Factors such as building size, proximity to trees, and orientation of streets all affect the temperatures throughout Eugene and Springfield. Many large shade trees are responsible for keeping temperatures lower, but canopy cover has declined in recent years.

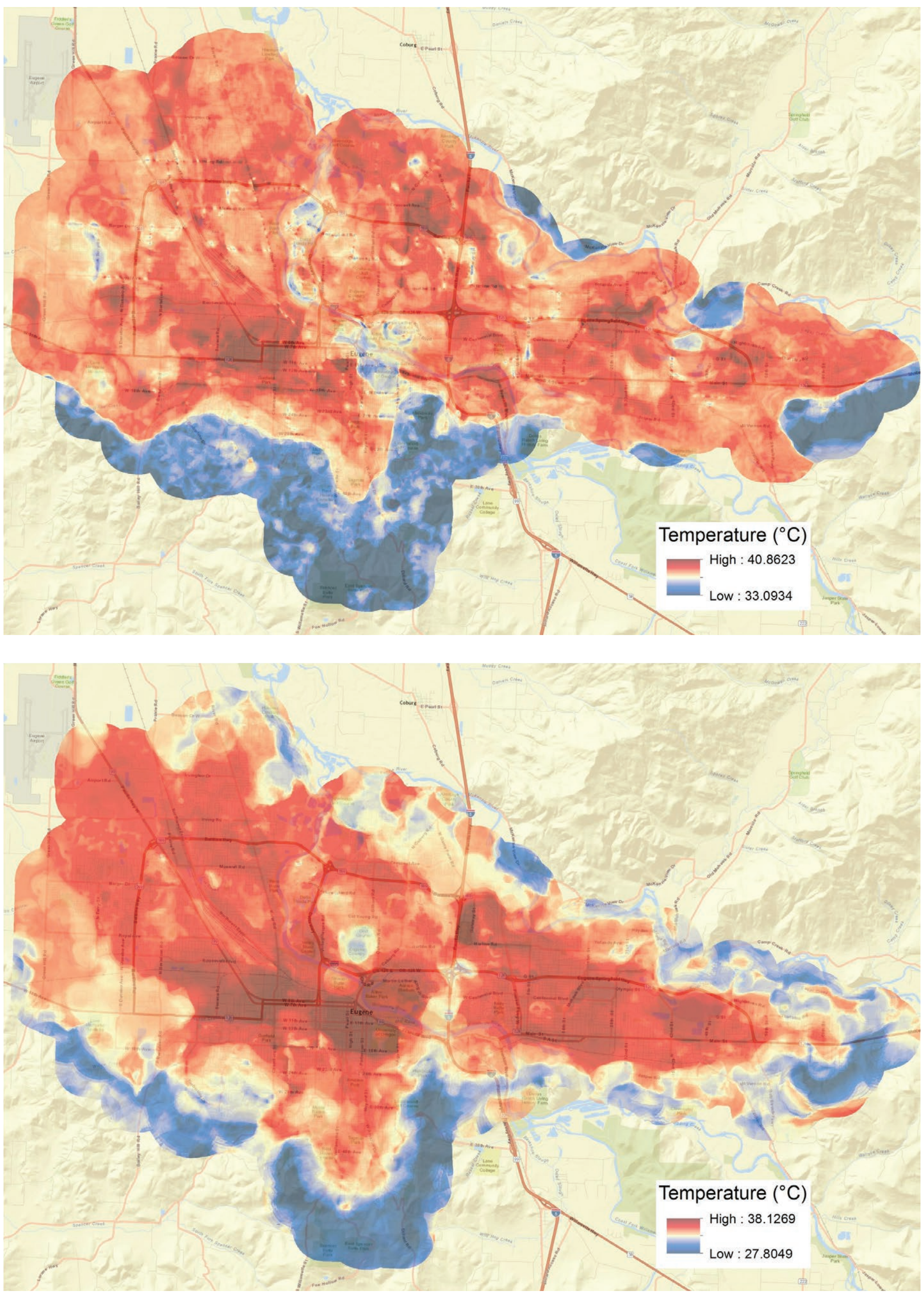

Figure 4. Variable heat across Eugene during an August 2016 heat wave, measured during the afternoon (top) and evening (bottom), as mapped by Vivek Shandas at Portland State University.

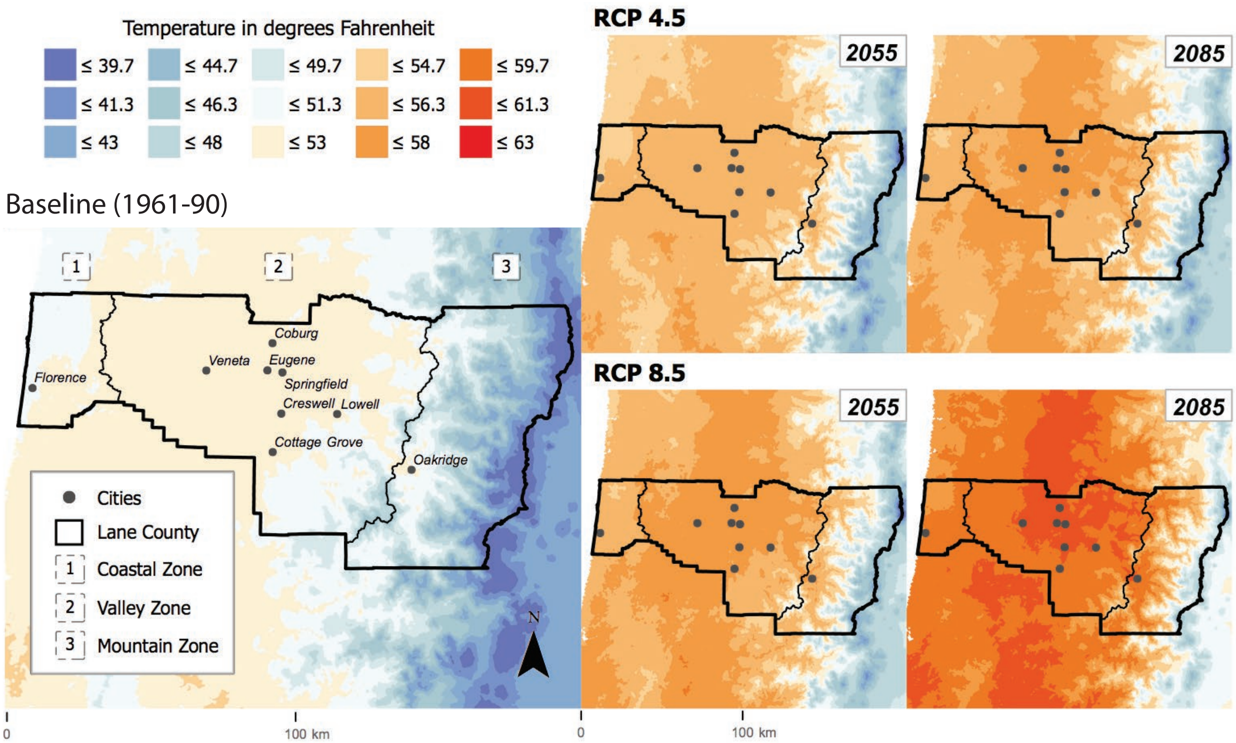

Figure 5. Mean annual temperature across Lane County, Oregon, based on 12 downscaled GCMs and 2 emissions pathways (RCP4.5 assumes lower emissions and RCP 8.5 assumes continued higher emissions) for the historical period (1961-1990) and 2 future time periods (2050s and 2080s). Data downloaded from ClimateNA portal.

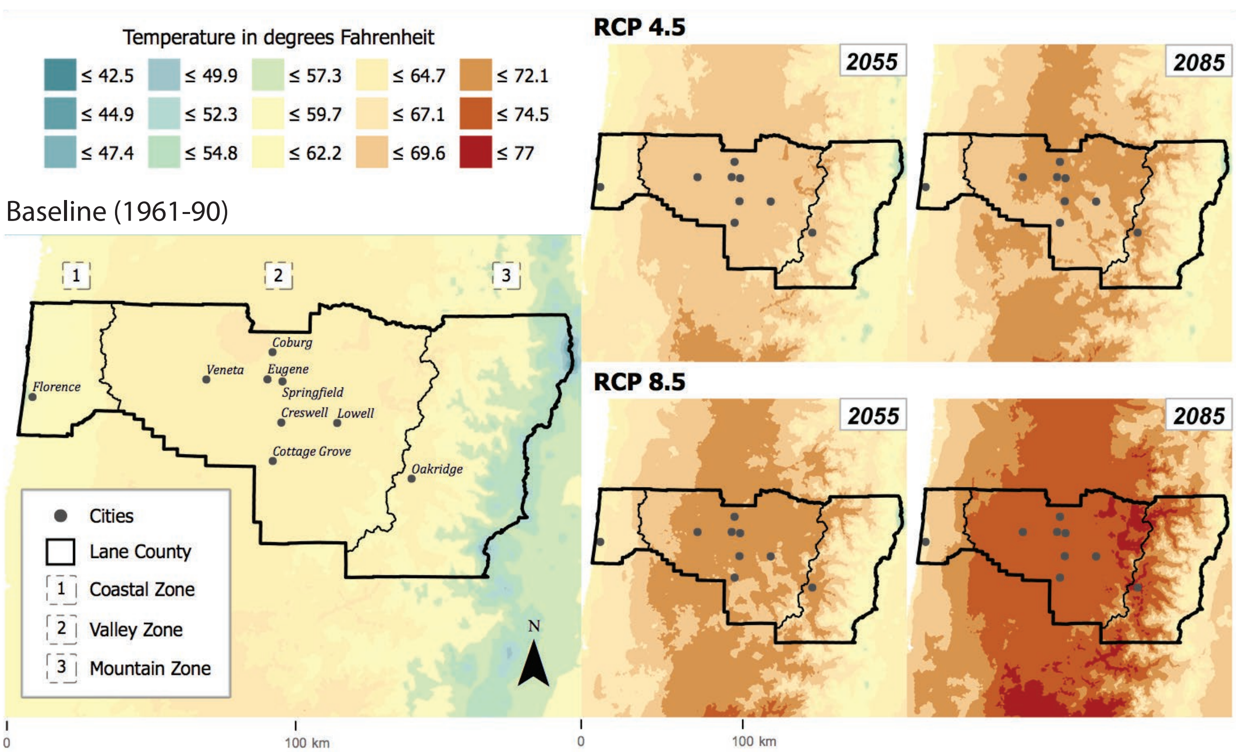

Figure 6. Mean summer temperature across Lane County, Oregon, based on 12 downscaled GCMs and 2 emissions pathways (RCP4.5 assumes lower emissions and RCP 8.5 assumes continued higher emissions) for the historical period (1961-1990) and 2 future time periods (2050s and 2080s). Data downloaded from ClimateNA portal.

Precipitation – Precipitation varies significantly year to year. Over the last 40 years, average precipitation in Lane County has declined approximately 6% (Fig. 7).

Precipitation projections vary among the different models, with some showing wetter conditions and others showing drier conditions. Overall, average precipitation may not change significantly (Fig. 8), but the timing and type of precipitation could change dramatically. Wetter winters and drier summers are likely, and at higher elevations snow is expected to shift to rainfall.

Snowfall is expected to continue to be replaced by rain at higher elevations. By the 2050s, snowfall may be reduced by 47-69% compared to historical levels and by the 2080s, it could be reduced 69-85% (Fig. 9).

Higher temperatures and little change to mean annual precipitation will result in declining soil moisture, thereby leading to more drought and wildfire. By the 2050s, drought stress could increase by 19-39% across Lane County. By the 2080s, drought stress could increase by 32-59%. Over time, drought stress will impact forest health, vegetation distribution, and streamflow.

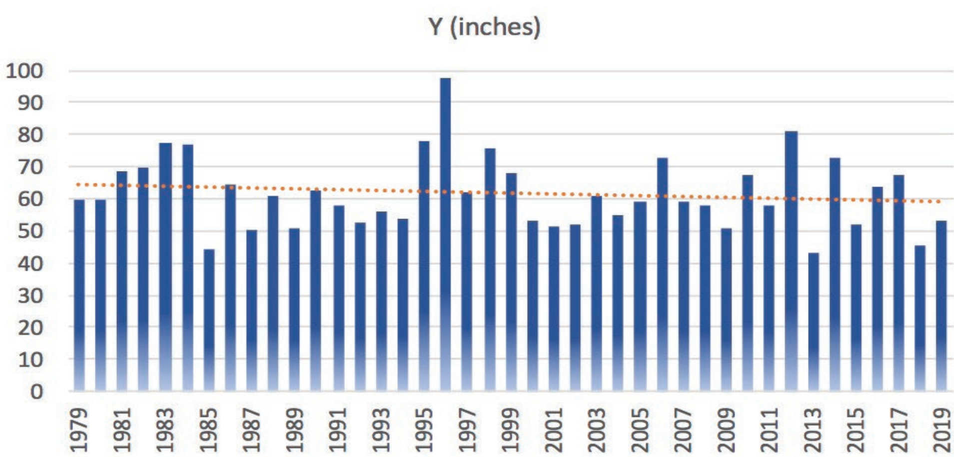

Figure 7. Average annual precipitation (in inches) from 1979-2019 across Lane County. Data from www.climatetoolbox.com.

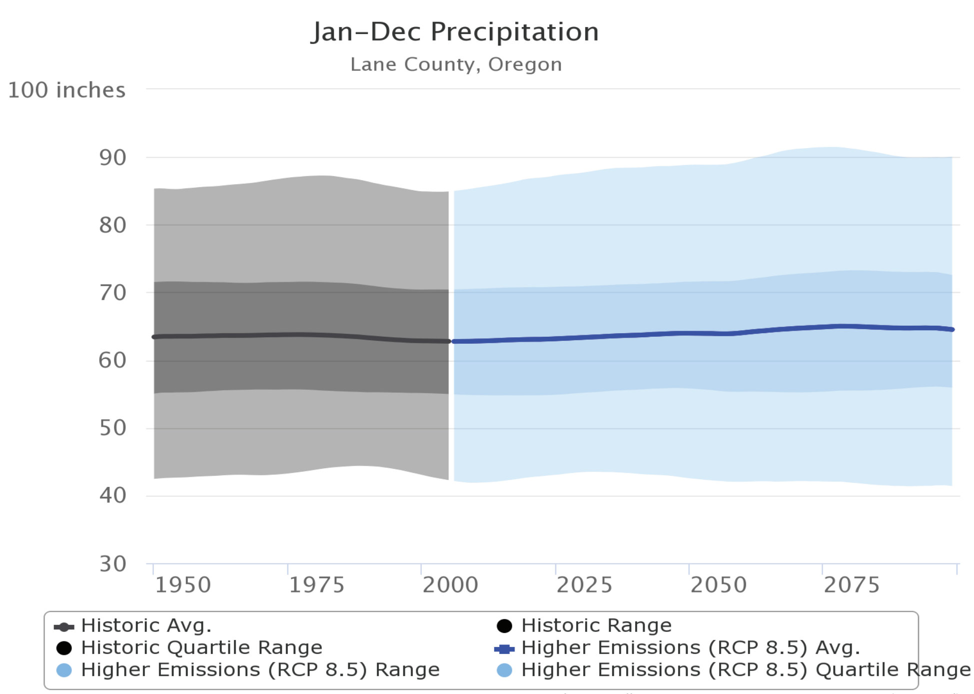

Figure 8. Average annual precipitation across Lane County from 1940-2000 (observed) and projected out to 2100 (modeled). Graph from www.climatetoolbox.com.

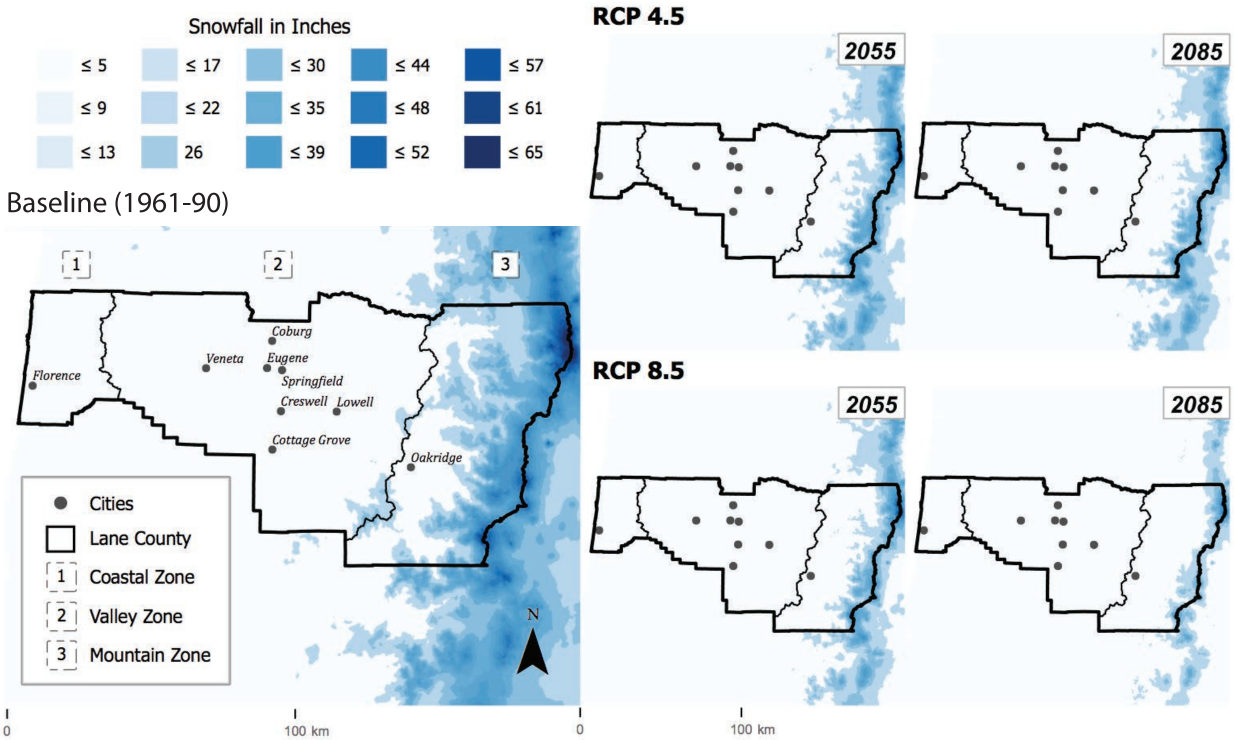

Figure 9. Mean annual snowfall across Lane County, Oregon, based on 12 downscaled GCMs and 2 emissions pathways (RCP4.5 assumes lower emissions and RCP 8.5 assumes continued higher emissions) for the historical period (1961-1990) and 2 future time periods (2050s and 2080s). Data downloaded from ClimateNA portal.

Fern Ridge Wildlife Area by David Geitgey Sierralupe

Streamflow – Historically, precipitation at higher elevations fell as snow during winter and spring. Melting snowpack resulted in a surge in springtime streamflow. As more precipitation falls as rain instead of snow, streamflow during winter and spring is expected to increase, but spring and summer flows could decline precipitously (Fig. 10).

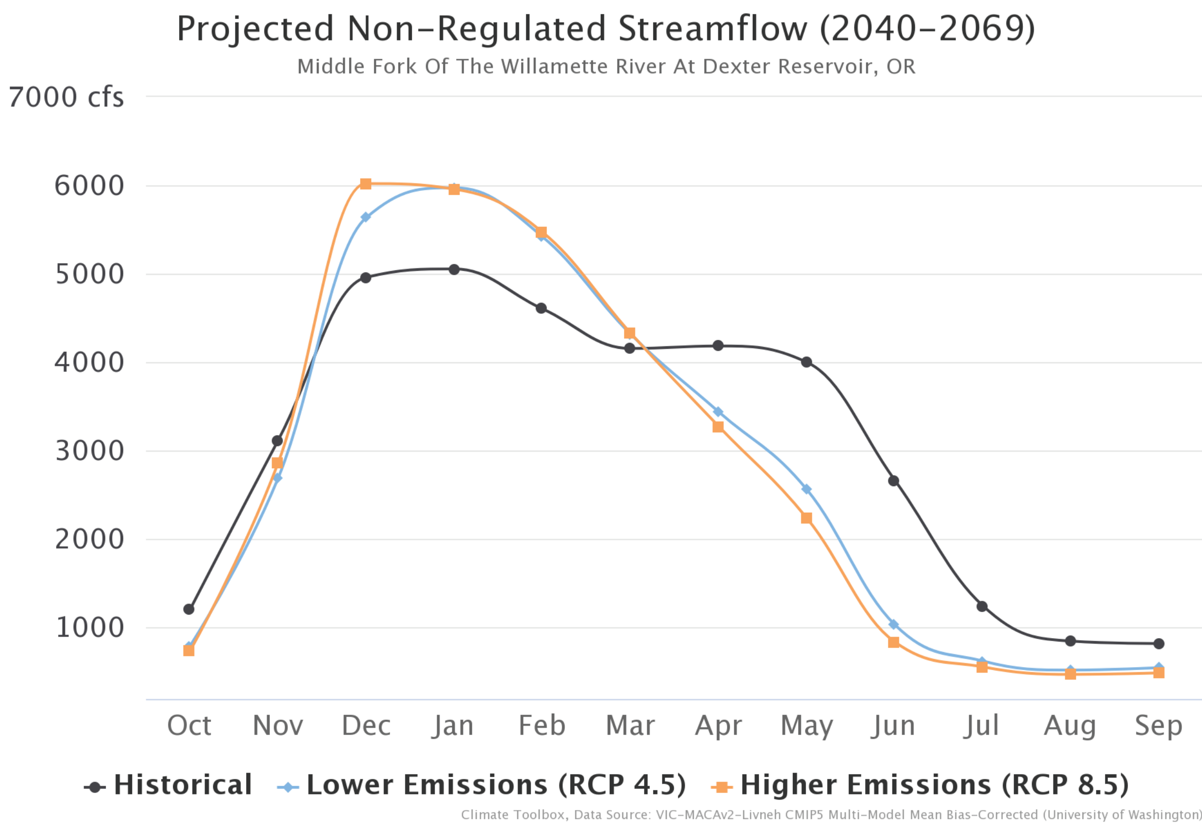

Figure 10. Streamflow projections for the Middle Fork Willamette River in mid-century, based on a lower (RCP 4.5) and higher emissions pathway (RCP 8.5). From Climatetoolbox.com.

Wildfire – As vegetation and climate conditions change, wildfire frequency, size, and severity are all expected to change over time. Wildfire is expected to continue to increase over the near term as temperature and drought stress both increase with climate change. Once existing vegetation burns and/or is replaced with other vegetation types, however, wildfire may decline again. The timeframe for this transition is not well understood. One model indicates that Eastern Lane County could experience a 281% increase in the potential for very large fires by the 2050s, as compared to 1971-2000 (Fig 11). Figure 12 shows the perimeter and grographic scope of a recent fire in Lane County.

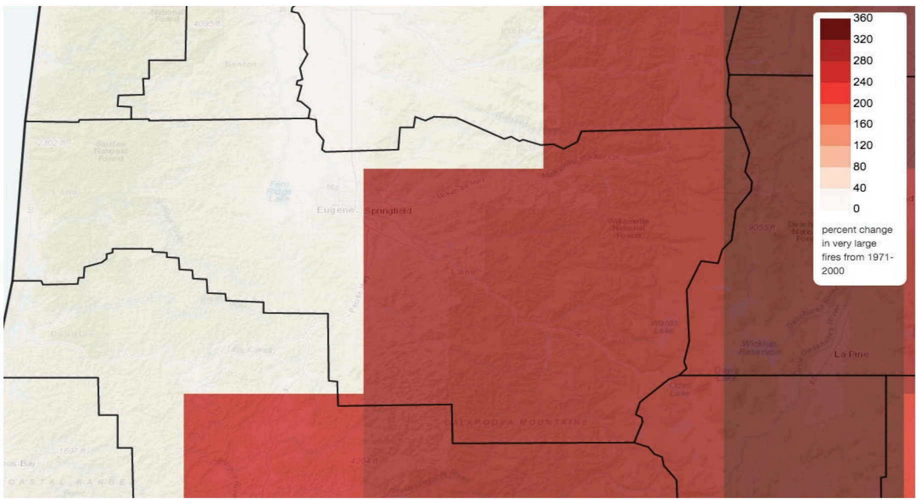

Figure 11. Projected change in very large fire potential for 2040-69 compared to the 1971-2000 average, assuming continued higher emissions pathway (RCP 8.5). Based on multimodel mean from 17 downscaled CMIP5 GCMs. From Climatetoolbox.com.

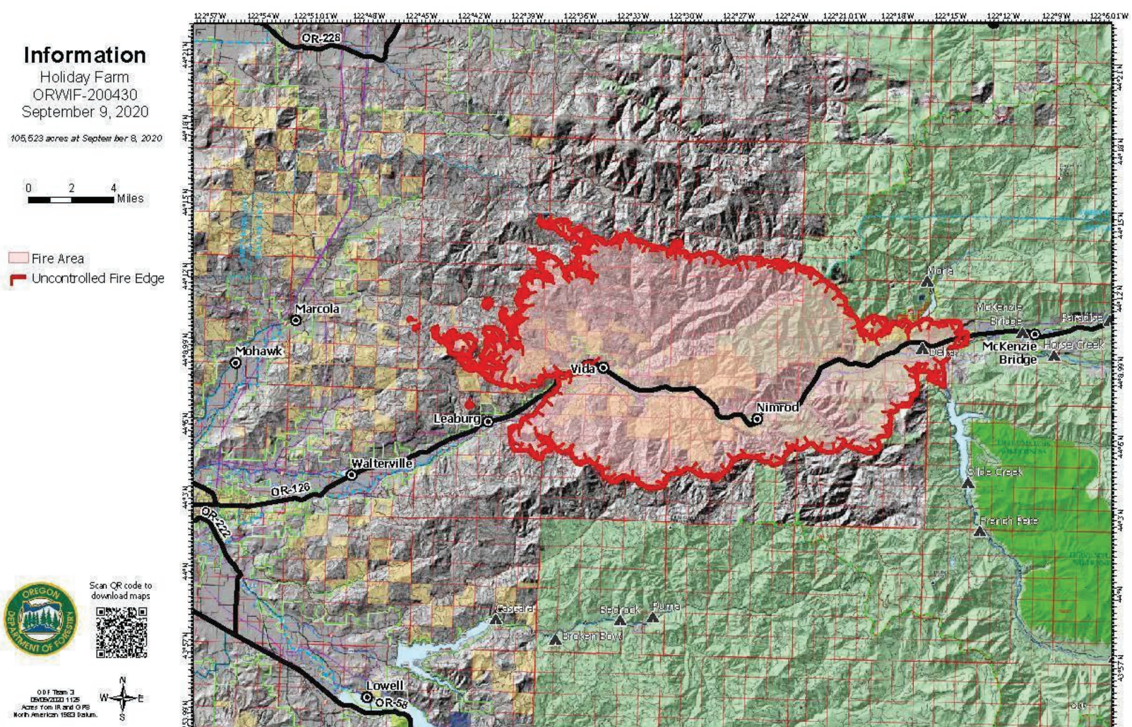

Figure 12. Holiday Farm Fire Perimeter Map (InciWeb September 2020). Red boundary represents the uncontrolled fire edge. The light shade of red represents fire area.

Sea Level Rise – Lane County encompasses 30 miles of the Oregon coastline.[5] Sea level rise projections vary substantially from one model to the next. Sea level rise of 4 feet would result in significant flooding to parts of Florence (Fig. 12), Dunes City, and the Oregon Coast Highway (101) especially north of Florence where it hugs the coast.

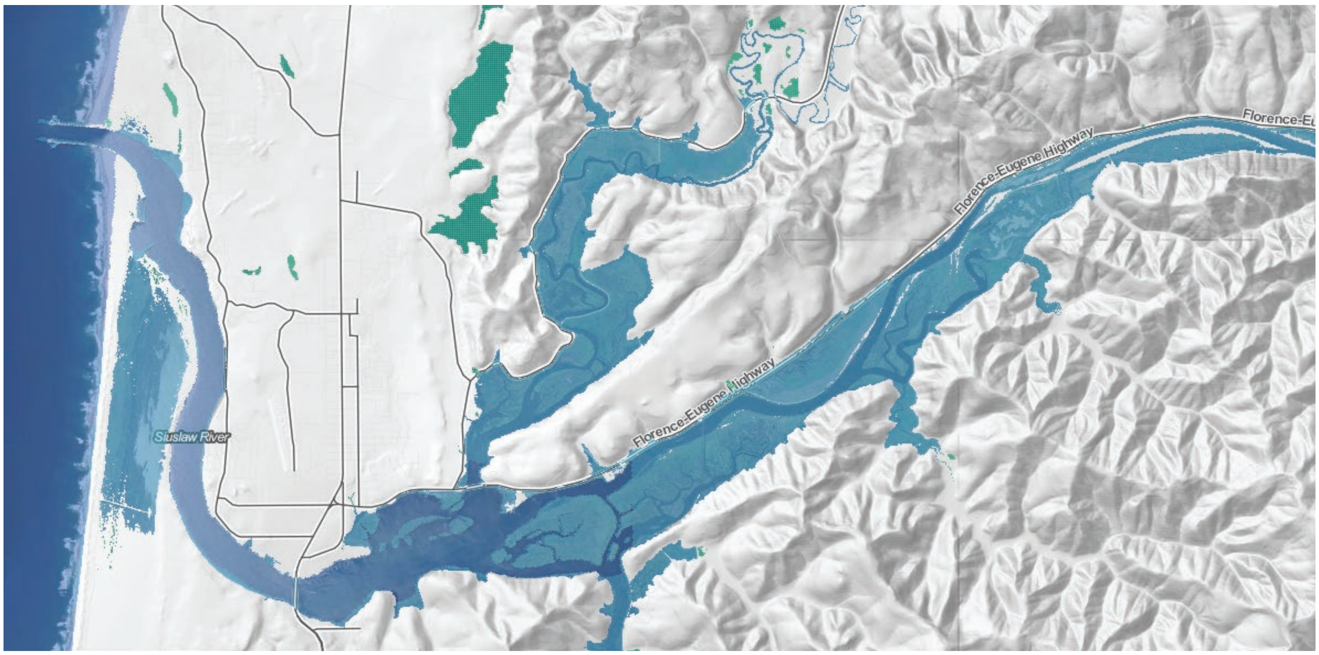

Figure 13. Projected sea level rise of 4 feet in Florence, Oregon. Lighter blue shading shows flooded/submerged areas. Green shading shows areas below sea level but disconnected from the ocean. Map created with Surging Seas Risk Zone Map by Climate Central.

Oregon and the Pacific Northwest

Future climate projections for Lane County sit within the context of changing climate throughout the state of Oregon.

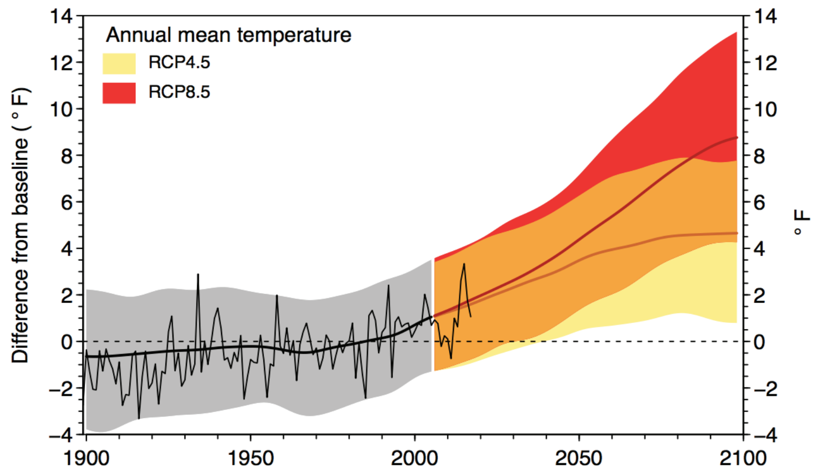

Figure 13. Historical and future projected changes in Oregon's mean annual temperature from baseline (1970-1999) under lower (RCP 4.5) and higher (RCP 8.5) global emissions pathways. From OCCRI 2019.

Temperature – Climate change is already impacting all corners of the state of Oregon. The warmest year in Oregon was 2015. All 10 of the most recent years have been significantly warmer than the historic average.[6]

Continued higher emissions (RCP 8.5) are expected to result in warming of 4-9° F in Oregon by the end of the century (Fig. 13). Coastal areas will experience less warming due to oceanic influences. Inland areas will experience greater extremes in temperature, precipitation, and drought.

Precipitation – Average precipitation has not changed significantly in Oregon, but snowpack has declined at 90% of all monitoring stations in the West, averaging about 15-30% decline overall.[7] Snowpack is expected to continue to decline by 80-100% throughout much of the state (Fig. 14 left). Declining snowpack results in loss of natural water storage, leading to drier conditions during summer months and dwindling supplies.

Overall, winters may become wetter while summers become dryer (Fig. 4 right), further amplifying the extremes of both floods and drought. Larger and extreme storms could increase by 20%,[8] leading to more flooding and damage to natural resources and infrastructure.

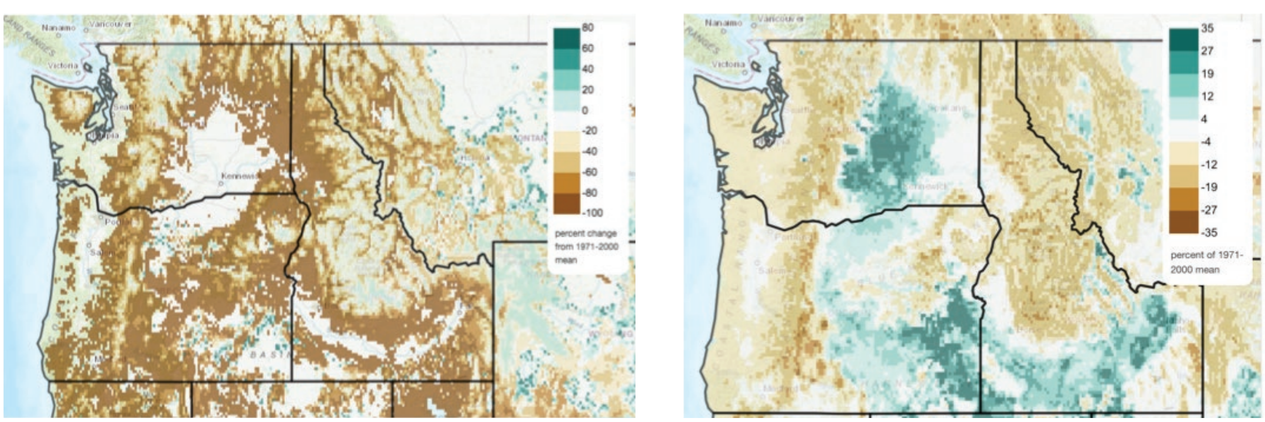

Figure 14. Change in April 1st snowpack (left) and summer soil moisture (right) for 2040-69, based on the higher emissions pathway (RCP 8.5), as compared to the 1971-2000 historical average. From OCCRI 2019 using the mapping tools at www.climatetoolbox.com.

Forests – Oregon's forests are expected to undergo substantial change. Models indicate loss of subalpine forests at higher elevations, shifts in coniferous forests towards more mixed forests with deciduous species replacing conifers, and more frequent disturbances including wildfire, disease, and insect outbreaks.

Oregon's wildfire season has historically run from late-July through mid-September, but fire season is becoming longer with climate change. Larger wildfires are associated with hotter and drier summers, such as the summers of 2005, 2006, 2012, 2015, and 2017. Models that include vegetation change indicate continued increase in fire risk throughout Oregon.[9]

Wildfire frequency and area burned are expected to increase in the Pacific Northwest. Model simulations for areas west of the Cascade Range project that the fire return interval, or average number of years between fires, may decrease by about half, from about 80 years in the 20th century to 47 years in the 21st century. The same model projects an increase of almost 140% in the annual area burned in the 21st century compared to the 20th century, assuming continued high emissions.[10]


McKenzie River by Hardebeck (Pixabay)

Oceans – Warmer ocean temperatures are already leading to shifts in marine ecosystems, causing challenges for salmon, and contributing to large harmful algal blooms. Every summer since 2002, a dead zone labelled "the blob" has formed off the Oregon coast due to upwelling linked to warming water. The blob is an area where algal blooms deplete the oxygen, causing marine organisms to die off.

Along the Oregon coast, sea level rise is expected to reach 19 inches (1.7 feet) by 2050 and 56 inches (4.7 feet) by 2100.[11] These projections account for the uplift that is experienced along the coast of Oregon, resulting in lower impacts than other parts of the Pacific coastline. Sea level projections are highly uncertain and vary significantly among models.

The oceans absorb a large portion of our CO_2 emissions, causing them to becoming more acidic. Ocean acidity has increased by more than 30% worldwide. Increased acidity reduces carbonate, which is needed by many marine organisms to form shells. In Oregon, naturally occurring upwelling brings acidic waters from deeper areas, compounding the problem.

The ocean's acidity is expected to double by the end of the century if emissions are not reduced.[12] By 2030, mean annual surface seawater aragonite saturation state off the Oregon coast is projected to reach a threshold known to disrupt calcification and development in larval bivalves.[13] Reductions in calcifying organisms at the base of the marine food web could have cascading effects on higher trophic marine fish, birds, mammals, and the people who rely on these resources. By 2050 the nearshore domain may see an annual mean pH as low as 7.82 ± 0.04 (compared to a pre-industrial value of 8.03 ± 0.03).[14]

Heceta Head – CAJC in the PNW

Global Climate Trends

Global climate trends indicate an urgency to act at the local level to address greenhouse gas emissions. The hottest year on record was 2016 for the entire globe. In fact, all years from 2015-2019 fall within the top 5 hottest years (Fig. 15).[15] The average global temperature across land and ocean surface areas for 2016 was 1.7° F (about 1° C) above the 20th century average.

Models project continued average global warming of 3-7° F (1.5° to 4° C) by the end of this century and continued warming for the next two centuries if business-as-usual emissions continue (Fig. 16). Because higher latitudes warm faster than areas closer to the equator, Oregon is expected to warm more than the global average.

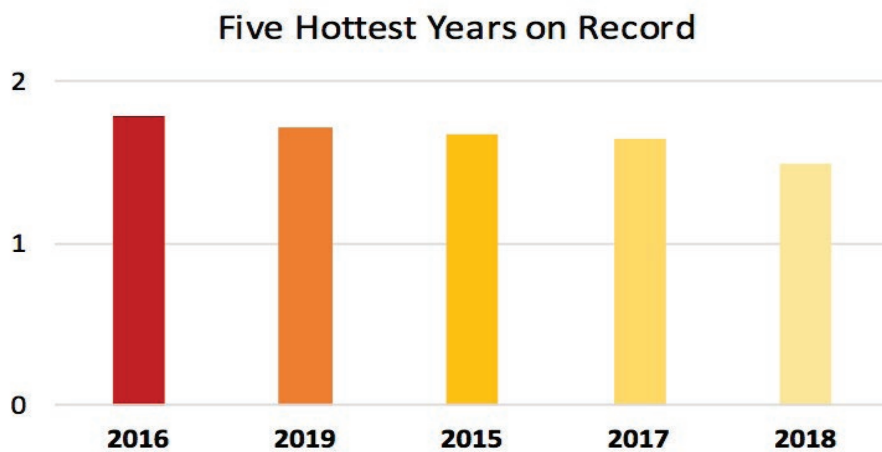

Figure 15. Five hottest years on record at the global scale. From NOAA 2020.

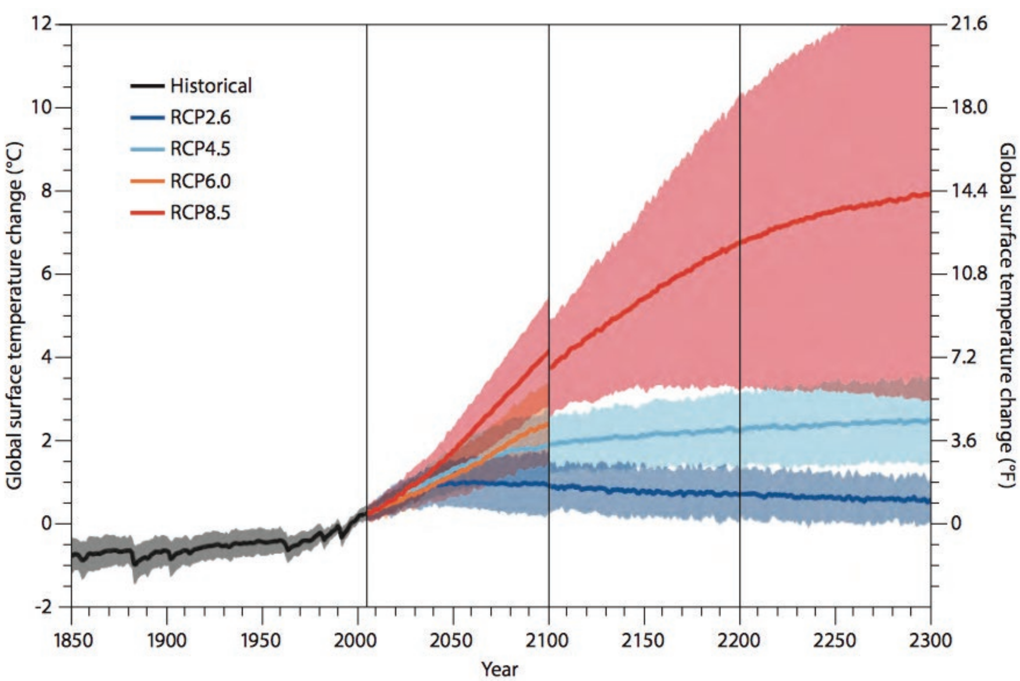

Figure 16. Future warming based on four different potential Regional Concentration Pathways (RCPs). RCP2.6 is the only pathway that stays below the internationally agreed upon limit of average global warming below 1.5-2.0° C. Our current trajectory is closest to RCP8.5.

References

1. Fitzpatrick, M. C. and R. R. Dunn. 2019. Contemporary climatic analogs for 540 North American urban areas in the late 21st century. Nature Communications 10:614.

2. Historical change data from www.climatetoolbox.com. Future projections from ensemble of 12 Global Climate Models available at http://tinyurl.com/ClimateNA based on methodology described by Wang, T., A. Hamann, D. L. Spittlehouse, and C. Carroll. 2016. Locally downscaled and spatially customizable climate data for historical and future periods for North America. *PLoS One* **11**: e0156720.

3. US EPA. 2020. Heat Islands | US EPA. [online] Available at: <https://www.epa.gov/heatislands> [Accessed 16 December 2020].

4. Shandas, V. 2017. Research identified local heat islands. News article about the research available at http://projects.registerguard.com/rg/news/local/36019919-75/psu-study-identifies-heat-islands-in-eugene-springfield-pair-of-public-talks-set-for-wednesday.html.csp

5. Chapter ***: (Lane) County Profile. Physical Features. https://www.lanecountyor.gov/UserFiles/Servers/Server_3585797/File/Government/County%20Departments/Public%20Works/Parks/MP%20Parks%20Masterplan%20Update/MP%20Chapter%20and%20Appendices%20Drafts/profile.pdf

6. Mote, P. W., J. Abatzoglou, K. D. Dello, K. Hegewisch, and D. E. Rupp. 2019. Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. occri.net/ocar

7. Mote, P.W., S. Li, D.P. Lettenmaier, M. Xiao, and R. Engel. 2018. Dramatic declines in snowpack in the western US. *Climate and Atmospheric Science,* **1**(1).

8. (after "increase by 20%) Mote, P. W., J. Abatzoglou, K. D. Dello, K. Hegewisch, and D. E. Rupp. 2019. Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. occri.net/ocar

9. Mote, P. W., J. Abatzoglou, K. D. Dello, K. Hegewisch, and D. E. Rupp. 2019. Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. occri.net/ocar

10. Sheehan T., D. Bachelet, and K. Ferschweiler. 2015. Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures. Ecological Modelling 317: 16–29.

11. National Research Council (NRC) Committee on Sea Level Rise in California, Oregon, and Washington. 2012. Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.

12. Chan F., A. B. Boehm, J. A. Barth, E. A. Chornesky, and A. G. Dickson et al. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust: Oakland, California, USA.

13. Ekstrom J. A., L. Suatoni, S. R. Cooley, et al. 2015. Vulnerability and adaptation of U.S. shell fisheries to ocean acidification. Nature Climate Change 5(3): 207–214.

14. Gruber, N., C. Hauri, Z. Lachkar, D. Loher, T. L. Frölicher, and G-K. Plattner. 2012. Rapid Progression of Ocean Acidification in the California Current System, *Science* 337, 220–223.

15. NOAA. 2020. More near-record warm years are likely on the horizon. https://www.ncei.noaa.gov/news/projected-ranks