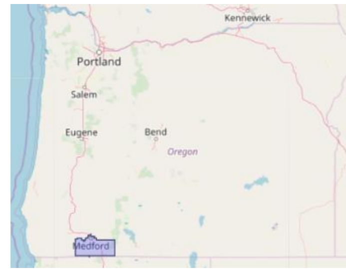
Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

Climate Change in the Oregon 3rd Senate District

August 2019



History, Projections, and Consequences.

1. The last half century witnessed an average annual temperature increase of over 1^{o}F. Meanwhile, projections suggest, compared to the average of the last half century, the temperature may rise about 9^{o}F by late this century, with summers potentially rising 12^{o}F and July reaching an average high of nearly 95^{o}F.

2. Although annual average precipitation is expected to remain steady, seasonally winters are expected to be a little wetter and summers dryer, with more heavy downpours promoting floods and soil erosion.

3. Snowfall and snowpack accumulation, already dwindling, are projected to reduce further, possibly to 10% or less of historic levels threatening agriculture as snowmelt arrives earlier and summer and fall water availability dwindles.

4. Wildfires, already exhibiting a 105 day longer season than in the 1970s, are expected to become more serious, with some 200 to 300 percent greater area being consumed by mid-century posing a substantially greater problem for forests and tourism but also for human health through lower air quality and greater water and vector-borne disease risk.

6 Climatic shifts themselves will likely compromise the viability of important forest and timber species, such as Douglas fir and Ponderosa pine, in the district at the current emissions trajectory, we need to reduce emissions 45% below 2010 levels by 2030, requiring immediate action.

7 Important wine varietals may be compromised as the growing season warms.

8 The main health threats from drought, wildfire, heat, and infectious disease are: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated and uncertain sources, food insecurity, vector-borne disease, income loss, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households, Native Americans, private well users, people working in agriculture and outdoor recreation, firefighters and first responders, and children and pregnant women.

9 To achieve required emissions reduction goals, we need to reduce emissions 45% below 2010 levels by 2030; this requires immediate action!

Compiled by Meghan Fagundes & Alan Journet (Thompsom5@sou.edu , 541-973-5144) (alanjournet@gmail.com, 541-301-4107) June, 2014

For more information on these points, see the full summary at: http://socan.eco/oregon-legislativedistricts/

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Climate Change in the Oregon 3rd Senate District

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Global and Regional Temperature:

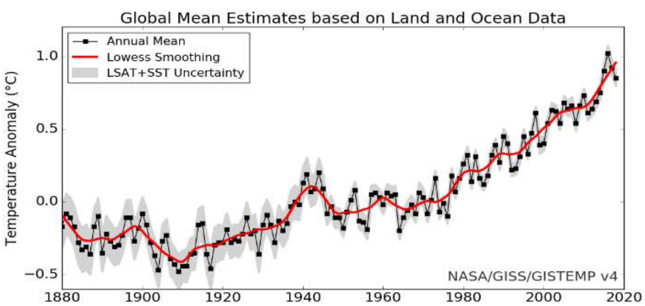

Figure 1. Historic global mean temperature 1880 - 2018 based on land and ocean data. (NASA-GISS 2019).

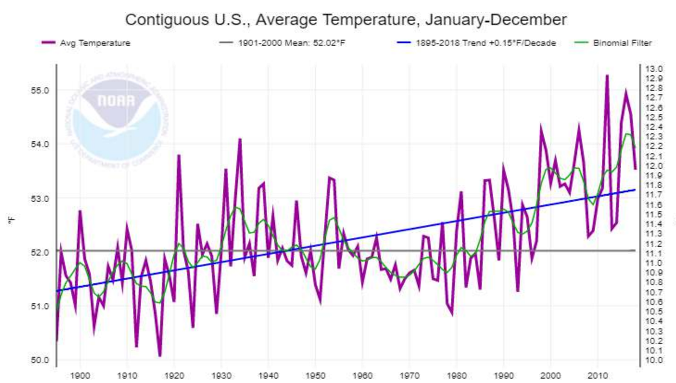

Figure 2. Contiguous U.S. Average Annual Temperature 1895 - 2018. (NOAA 2019).

Data from NASA reveal that the Global and U.S. atmospheric temperatures have increased substantially since 1880 (Figures 1 and 2).

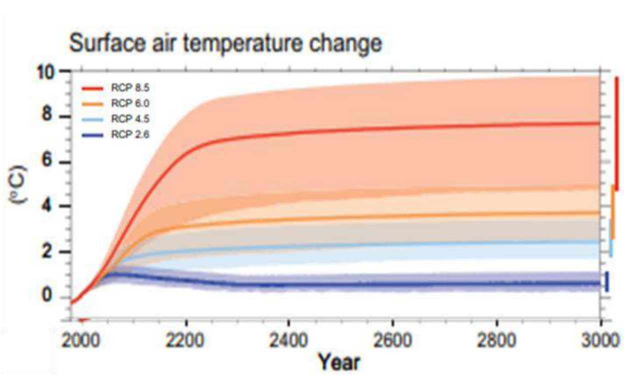

Figure 3. Long term global temperature trends according to RCP values. (IPCC 2013).

Meanwhile, global temperature projections are presented (Figure 3) in terms of RCP scenarios, where RCP refers to Representative Concentration Pathway meaning the concentration of greenhouse gases in the atmosphere and the warming impact (radiative forcing) they induce. The RCP 2.6 scenario assumes we rapidly eliminate emissions, whereas RCP 8.5, sometimes also identified as the Business as Usual (BAU) scenario, assumes we follow the current trajectory of accelerating emissions. RCP 6.0 and 4.5 assume intermediate trajectories of emissions between the extremes. Note that only the RCP2.6 scenario results in a long-term global temperature increase below 2°C above pre-industrial conditions - the upper target for the 2015 Paris Agreement. It is noteworthy that actual temperature trends we have experienced follow the RCP 8.5 scenario which is exactly why it is identified as the Business as Usual (BAU) scenario. Regrettably, we have yet to undertake sufficient action to slow this trend.

Depending on the RCP we follow globally (Figure. 3), this century may result in from a 1^0C (1.8^0F) increase, assuming immediate action, to a high of over a 4^0C (> 7^0F) increase. The trajectory beyond the century offers an even more challenging high extreme with an annual extreme approaching 10^0C (18^0F) warmer. Meanwhile, temperature projections for this century in Oregon (Figure 4) suggest a similar range of temperature increases, reaching – as a possible average – over a 13^0F increase by the end of the century under the BAU scenario (RCP 8.5) in which we continue the current trajectory of accelerating emissions.

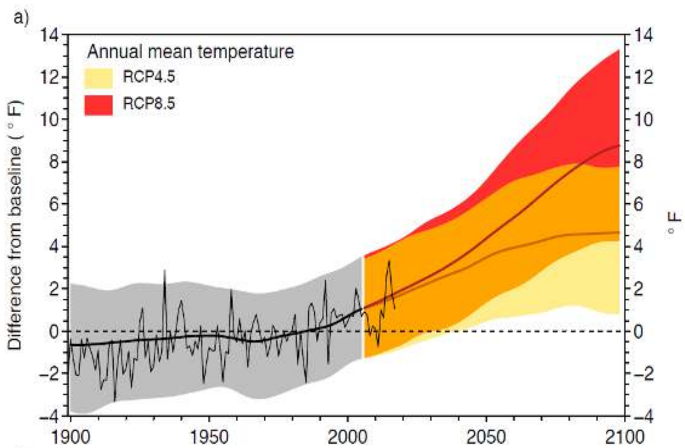

Figure 4. Oregon temperature history and projections through the century; baseline: 1970 - 1999 (Mote *et al.* 2019).

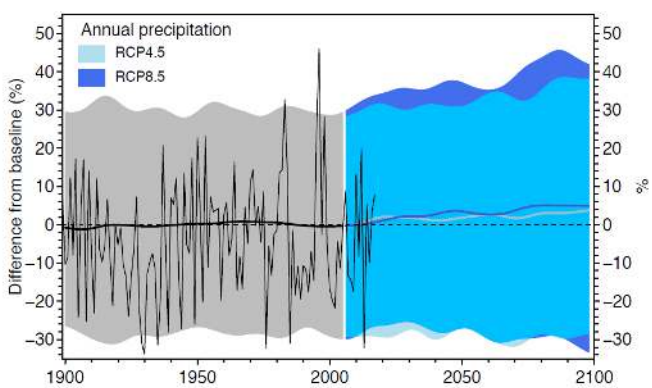

Figure 5. Oregon precipitation history and projections through the century; baseline: 1970 - 1999 (Mote *et al.* 2019).

The higher range of temperature increase would be unmanageable. It would devastate natural systems (see below:) and simultaneously threaten our climate dependent agricultural, ranching, and forestry activities. Bark beetle and other pest destruction of forests and natural and agricultural systems would likely increase because warmer temperatures enhance insect growth and development rates and enable greater overwintering populations. Similarly, invasion of forest, natural, and agricultural systems by drought tolerant invasive species and pests will likely be enhanced.

The lower range for continued temperature increase resulting from the greenhouse gases ***already released*** is inevitable; for this we will simply have to prepare and adapt.

Regional Precipitation:

Much of Oregon (especially between the coast and the Cascades) experiences a Mediterranean climate where winters are cool and wet while summers are warm and dry (Dalton *et al*. 2013).

Fire is a dominant factor determining the plant species composition and diversification in these climates (Rundel *et al.* 2018).

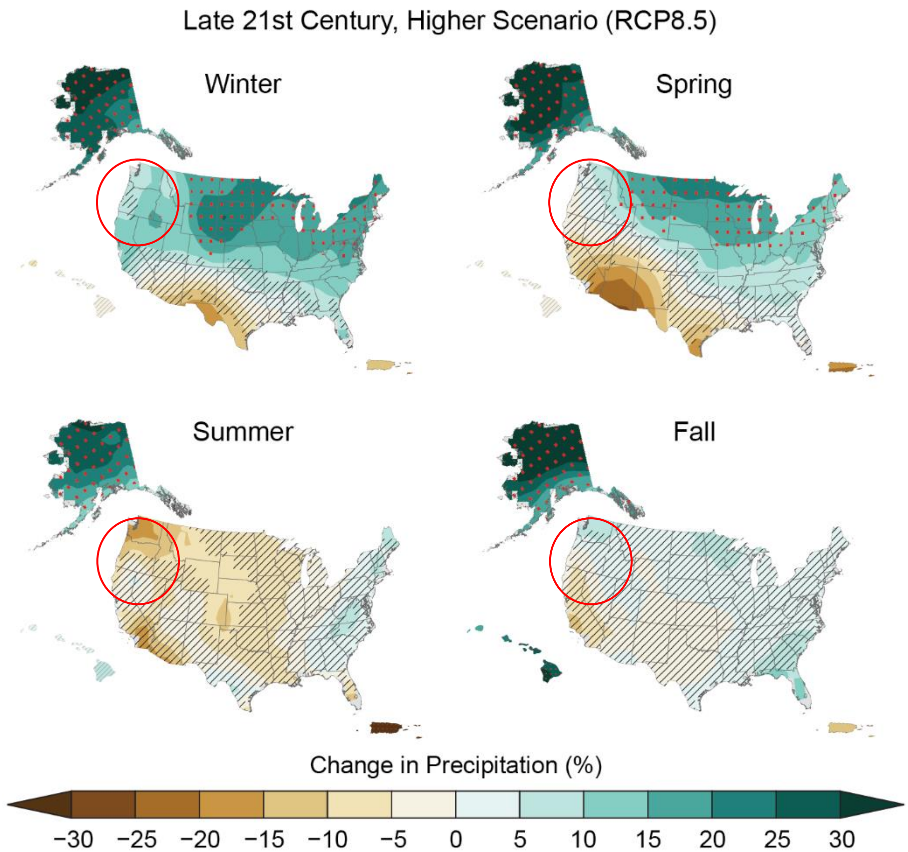

Figure 6. Projected late century seasonal precipitation patterns in the U.S. compared to the 1900 – 1960 average (USGCRP 2018).

Annual precipitation is expected to increase very slightly in Oregon through the balance of this century (Figure 5). However, the 2018 US Climate Change Assessment Report (USGCRP 2018) provides projections for seasonal late century precipitation patterns (Figure 6) according to the 'business as usual' scenario.

The region generally is expected to exhibit fall and spring seasons that are little different from historical patterns, with winters possibly a little wetter. Notably, however, in our current western U.S. Mediterranean climate, summers will likely be considerably drier.

Increasing temperature combined with the trend towards drier summers (Figure 6) will likely counter any increase in precipitation. Thus, drought conditions will likely increase. Water resources, already severely compromised in many locations, will become more threatened as snowpack continues to decline. Meanwhile, the current trend of precipitation occurring more frequently as severe storms rather than the light drizzle that rejuvenates soil moisture continues (Karl *et al.* 2009, USGRP 2017). This will likely enhance floods, soil erosion and potentially landslides.

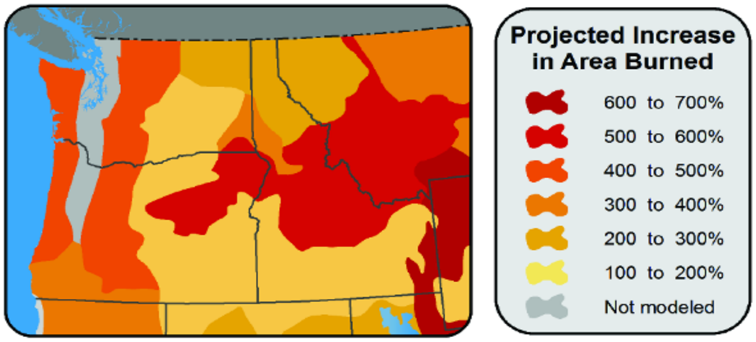

Figure 7. Anticipated wildfire consequences of a 2.2^{0}F warming in area burned (Melillo *et al.* 2014).

Stream and river flow occurring during summer/fall will decline and become warmer compromising many iconic Pacific Northwest cold-water and migratory aquatic species. Meanwhile, peak river flow will continue to advance further potentially compromising migratory fish species.

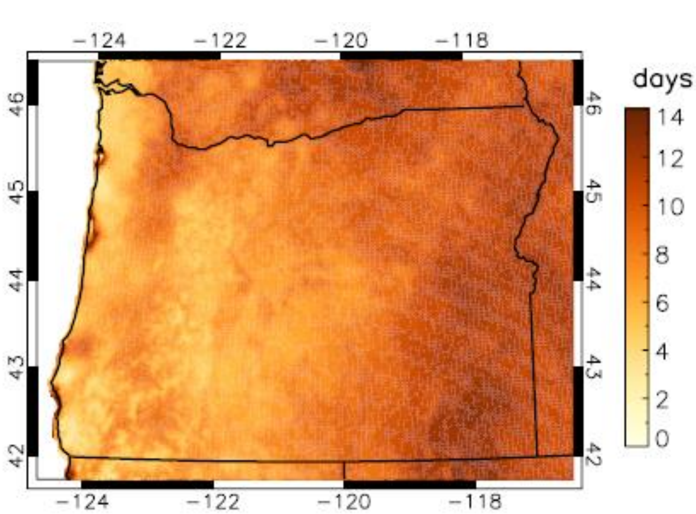

Figure 8. Increase in number of days experiencing high fire risk by mid- century (2040 - 2069) compared to the end of the last century (1971-2000). (Mote *et al.* 2019).

Over a decade ago, Westerling *et al.* (2006) reported that growing season temperature and date of spring snowmelt served as major predictor of fire season severity. Our future climate will exacerbate this problem

Melillo *et al.* (2014) offered wildfire projections for area burned consequent upon just a 2.2^{0}F warming (Figure 7), a condition potentially evident within a couple of decades (Figure 4). Meanwhile, Mote *et al.* (2019) presented a summary of the potential increase in **extreme** fire risk days by mid-century (2040 - 2069) compared to historical conditions (1971 - 2000) where an increase of up to 14 days in the SE corner of the state is evident (Figure 8).

The fire season, already extended by 105 days since 1970s (Kenward *et al.* 2016), will likely become longer and more severe in Oregon. Both human safety and human health will likely be threatened.

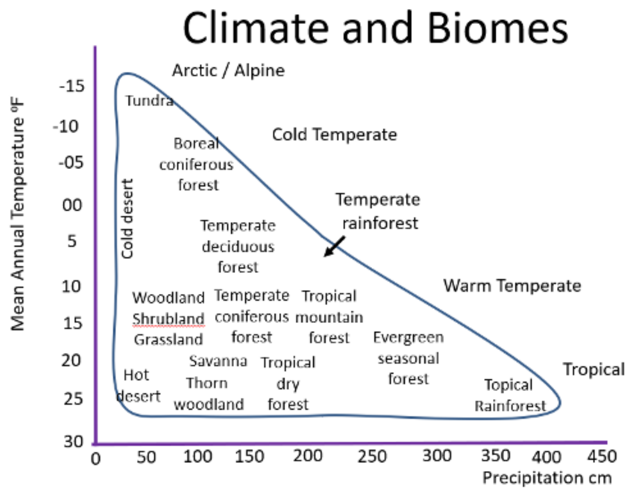

Figure 9. Global distribution of natural ecological systems in relation to mean annual temperature and precipitation patterns. (Modified from Whittaker 1975).

Natural System Consequences

That the geographic distribution of our natural ecological systems (biomes) is largely determined by the variables of temperature and precipitation (water availability) has been understood for decades. Community ecologist Robert Whittaker (1975) developed a classic chart indicating this relationship (modified in Figure 9). The chart depicts the climatic conditions that allow each of the designated biomes to exist. The critical message is that even a small shift in either of these variables from current conditions may threaten the viability of the biomes and the species of which they are composed. This will be especially true for biomes currently existing at the edge of their climatic range. It is especially worth comparing these temperature ranges to the potential shifts in Oregon's temperature through the century (Figure 4). From this, it is evident that between many and most of our state's precious natural systems will be threatened if not eliminated under future conditions. It is worth remembering also that the same variables control our agricultural productivity, and clearly, our forest viability. Thus, climatic shifts of the dimensions anticipated absent any adjustment in our collective behavior, will likely compromise agriculture and forestry in the state. Indeed, Dalton *et al.* (2017) indicate not only that "suitable climates for many important tree species and vegetation types may change considerably by the end of the 21st century…" but also that: "different trees have varying degrees of sensitivity to climate change and adaptive capacity." This issue will be explored in the local district discussion below.

Coastal Concerns:

Though much of Oregon is land-locked, and will suffer little directly because of ocean consequences, coastal regions and economies will have to contend with warming oceans, sea level rise, and increasing ocean acidification.

Warming Oceans. Although there is considerable seasonal fluctuation in ocean sea surface temperature, warming of oceans is already documented with further increases at the rate of 0.05°C to 0.5°C per decade expected (Alexander *et al.* 2018). Besides influencing species directly, temperature changes impact such factors and events as dissolved oxygen concentration, algal blooms, and shellfish poisoning.

Sea Level Rise. Sea levels are rising and will continue to rise for two reasons. First, water expands as it warms from 4ºC (approximately 37ºF). As the ocean warms, it inevitably expands and sea level rises. Second, as land borne ice enters the ocean, whether as water or ice, it increases the volume of the ocean. Both these phenomena have already caused sea level to rise and are expected to continue this impact. The impact is influenced by the pattern of land adjustment: if land is rising, the impact is reduced, whereas a subsiding coastal plate will exacerbate the impact. This complication is particularly relevant to the impact of the Cascadia Subduction Zone (CSZ) where a rising or falling land tectonic plate will influence apparent sea level rise along the coast. In Oregon, the impact of the oceanic Juan de Fuca plate sliding under the continental North American plate is a rising continental plate (Lieberman 2012) countering the sea level rise. However, should the earthquake occur, there will likely result a drop in the land level of a meter (3 feet) or so. Mote *et al.* (2019), however, indicated that by century's end, the actual sea level rise off the coast of Oregon could plausibly reach 8 feet. During storm surges, a higher sea level will generate conditions that promote far greater storm damage and flooding than would otherwise have been the case. The impact of Hurricane Sandy is a perfect illustration of this problem. Not long ago, the suggestion that New York subways could be flooded by a coastal storm would not have been taken seriously – yet it happened! Results of ocean rise, such as increased erosion and compromised coastal habitat integrity for tidal flat, estuary, and marsh natural communities, could become serious.

Ocean Chemistry. Serious as direct climatic consequence are, they do not constitute the sum total of the impacts of our emitting carbon dioxide into the atmosphere.

Because carbon dioxide is absorbed by our oceans, and is transformed into carbonic acid, oceans are becoming more acidic. This is detrimental for marine organisms with carbon-based shells since either, they are unable to form shells in acid conditions, or they lose shells already established. Oysters suffering directly, and salmon indirectly, have been noted as particularly threatened by acidification. Acidosis, a build-up of acidic conditions in the tissues, threatens many marine life forms.

In addition, warming oceans exhibit reduced oxygen levels, potentially critical for marine animals since, like terrestrial animals, they rely on oxygen for basic metabolic respiration.

These consequences of increasing atmospheric greenhouse gases (notably carbon dioxide) pose threats to marine life, and thus to our fisheries, coastal economies, recreation, and tourism.

Rural *vs* Urban Oregon

Although climate change has a far greater direct effect on rural communities than urban areas, it must be remembered that urban areas rely on healthy rural regions for their water supply and their agricultural, and forestry products. Indirect effects, therefore, can be substantial. Climatic events that compromise natural systems, and thus urban watersheds, and regional agriculture and forestry will also have a profound impact on life in the urban centers. This impact will not be limited to impacts on prices of food and wood products, but will also compromise regional recreational opportunities as reduced snowpack diminishes skiing, reduced river flow potentially diminishes fishing and water recreation, rising seas compromise our coastal communities, and increasing wildfire risk compromises our forests and air quality. Additionally, because the Pacific Northwest is projected to suffer less than most of the country from the warming climate, the region will become the target for climate refugees from across the U.S. These migrants will increase our population and impose a greater burden on our natural resources and dwindling water supplies.

The 3rd Oregon Senate District Climate History and Projections:

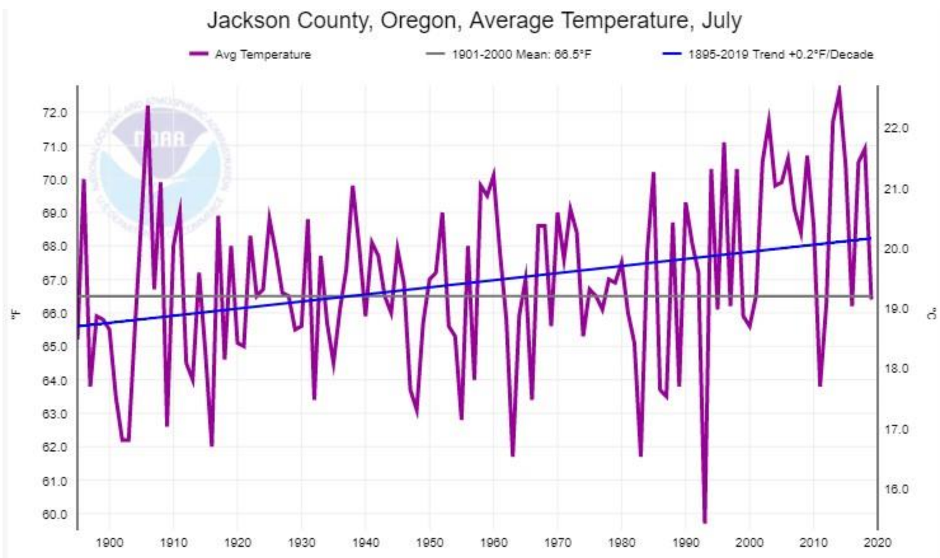

Figure 10. Warming Trends for Jackson County from 1895 - 2018 (NOAA 2019b)

The temperature history for Jackson County is presented in Figure 10 demonstrating a warming trend from 1895 to 2018 of about 2.5^{o}F at the rate of 0.2^{o}F per decade. Meanwhile, the county projections through the end of the century, depicted in Figure 11, indicate a warming of over 9^{o}F by 2100 under the Business as Usual scenario with summers up to nearly 12^{o}F warmer and July exhibiting an average maximum of nearly 95^{o}F. However, warming reaches only about 5^{o}F if we adopt a less extreme RCP 4.5 trajectory.

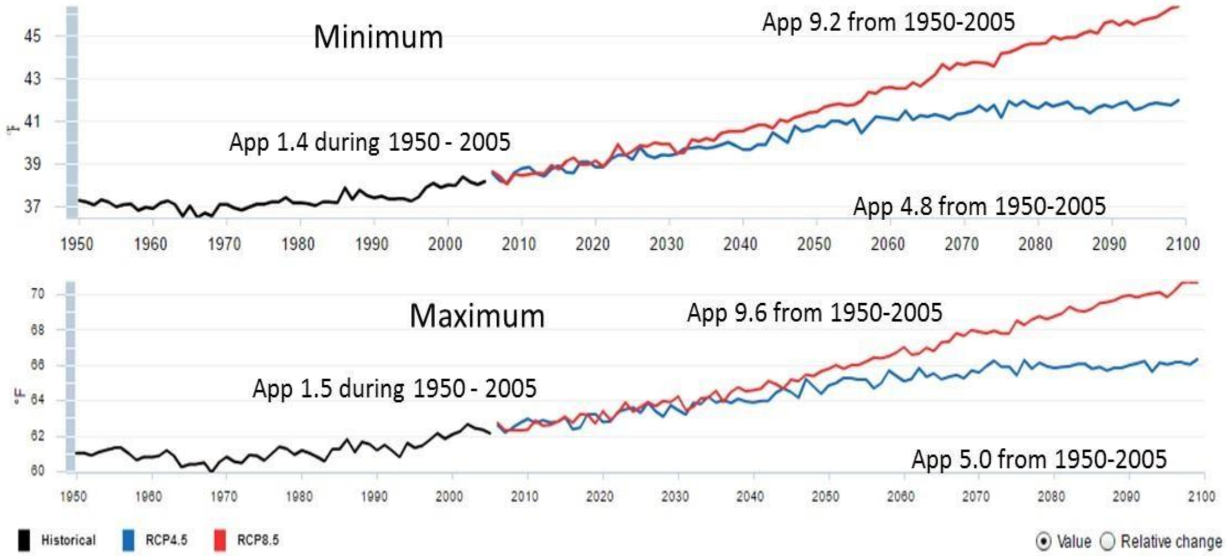

Figure 11. Jackson County temperature projections averaged from 28 models for the balance of this century (upper average annual minimum temperature, lower average annual maximum temperature). Red represents the Business as Usual RCP 8.5 Scenario; blue represents the RCP 4.5 scenario. (USGS 2019

The trends and projections for precipitation in Jackson County (Figure 12), indicate a historical pattern that is variable but, on average, level, and a future on average about the same but with greater variability: namely, more frequent and severe wet and dry years

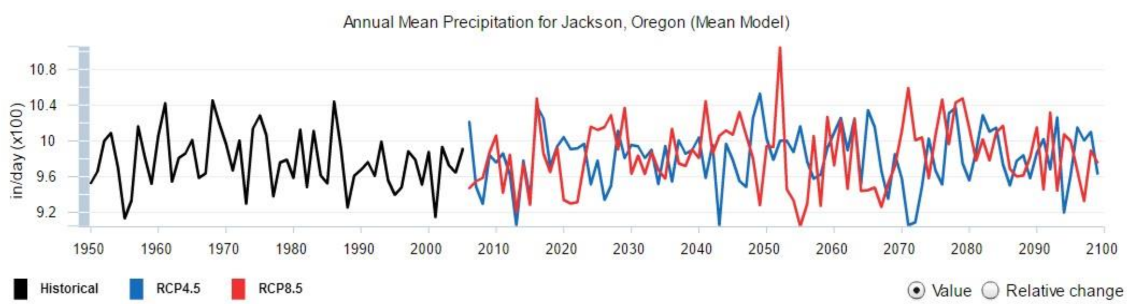

Figure 12. History and projections for precipitation in Jackson County (USGS 2019)

Meanwhile the seasonal patterns (Figure 6, above) indicate that winters may be wetter; but summer months will potentially be dryer. Spring and fall are not expected to change. This means that the county has the potential for longer more severe summer/fall droughts. Lower levels of precipitation have a negative impact on recreational water activities for the area, but more importantly will substantially impact irrigation and the general summer water supply for the region.

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The trend in the declining mid-elevation snowfall at Crater Lake (Figure 13) has been occurring since the 1930's. This trend is repeated in the mid elevation northern Siskiyou's which lost 13% snowpack in the second half of the last century (Howat and Tulascyk 2005). Snowpack, measured as Snow Water Equivalent, has been declining since the 1970s. During this Century, it may drop to less than 10% of historical records (Figure 14). Lack of snow pack has negative effects on the valley since snowpack has been the historical reservoir for summer and fall water supplies. Reduced snowpack, accompanied by earlier snowmelt will likely increase the threat of drought and wildfire in summer and fall. Snow pack also affects winter recreational activities in the area; with reduced snowfall, the valley loses the potential revenue brought in by Mt. Ashland and its patrons.

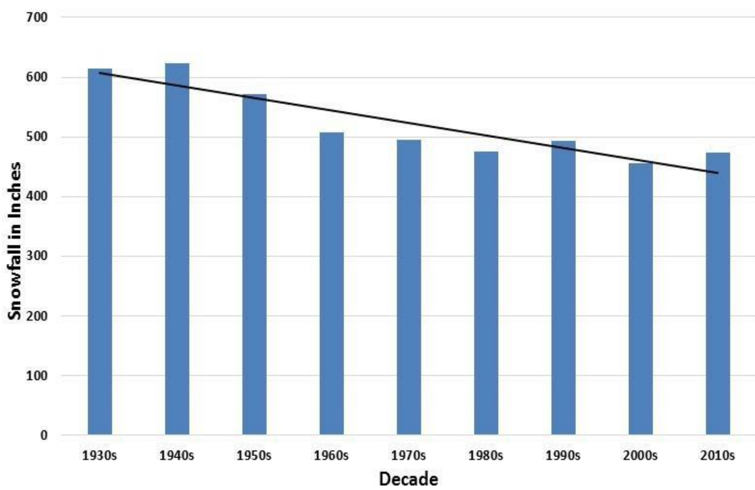


Figure 13. Average annual snowfall, by decade, at Crater Lake (Source - Crater Lake N.P

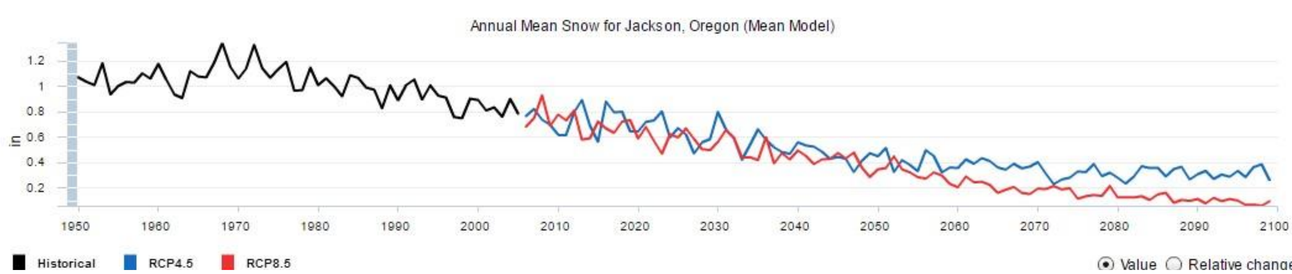


Figure 14. Trend and projections of snowpack as snow water equivalent in Jackson County (USGS 2019)

Federal 2nd Congressional District Historic Temperature Trends

Since the Oregon Senate 3rd District falls within the Second Federal Congressional District, it is instructive to see how historic patterns have fared across that district. The data indicate (Figure

15) that the second Congressional District has warmed 1.9°F since 1895, a rate comparable to that of Oregon as a whole but faster than the United States average rate of 1.5°F for the same period. The entire district is subject to the consequences of climate change

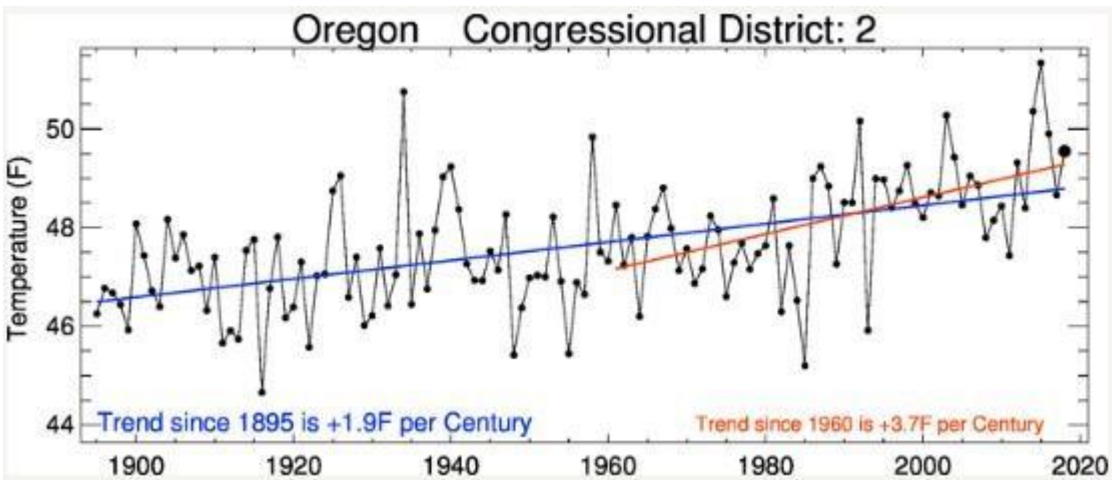


Figure 15. Temperature trends through the Second US Congressional District (CTT 2018).

Oregon 3rd Senate District Economy:

The economy of Oregon's 3rd Senate district involves healthcare, agriculture, forestry, manufacturing, and tourism. Even though timber/lumber production has declined it is still a significant component of this district's economy.

The most important commercial tree species in the 3rd Senate District are Douglas fir and Ponderosa pine. Their current distributions, and the location of the climate conditions supporting them through the century have been analyzed at the USDA Forest Service Labs in Moscow, Idaho. Projections for these tree species are presented in Figures 16 and 17 for models that assume the Business as Usual trend of increasing atmospheric carbon dioxide emissions. High tree viability is indicated in red, low viability in green and absence in areas without color.

These projections suggest conditions for these species may be less favorable than currently- meaning the forests and timber industry of the district could be severely challenged as the century unfolds, especially if we do nothing to mitigate the climate trends already evident.

Furthermore, given the ability of many Oregon forests to store carbon (Hudiburg *et al.* 2009; Law *et al.* 2018), it is critical that climatic conditions not diverge such that these important species are compromised. Halafsky *et al.* (2016) discuss the potential and disturbing impacts of climate change of SW Oregon's forests.

Figure 16 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century (Crookston 2019).

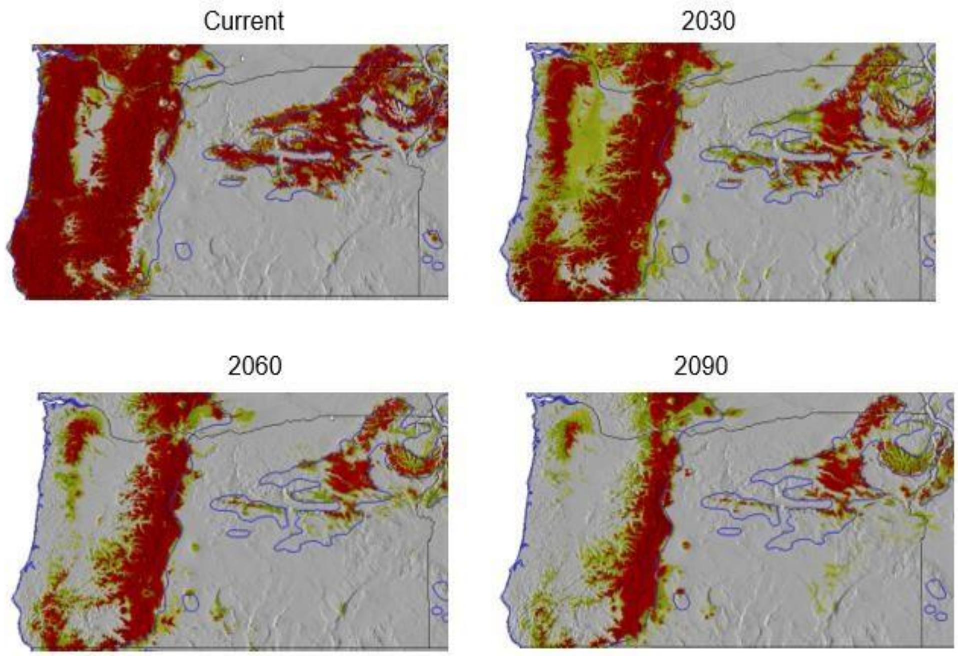
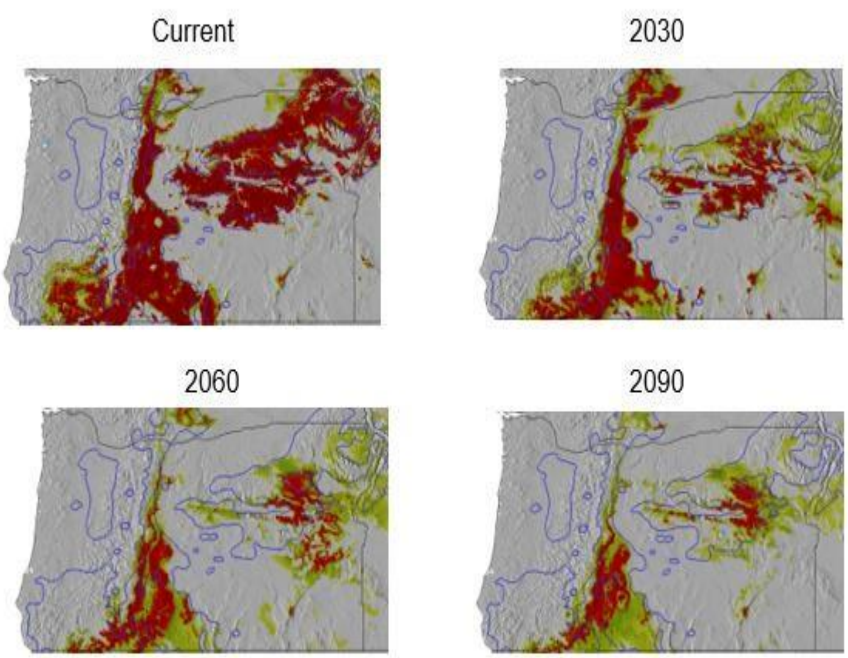


Figure 17 Ponderosa pine (*Pinus ponderosa*) Current and Projected Distribution through the 21st Century (Crookston 2019).



Potential Agricultural Impacts:

Our field crops are planted in soil and climatic conditions to which they are well adapted. This means adjustments from current climate can be detrimental. The agricultural ‘one-degree problem’ occurs because increasing temperature generally reduces crop yield. In fact, for each degree C temperature rise crop yield drops some 5 - 10% (Brown 2006). Meanwhile, the ‘business as usual’ scenario of increasing greenhouse gas emissions suggests that throughout Oregon the temperature will likely increase 5 or more degrees C with decreasing soil moisture (USGS 2014) posing a great risk of extended drought. Farmers and home gardeners in Oregon should be concerned about a compromised future.

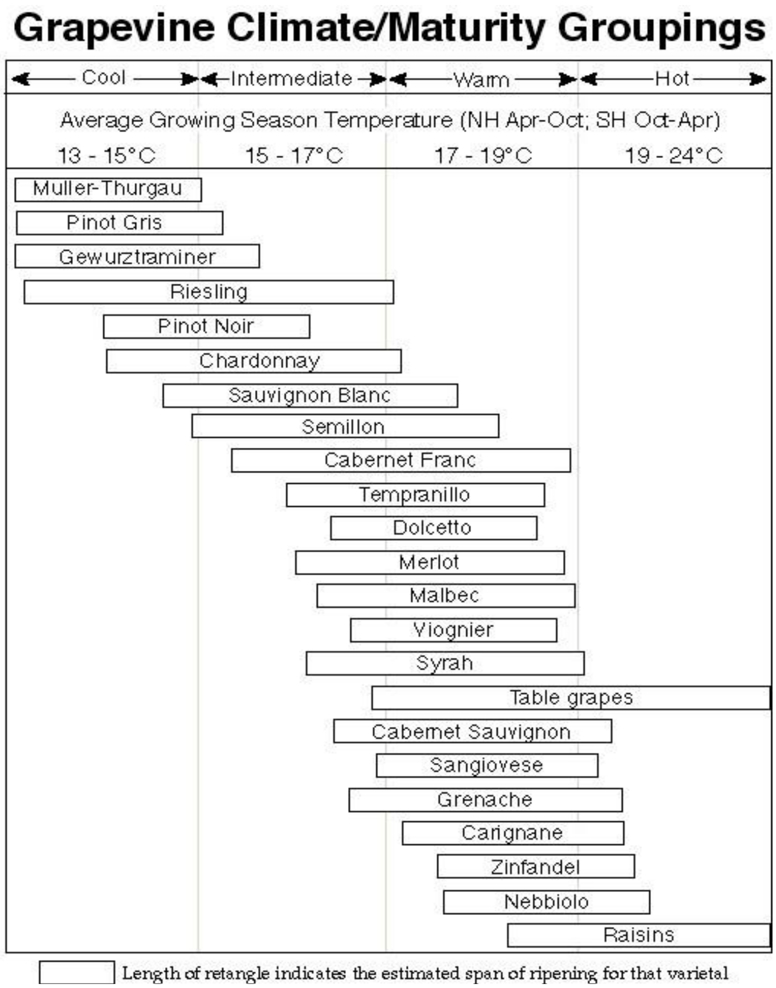


Figure 18. Grape varietal optimum gorsin season (Jones 2015)

Future climate patterns as projected would negatively impact the economy through reduction in crop yields since increasing temperature consistently reduces crop productivity and a potential for lost tourism due to wildfire. The blossoming wine industry and the pears produced by and for Harry and David could also be affected by the altered growing season. A potential problem for pear growers is the need for a solid winter chill period This is decreasing. While not immediately a problem, if the trend of decreasing chill hours continues the consequences for pear production could become relevant and severe.

The predominant wine varietals cultivated in the 3rd District include Pinot gris, Chardonnay, Sauvignon blanc, Cabernet franc, Malbec, Syrah, Merlot, and Cabernet Sauvignon. Figure 18 indicates the potential impact climate change will have on the growing season. While most seem well adapted to forthcoming conditions, some of these varietals may well be compromised. Many vineyards in the area that contribute substantially to the local economy will likely be directly affected

Potential Health Risks:

Oregon Senate District 3 and surrounding areas have become increasingly popular as retirement locations. Climate change and its consequences target the most vulnerable - such as the young and the elderly. The consequences depicted here could have a severe impact on the health of the elderly. Many of the health consequences involve respiratory problems for this vulnerable segment of the population. Heat waves and particulates emitted by wildfires can be particularly hazardous to those with respiratory problems. Not only will the projected climate change be negative for our economy, it will also change the lives of people in the 3rd District.

As illustrated above (Figure 6) with only a 2.2^{o}F temperature increase, wildfire risk will increase substantially.

If climate trends continue as projected, Oregon's 3rd Senate District will experience considerable natural and economic disruption. In order to sustain a vibrant economy, the region will find it necessary to adapt. Avoiding the worst-case scenario depicted in these projections will require the concerted effort of elected leaders at all levels of government: regional, national, and international.

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: drought, wildfire, heat, and infectious disease. The top health concerns will be: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated drinking water, water insecurity, food insecurity, vector-borne disease, income loss, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households, American Indians, private well users, people working in agriculture and outdoor recreation, firefighters and first responders, and children and pregnant women.

A Timeline for Action:

Based on the projected consequences of the warming lobal climate, international agreements (e.g. UNFCCC 2015) some years ago established 2^{o}C (preferably 1.5^{o}C) above pre-industrial conditions as the limit beyond which we should not allow the global temperature to climb. This limit was echoed by the World Bank (2014). Meanwhile, the Intergovernmental Panel on Climate Change (IPCC 2018a) indicated that the 2^{o}C limit pushes us too close to many global tipping points beyond which recovery becomes a reducing possibility. Thus, they recommend that we absolutely should target 1.5^{o}C if we wish a reasonable chance of retaining a livable planet. Unfortunately, underlining the urgency, emissions to date may have already committed us to the 1.5^{o}C increase (Mauritsen and Pincus 2017).

Global greenhouse gas emissions during 2017 totaled 53.7 Gigatonnes (GT) of carbon dioxide equivalent (IPCC 2018b) which includes between 32.5 (IEA 2019) and 36.5 GT of carbon dioxide (WRI 2018). This implies that between 30% and 40% of the global warming emissions are due to gases other than carbon dioxide. The trends and consequences discussed here are based on readily available data. This underlines the urgency for immediate action across the globe to curtail greenhouse gas emissions if we wish to avoid an increase over 2^{o}C. Considerable variability exists among estimates of the emissions budget remaining if we are to restrict warming to the 1.5°C increase targets (Levin 2018, Carbon Brief 2018). Indeed, the latter source identifies a large range in estimates for a 66% chance of keeping warming to below 1.5°C of between 28 GT and 779 GT. Meanwhile, the IPCC (2018a) indicated that the rate of carbon dioxide emissions alone is currently 42± 3 Gigatonnes annually suggesting that, for a 50% chance at a rise below 1.5°C, the remaining budget for emissions is 580 GT CO_2, while for a 66% chance, the remaining emissions budget is 420 GT CO_2. Considering the current accelerating rate of emissions, the IPCC (2018a) concluded that by 2030 we must impose a reduction in emissions of 45% below the 2010 level and by 2050 we must reach net zero emissions. Considering the increasing impact of greenhouse gases other than carbon dioxide, that seems both conservative and reasonable. Underlining the urgency and imperative of limiting warming to 1.5°C, long ago the World Bank (2014) acknowledged there is: “no certainty that adaptation to a 4^{o}C world is possible.”

Representing the People at the 24th United Nations Framework Convention on Climate Change Conference of the Parties in Poland (COP24), British naturalist and broadcaster Sir David Attenborough argued that in climate change “we are facing a man-made disaster of global scale, our greatest threat in thousands of years…” and "If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon." (Domonoske 2018). The choice is ours!

From the trends and consequences discussed here, all based on readily available data, there should be little doubt that substantial urgency must be attached to addressing this issue.

Solutions:

In addition to individual action wherein we evaluate our actions and adjust our behavior to reduce activities that result in greenhouse gas emissions, or increase those that result in atmospheric greenhouse gas capture and sequestration, we can promote local, state and federal actions that do the same on a larger scale. Local communities can develop Climate Action Plans that promote emissions reductions and capture/sequestration activities. Meanwhile, at the state and federal level, similar such programs can be instituted. The predominant proposals to achieve this involve either

a) imposing a jurisdictional cap on emissions which declines over time to establish a trajectory of emissions reductions that meet long term reductions goals. This approach involves the issuance of allowances to emit that reduce over time. Allowances may be sold/auctioned, or allocated free, or involve some combination.
b) imposing a fee or tax on emissions that rises over time to achieve reductions that are consistent with a desired trajectory and long-term goals.

The cap approach is direct since it involves assessing emissions from target polluters and requiring that reductions occur while the tax/fee approach is indirect since it is based on the assumption that a rising tax will result in reduced emissions.

Both approaches usually involve the generation of funds either via sold/auctioned allowance in the case of the cap, or a fee in the case of the tax/fee approach. The second question associated with either approach involves a decision as to what will be done with the funds raised. One approach is to return these to residents or taxpayers (the individuals who ultimately pay the cost of the pollution reduction); hence the concept of a Dividend. Alternatively, the funds raised can be used to offset allow reductions in other taxes, whether individual or corporate. Finally, these funds may be used for investments that (a) promote activities that themselves lead to reductions in atmospheric greenhouse gas concentrations, either by reducing emissions of promoting sequestration and/or (b) serve the goals of promoting environmental / social justice by assisting communities historically disadvantaged by pollution or likely to suffer disproportionately from the transition to a clean energy economy.

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