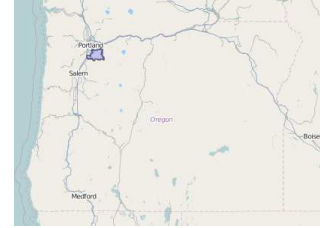




Climate Change in the Oregon 20th Senate District



July 2017

History, Projections, and Consequences

1. The last half of the 20th Century witnessed a temperature increase of about 1°F. Meanwhile, projections suggest a rise of up to 10°F is possible from the average over that period during this century.
2. Snowfall and snowpack accumulation, already dropping is projected to dwindle further, possibly to 10% of historic levels.
3. Annual average precipitation is expected to hold steady but, seasonally, winters are expected to be wetter and summers dryer with more heavy downpours causing floods and erosion.
4. Wildfires, already exhibiting a 2.5 month longer season than in the 1970's, are expected to become more serious, with a 200% to 300% increase in area consumed by mid-century.
5. An increase in wildfires will likely pose a substantially-greater problem for forest and human health.
6. Climatic shifts themselves will likely compromise the viability of important forest and timber species in the district, especially Douglas fir - posing a threat to timber activities.
7. Agriculture, commerce and human water needs will be compromised as summer and fall availability dwindle.
8. With reduced snowpack and summer/fall stream flow, warmer water will likely compromise the ability of streams and rivers to support iconic freshwater species of the region.
9. Tourism, in the form of winter sports and mountaineering, will be negatively affected if Mt. Hood receives less snow, as projected.
10. At the current emissions trajectory, we will exhaust our global emissions allowance in 17 years if we wish to maintain the global temperature increase below 2°C (3.6°F) as international agreements dictate.
11. Main health impacts are likely to be: heat, allergens, and storms and floods. The main health concerns will be: poor air quality, respiratory illness, heat-related illness, harmful algal blooms, recreational hazards, increased allergens, displacement, landslides, economic instability, and mental health impacts. Vulnerable communities will be: low-income households and neighborhoods, communities of color, older adults, people living on steep slopes, people working in agriculture, first responders, and children and pregnant women.



Compiled by Peter Kleinhenz (kleinhenp@sou.edu) 614-202-5161) & Alan Journet (alanjournet@gmail.com), 541-301-4107) June, 2014

For a more complete summary, including sources, from which these points are taken, visit:
<http://socan.eco/oregon-legislative-districts/>

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Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

Climate Change in the Oregon 20th Senate District

Compiled by Peter Kleinhenz

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July 2017

Global and Regional Temperature:

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

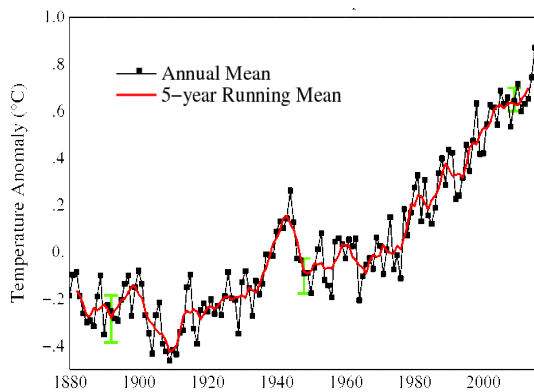


Figure 1. Historic global temperature trend NASA
Goddard Institute for Space Studies 2017.

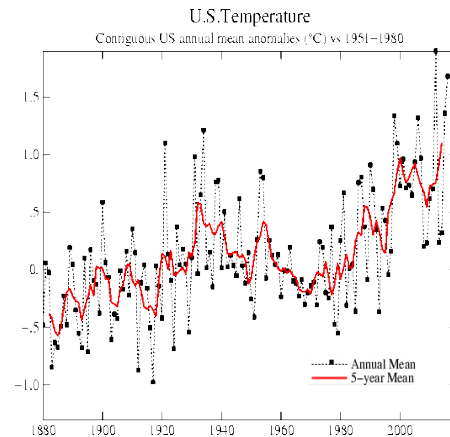


Figure 2. Historic U.S temperature trend. NASA
Goddard Institute for Space Studies 2017.

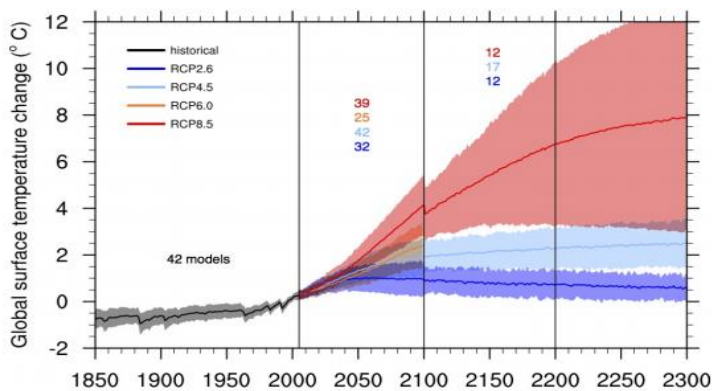


Figure 3. Intergovernmental Panel on Climate Change 2013
global projections.

http://www.climatechange2013.org/images/uploads/WGIA_R5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

Depending on the RCP (Representative [Carbon] Concentration Pathway) we follow globally (Fig. 3), this century may result in from a 2⁰F increase, assuming immediate action, to a high of over a 9⁰F increase. The trajectory beyond the century offers an even more challenging high extreme with an extreme 20⁰F hotter. Meanwhile, temperature projections for the Pacific Northwest (Figure 4) suggest a similar range of temperature increases are possible, reaching – as an average – nearly a 12⁰F increase by the end of the century

under the Business as Usual scenario (RCP 8.5) in which we continue the current trajectory of accelerating emissions.

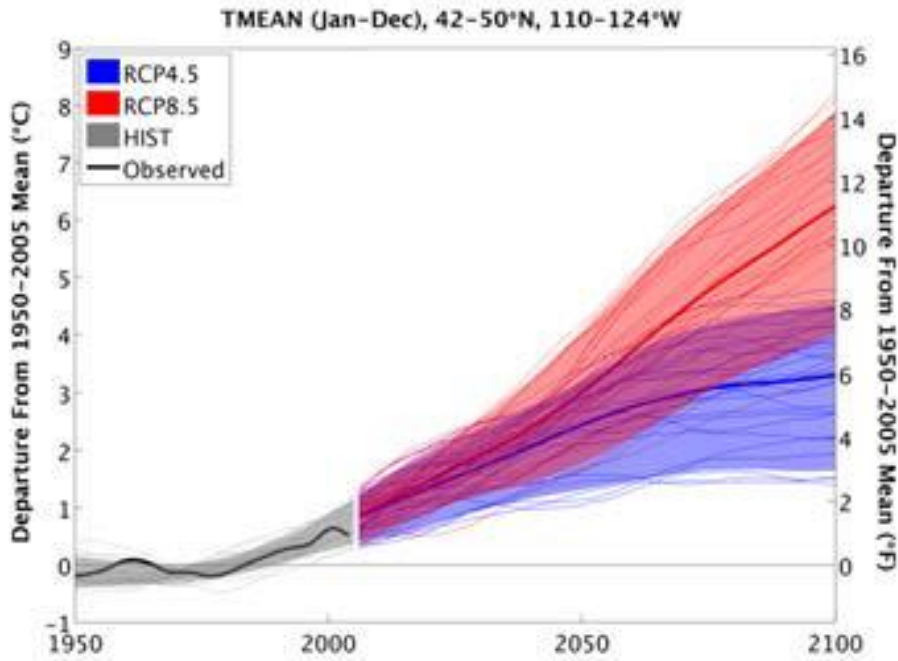


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).

<http://library.state.or.us/repository/2010/201012011104133/summaries.pdf>

The higher range of temperature increase would be unmanageable. It would devastate natural systems (forests, woodlands, shrub lands and the species they support) and simultaneously threaten our climate dependent agricultural, ranching, and forestry activities. Bark beetle and other pest destruction of forests would likely increase as warmer temperatures enhance insect growth and development rates and enable greater overwintering populations. Similarly, invasion of 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:

The 2013 US Climate Change Assessment (Melillo *et al.* 2014) provides projections for future precipitation (Figure 5) 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, summers will likely be considerably drier.

Projected Precipitation Change by Season

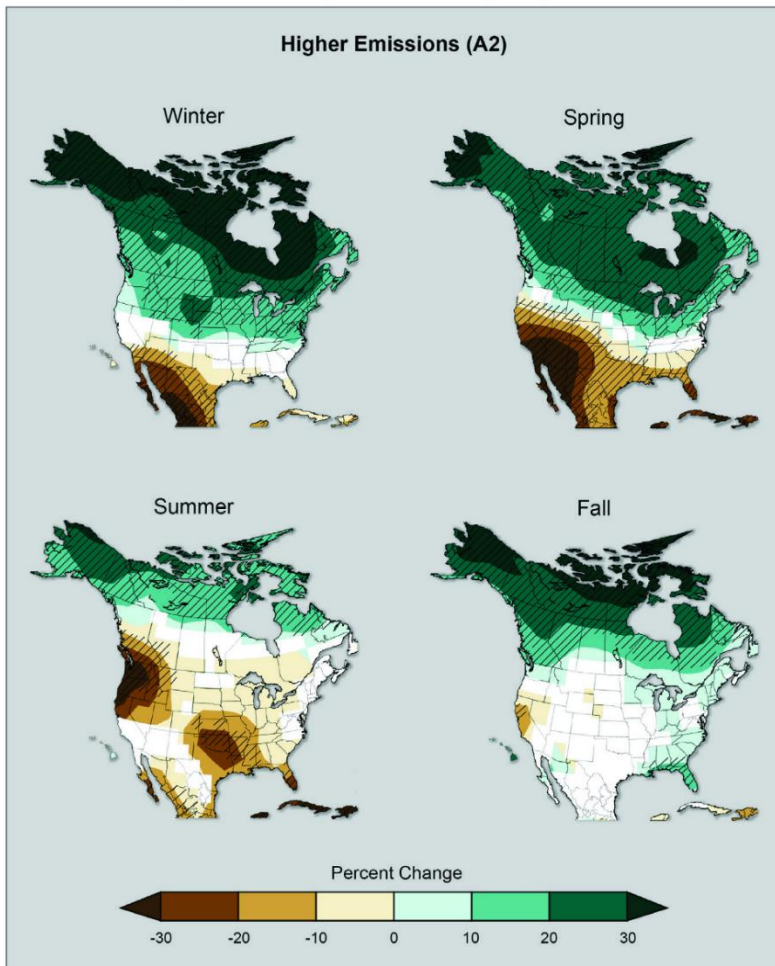


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014).

<http://www.globalchange.gov/what-we-do/assessment>

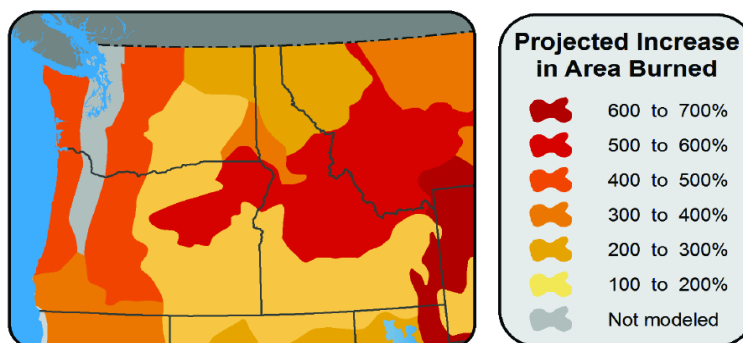


Figure 6. Anticipated wildfire consequences of a 2.2°F warming in area burned (Melillo *et al.* 2014).

<http://www.globalchange.gov/what-we-do/assessment>

Water resources, already severely compromised in many locations, will become more threatened as snowpack declines and precipitation occurs as severe storms rather than the typical light drizzle that rejuvenates soil moisture. This trend will likely enhance floods, soil erosion and potentially landslides.

The reduced stream and river flow occurring during summer/fall will be warmer compromising many iconic Pacific Northwest cold-water aquatic species.

Melillo *et al.* (2013) also offered wildfire projections accompanying just a 2.2°F warming, a condition potentially evident by mid-century (Figure 6).

The fire season, already extended by 2.5 months since 1970 (Westerling *et al.* 2006), will likely become longer and more severe in Oregon, with two to six times as many acres burned. Both human safety and human health will likely be threatened.

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 temperature, warming of oceans in the Northwest between 1900 and this century are already documented with further increases to 2.0 °F by mid-century expected. Besides influencing species directly, temperature changes impact such events as 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 4°C (approximately 37°F). As the ocean warms, it 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. Projections for Newport suggest a potential century rise of between 6” and nearly five feet. Higher sea level poses a greater threat than merely its impact on tidal level. 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 have not received any serious consideration – 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 Acidification. Serious as 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, our oceans are becoming more acidic. This is detrimental for marine organisms with carbon-based shells since 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.

[Closing Sections]

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.

Even though an urban district may not encompass agricultural areas, individuals living in the district assuredly rely on agricultural productivity from neighboring districts. If productivity in such areas is compromised, the price of food will respond accordingly.

Sea Level Rise:

Sea level rise in the Pacific Northwest by 2100 is anticipated to range from 1 to over 4 feet (Melillo *et al.* 2014, Dalton *et al.* 2013). This will likely inundate wetlands, and cause declines in quality of tidal flats and beaches. With higher ocean level the impact of storms will become more dramatic and destructive. Meanwhile, warming oceans will compromise marine migratory species such as salmon while these species and others such as oysters and crustaceans will suffer more extensively as ocean acidification becomes more severe.

The 20th Oregon Senate District Climate History and Projections:

Temperature projections for Clackamas County (Figure 7) show a rise of over a degree during the latter half of the 20 Century with a projected rise of 9 to 10⁰F from the average over that period by the end of this Century. Red lines represent the business as usual scenario of accelerating fossil fuel use and greenhouse gas emissions; blue lines represent a substantial reduction in the emissions trajectory.

Oregon Senate District 20 Climate Summary

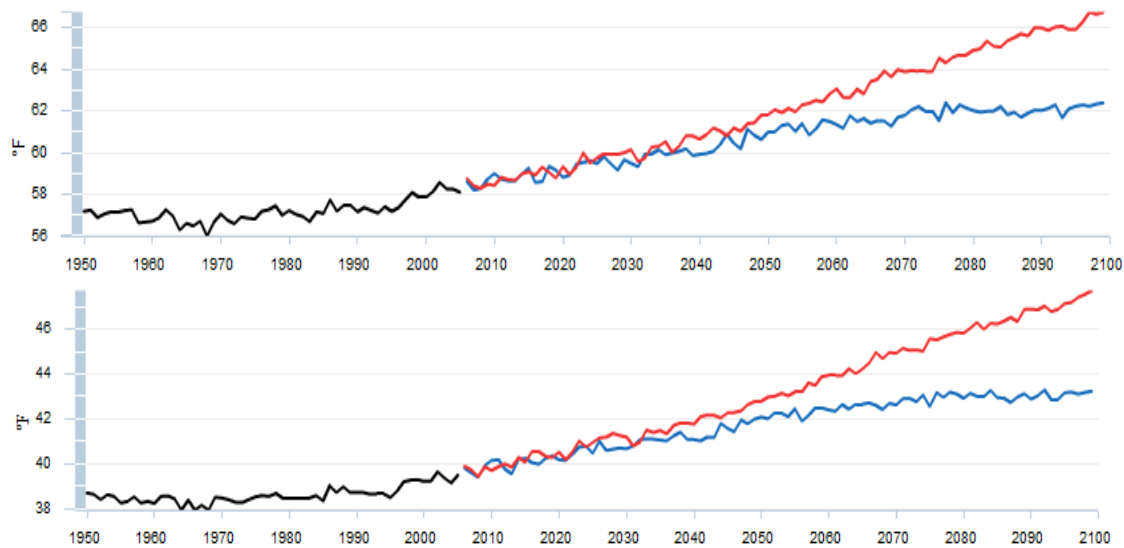


Figure 7. Average Maximum and Minimum temperatures for Clackamas County. Upper is mean maximum temperature, lower is mean minimum temperature (USGS 2017).

Precipitation projections for Portland show no change in mean precipitation levels historically or through the coming century (Figure 8) though with greater variability, meaning wetter and dryer years. However, given the increasing temperature, especially dryer summers, the future is likely to include increased drought.

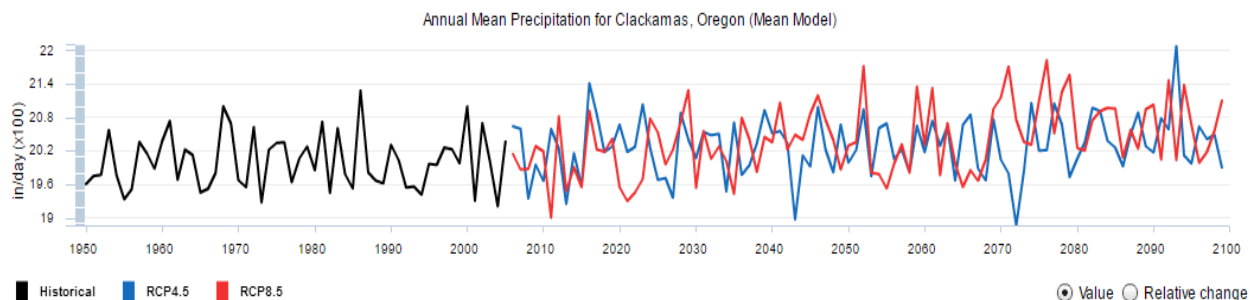


Figure 8. Precipitation history and projections for Clackamas County (USGS 2014)

Snowfall is decreasing rapidly in Senate District 20 (Figure 9), a decrease that is projected to continue through the century regardless of emissions scenario, though the 'business as usual' scenario (red) clearly exhibits a greater drop than that when some emissions limitations are imposed (blue). As snow melts, streams and aquifers get replenished. Senate District 20 will face water scarcity if climate change continues unabated. The social, economic, and environmental consequences of snowfall scarcity are varied and require careful consideration

Oregon Senate District 20 Climate Summary

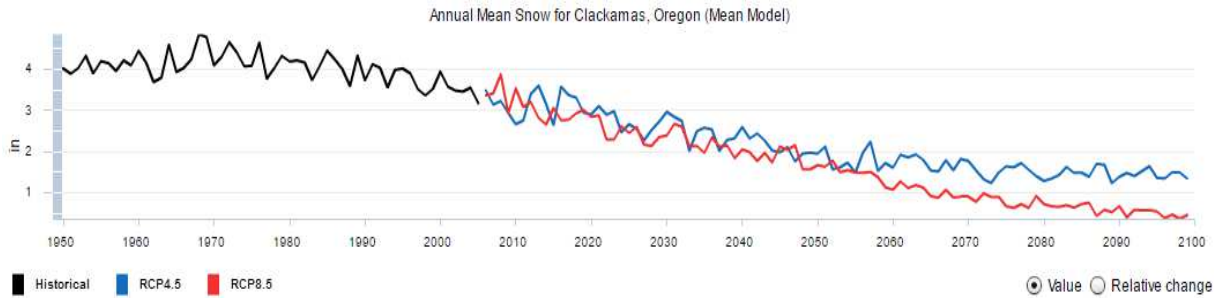


Figure 9. Snowfall history and trends for Clackamas County, Oregon (USGS 2014).

The synergistic effects of higher temperatures, lower precipitation, and snowfall should not be underestimated. Evaporation will increase with higher temperatures and less surface water will be available. Droughts can be expected to lengthen, which will decrease agricultural productivity and increase the risk of wildfires in Senate District 20.

Federal Congressional District Historic Temperature Trend

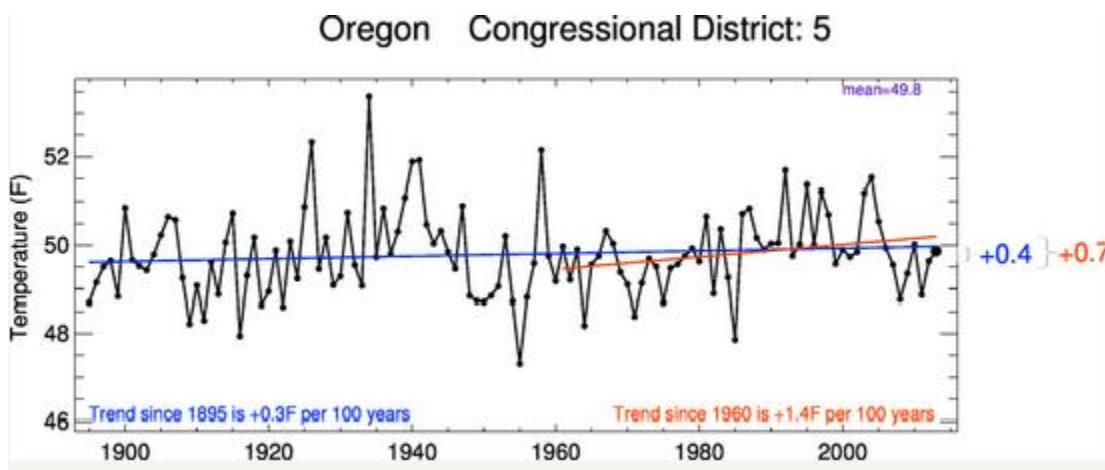


Figure 10. Congressional District 5 historic temperature trends.

<http://temperatretrends.org/district.php?district=5&state=OR>

A large portion of Senate District 20 lies within Oregon's 5th Federal Congressional District. Temperature trends from that district (Figure 10) show that the temperature, on average, has risen 0.4 degrees Fahrenheit since 1895 whereas the temperature rise since 1960 has been nearly twice that rate.

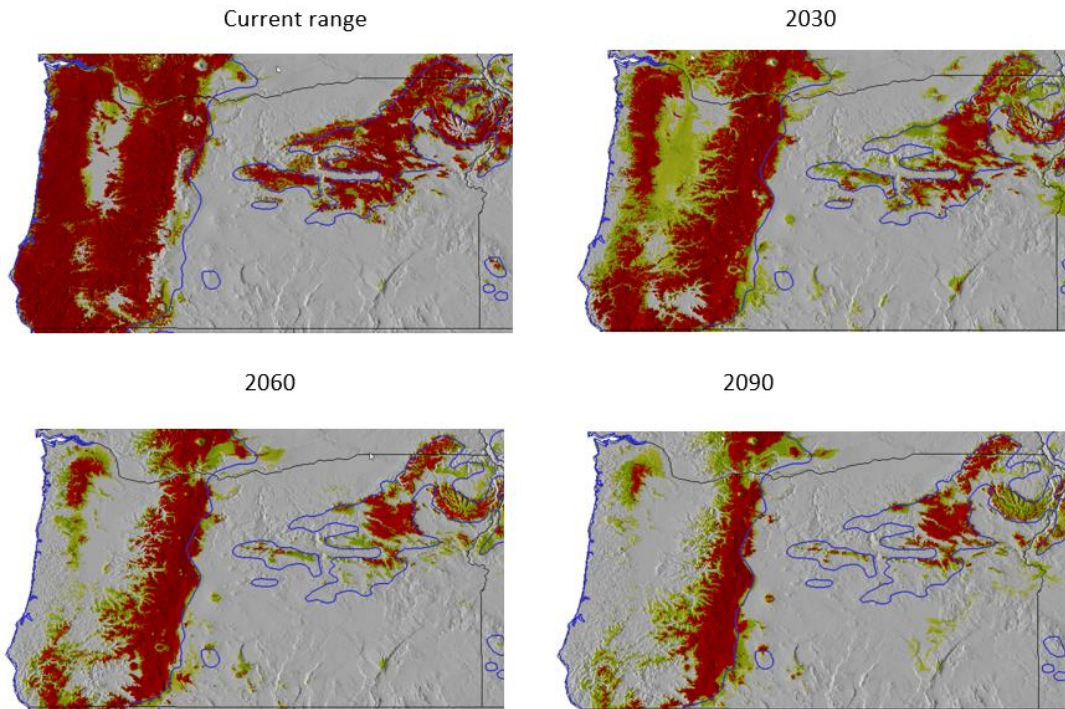
Oregon 20th Senate District Economy:

Climate change would significantly impact the economy of Clackamas County, which the majority of Senate District 20 is contained within. The economy of Clackamas County centers on agriculture, timber, manufacturing, and tourism.

The farms in Senate District 20 are famous for the quality of berries that they produce. From raspberries to marionberries, these fruits grow well in the moderate, moist climate of the area. Climate change is predicted to decrease the amount of precipitation that Senate District

Figure 11| Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century

<http://charcoal.cnre.vt.edu/climate/species/>



20 receives. This, coupled with a rising temperature, could substantially impact the crop production within the Senate District. Although a decrease in crop production will certainly affect Senate District 20 financially, it will also decrease the amount of food available for its residents.

The timber industry, a major economic component of Clackamas County, relies mainly on Douglas fir-dominated forests. The climate envelope projections presented for Douglas fir in Figure 11 indicate that conditions for this species may be severely compromised through the century. This poses a major threat to the regional timber industry. Given the ability of many Oregon forests of to store carbon (Hudiburg *et al.* 2009), it is critical that climatic conditions not diverge such that these important species are compromised.

Manufacturing comprises a large portion of the economy in Clackamas County. Interestingly, it too is tied to climate change. As the federal government increases restrictions on fossil fuel use (a leading cause of climate change) in this country, Clackamas County's manufacturing sector could benefit. Opportunities will increasingly exist to develop the parts

needed to run the abundant wind turbines, and other renewable energy projects, in and around Portland. Clackamas County could lessen the emissions that are driving climate change while growing their economy in preparation for the emphasis on alternative energy projects that are sure to come. In June of 2014, the Obama Administration required states to limit their carbon dioxide emissions substantially by 2030. Additionally, Oregon plans to source twenty percent of its energy from clean, renewable sources by 2020. Clackamas County could be a leader in the manufacturing of alternative energy materials and, as a result, also be a leader in the fight against climate change.

The most iconic natural feature in Oregon stands 11,250 feet above Clackamas County and can be seen from anywhere in Senate District 20. This, of course, is Mt. Hood. Not only is the volcano part of Oregon's natural heritage, but it is home to the only year-round ski resort in the United States. The ski resort is used by thousands of skiers and snowboarders a year, as well as thousands of mountaineers hoping to summit Mt. Hood. These outdoor enthusiasts spend millions of dollars each year in Senate District 20. A decrease in snowfall would limit the number of days these people would be able to enjoy Mt. Hood. Consequently, the economy of Senate District 20 would suffer considerably.

If climatic changes continue unabated, the nature and economic activity contained within Senate District 20 will suffer. Senate District 20 is a prosperous district. If the district is to stay that way, it should recognize its role in preventing the worst potential climate change impacts. Policies made in the next few years should reflect a commitment to addressing the impacts of climate change. Policies made in as little as a decade should reflect adaptation to the changes certain to happen within Senate District 20 unless serious action is taken soon. There will be times in the future when those living in Senate District 20 will have to adapt to inevitable changes. But, for now, we have a moral choice to make about how much we want to reduce the extent of climate change impacts. The choice is yours.

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.

Even though an urban district may not encompass agricultural areas, individuals living in the district assuredly rely on agricultural productivity from neighboring districts. If productivity in such areas is compromised, the price of food will respond accordingly.

Potential Health Risks:

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: heat, allergens, and storms and floods. The top health concerns will be: poor air quality, respiratory illness, heat-related illness, harmful algal blooms, recreational hazards, increased allergens, displacement, landslides, economic instability, and mental health impacts.

Communities that will be especially vulnerable will be: low-income households and neighborhoods, communities of color, older adults, people living on steep slopes, people working in agriculture, first responders, young children, and pregnant women.

A Timeline for Action:

Based on the projected consequences of a warming climate, International agreements (e.g. UN 2009) have established 2°C as a limit beyond which we should not allow the global temperature to climb. This limit is echoed by the World Bank (2012, 2013, and 2014) and the International Energy Agency (IEA 2009).

Table 1 Carbon Dioxide Emissions and Temperature Consequences		
Emissions	Gigatons CO₂ added to atmosphere	Temperature increase
1850 – 2000	1035	0.8°C
2000 – Now	440	1.5°C
Emissions Allowed	825	2°C
Fossil Fuel Reserves	725	3 - 4°C
Accessible Reserves	780	5 - 6°C

The trends and consequences discussed here are based on readily available data. An overall summary of our global temperature trajectory is depicted in Table 1 (from Quick M 2014) This shows that emissions of greenhouse gases to date have induced a temperature rise and inevitable continued rise totaling 1.5°C to 1.6°C (2.7 - 2.9°F) (Dixon 2001). If we wish to avoid an increase over 2°C the math tells us that we can only allow another 825 gigatons (billions of tones) of Carbon dioxide and equivalent emissions. Given that the current annual rate of global emissions is 37 gigatons (Le Quéré *et al.* 2014) and assuming the ‘business as usual’ scenario of accelerating emissions is followed into the future as it has been to date, we will exhaust this budget in about 17 years. Unfortunately, if known and suspected fossil fuel reserves were extracted and burned, the temperature impact would be far more than that

agreed 2°C upper limit. In relation to shooting beyond 2°C, the World Bank (2012) acknowledged there is: “no certainty that adaptation to a 4°C world is possible.”

There can be little doubt that substantial urgency must be attached to addressing this issue.

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