Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

Climate Change in the Oregon 16th Senate District

July 2017

History, Projections, and Consequences

1. The temperature has risen some 0.5°F during the last half of the 20th Century and is anticipated to rise another 8°F above the average for that period if we follow the 'business as usual' scenario of accelerating emissions to continue.
2. The precipitation trend has been level while the projections suggest essentially the same pattern but with greater variability. Seasonally, however, winters are likely to be wetter and summers drier while rain received will fall increasingly in heavy downpours.
3. The current trend of decreasing snowfall is projected to continue through the coming century dropping to < 10% of historic averages.
4. The combination of precipitation and temperature patterns suggests that water availability for human / agricultural needs will be severely compromised during the latter decades of the century.
5. The changing climate is likely to threaten the viability of ecologically and commercially important tree species and increase wildfire risk.
6. The warming climate will also depress the yield of many agricultural crops.
7. 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.
8. The main health impacts are likely to be: storms, floods, and sea level rise. The main health concerns are: disruption in core services, injuries, displacement, landslides, income loss, economic instability, and mental health impacts. Vulnerable communities will be: low-income households, older adults, people living on steep slopes, farmers of fish and shellfish, first responders, young children, and pregnant women.

Compiled by Emily Patrick & Alan Journet (patricke@sou.edu, 541-880-6563)
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For a more complete summary, including sources, from which these points are taken, visit:
http://socan.eco/oregon-legislative-districts/

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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).

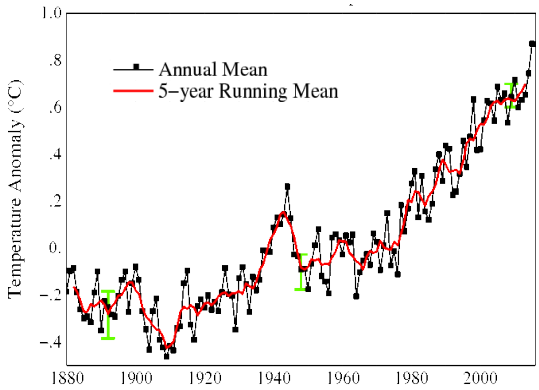


Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2017.

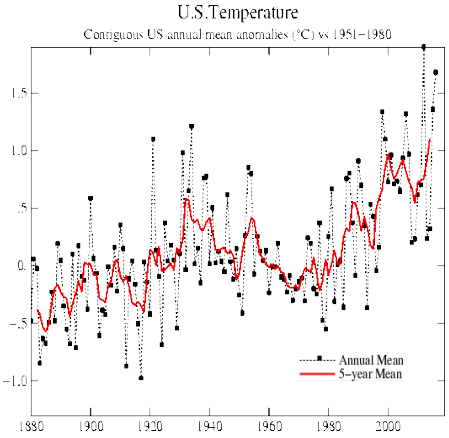


Figure 2. Historic U.S temperature trend. NASA Goddard Institute for Space Studies 2017.

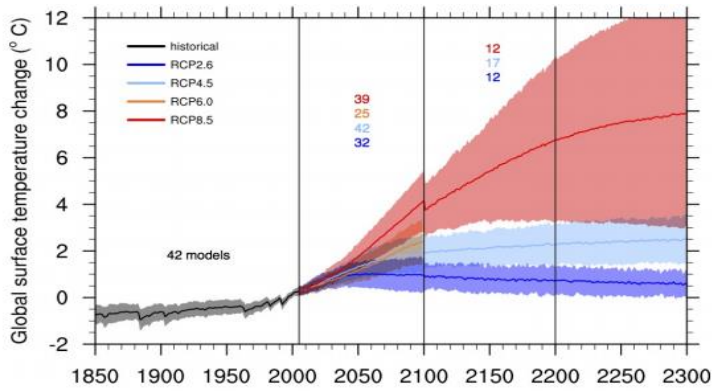


Figure 3. Intergovernmental Panel on Climate Change 2013 global projections.
http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

Depending on the RCP (Representative [Carbon] Concentration Pathway) we follow globally (Fig. 3), this century may result in from a 2^0F increase, assuming immediate action, to a high of over a 9^0F increase. The trajectory beyond the century offers an even more challenging high extreme with an extreme 20^0F 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 12^0F 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.

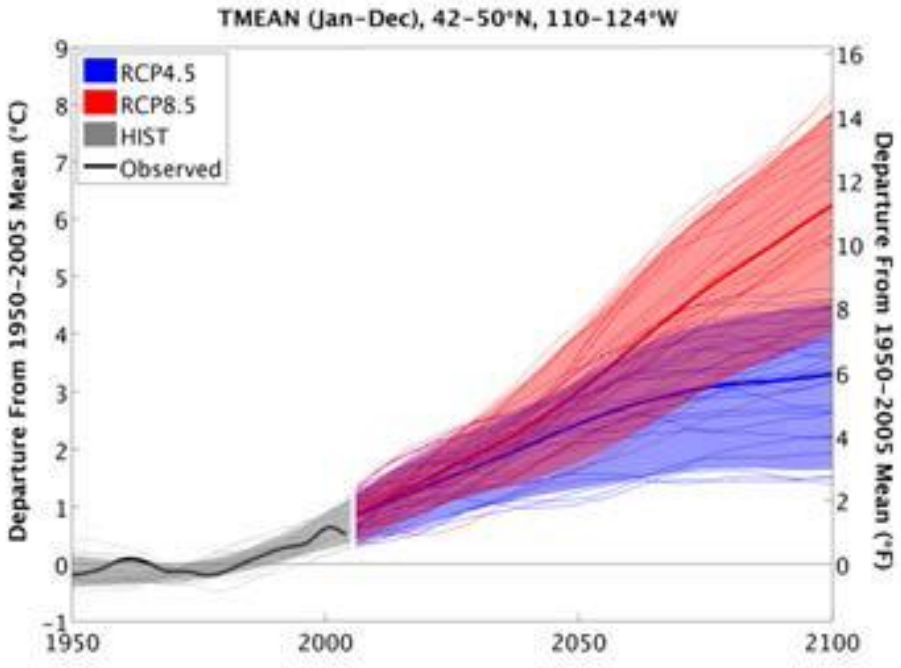


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).
http://library.state.or.us/repository/2010/201012011104133/summaries.pdf

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.

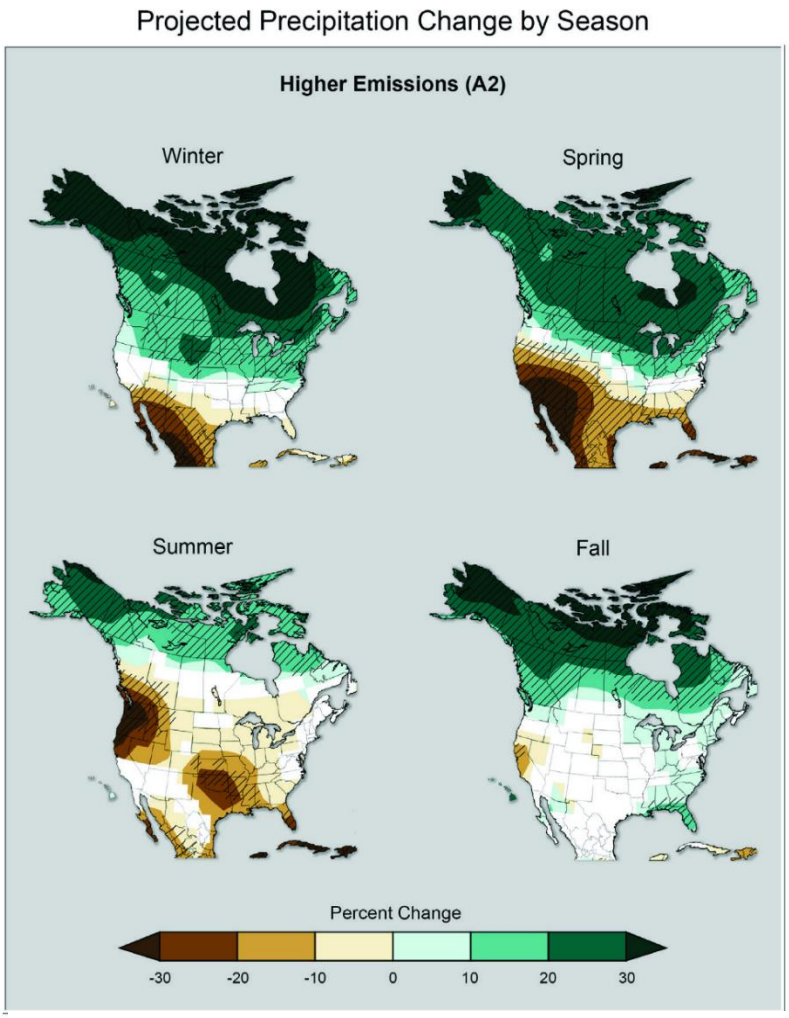


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

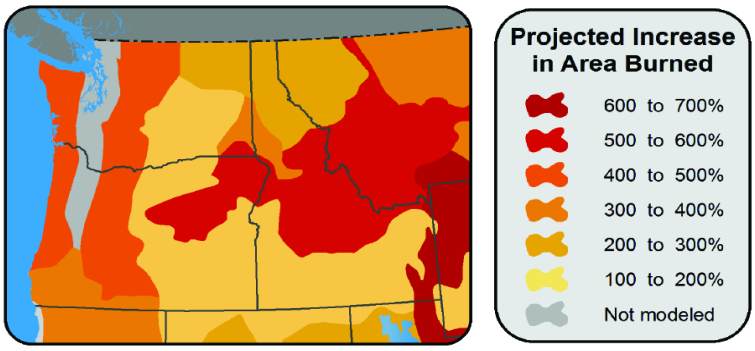


Figure 6. Anticipated wildfire consequences of a 2.2^{o}F warming in area burned (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

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^{0}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 ^{o}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^{o}C (approximately 37^{o}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.

Oregon Congressional Districts 1 and 5

State Senate District 16 falls in Federal Congressional Districts 1 and 5. The temperature trends for these Federal Districts are presented in Figures 7 and 8. When compared to the Oregon overall trend (Figure 10) indicate that the more northerly District (1) was warming slightly faster than the southerly District 5 while both were warming at a slower rate than the Oregon average (Figure 9).

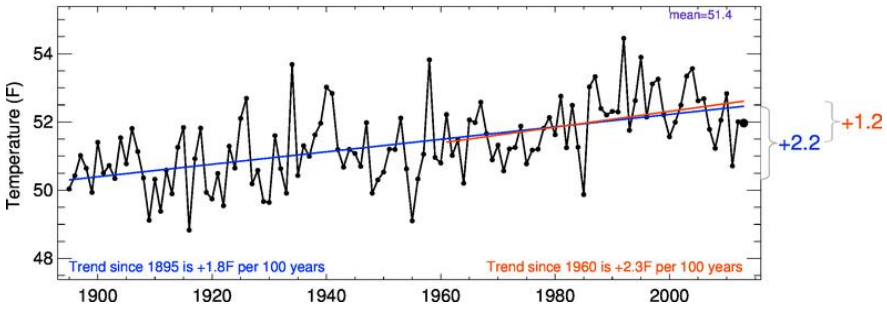


Figure 7. Historic Temperature for Oregon's Federal Congressional District 1.
http://temperaturetrends.org/global.php?district=5&state=OR

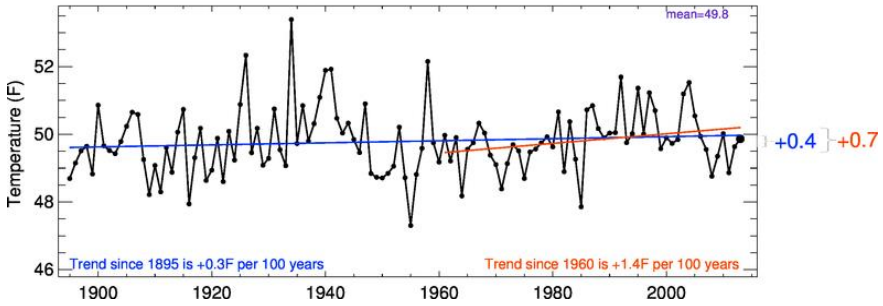


Figure 8. Historic Temperature for Oregon's Federal Congressional District 5.
http://temperaturetrends.org/global.php?district=5&state=OR

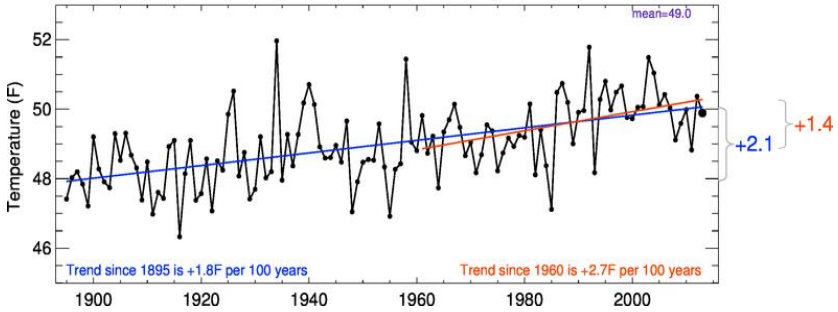


Figure 9. Historic Temperature for Oregon.
http://temperaturetrends.org/global.php?district=5&state=OR

The 16th Oregon Senate District Climate History and Projections:

Although climate change is a complex issue, current models indicate several important trends in weather and climate that Oregon's 16th senate district is likely to experience if greenhouse gas emissions continue to increase.

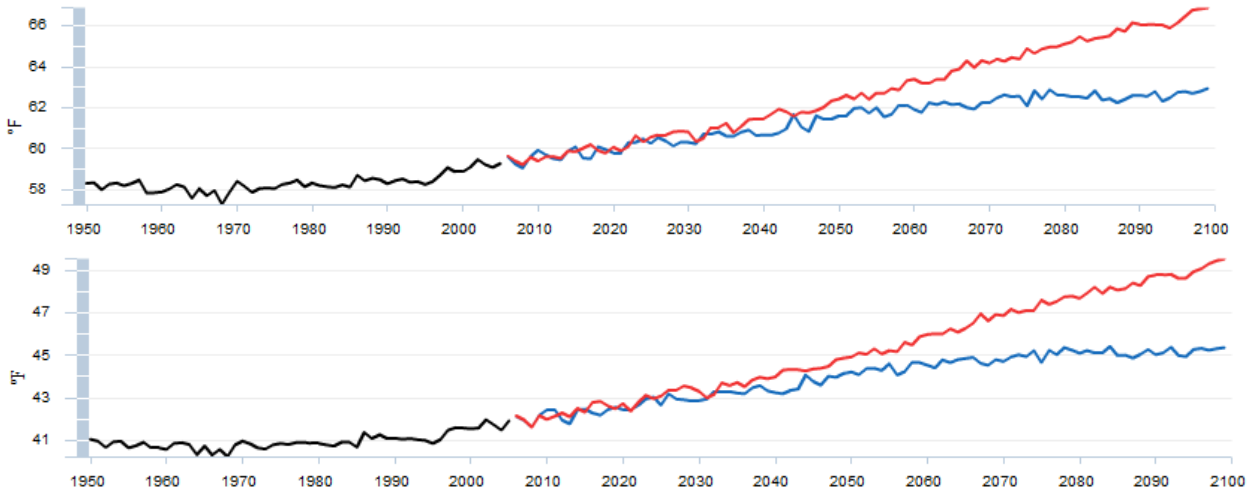


Figure 10. Historical and projected temperature for Clatsop County; upper is mean maximum, lower is mean minimum. USGS 2017

For Clatsop County, the historical temperature trend for the last half of the 20th Century exhibited a rise of over 0.5°F (Figure 10). The business as usual scenario of increasing fossil fuel use and greenhouse gas emissions indicates a further rise beyond the late 20th Century average of over 8°F (red line) while reducing the emissions trajectory substantially will decrease that to about 4°F.

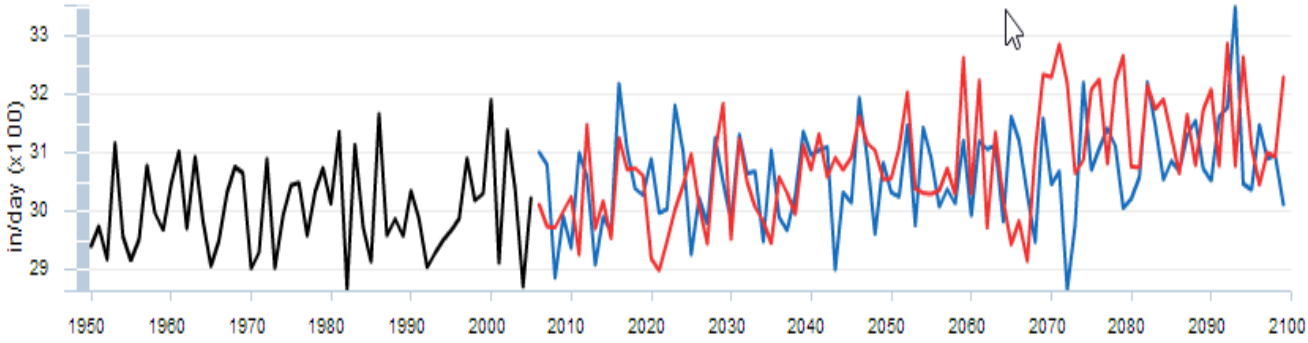


Figure 11. Historic and projected precipitation trends for Clatsup County, Oregon. Red represents a high emissions scenario, while blue a lower emissions future. USGS 2017.

The historic and projected trend in precipitation for Clatsup County (Figure 11) indicates a relatively consistent pattern into the future but increasing variability with wetter and drier year

extremes. However, with increasing temperature and evaporation, and the seasonal precipitation pattern exhibited in Figure 5 such a trend will likely lead to increased drought.

Meanwhile, snowfall, represented by Clatsup County (Figure 12), in the 16th Senate District has been declining recently, a trend that has many adverse impacts on the district such as reduced water for natural communities, crop irrigation, and human consumption. The projected trend in snowpack is for a continued decline, possible to only 10% of historical levels by late century. Combined with the trend towards precipitation falling in heavy downpours on few days rather than light rain on many days as seen historically, this will likely result in earlier and decreased stream flow, a consequence that poses a serious threat to those agricultural activities dependent on late summer and early fall snowmelt as an irrigation source. These trends suggest a future with more severe wildfire seasons.

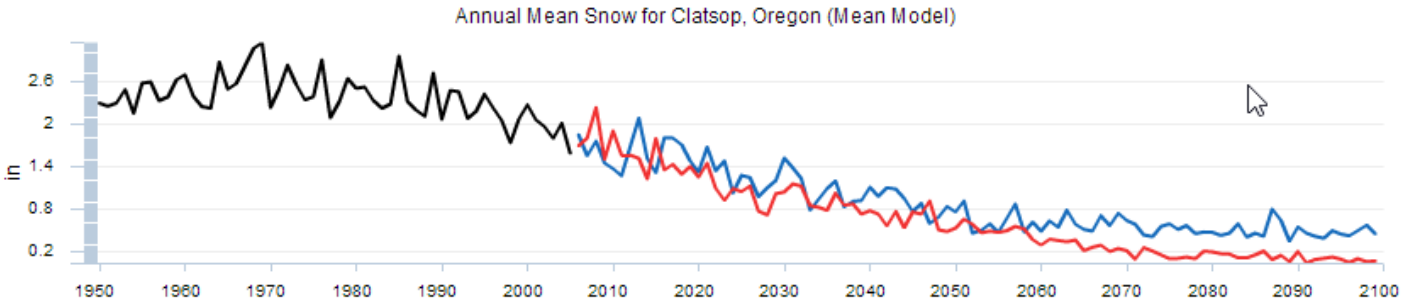


Figure 12. Snowfall trends and projections for Clatsup County, Oregon. Red represents a high emissions scenario, while blue a lower emissions future. USGS 2017

Snowfall and consequent snowpack accumulation have been declining for decades both at Crater Lake and in the northern Siskiyous, compromising water supplies through the summer and drying soil and vegetation.

Oregon 16th Senate District Economy:

Although much of Oregon's 16th Senate district consists of urban areas whose economies focus on manufacturing, retail sales, transportation, technology, tourism and the like, much of the region's economy is still dependent on agriculture and the timber industry. These industries, unfortunately, will be threatened as climate change progresses.

As was outlined above, under current carbon emissions scenarios, temperatures in Oregon's 16th senate district are expected to rise in the next century, winter chill period and snowpack are expected to decline, and less snowpack combined with a shorter period of snowfall means a longer summer drought period, as well. All scenarios will pose a problem for agriculture, especially for orchards, which are important staples of the region's economy. Irrigation will become increasingly difficult. Pear growers know that this crop requires a significant winter chill

period in order to produce, and climate change threatens to shorten that period. Some crops require a specific temperature range in which to grow, and rising temperatures over the next century mean that Oregon's 16th senate district may become a less favorable place to grow some of its most important crops as climate change continues to progress.

The dominant commercial tree species processed in the region are Douglas fir, Western hemlock, Sitka spruce, and Incense cedar. The current and projected distributions of these species are depicted in Figures 13 – 16.

Figure 13 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

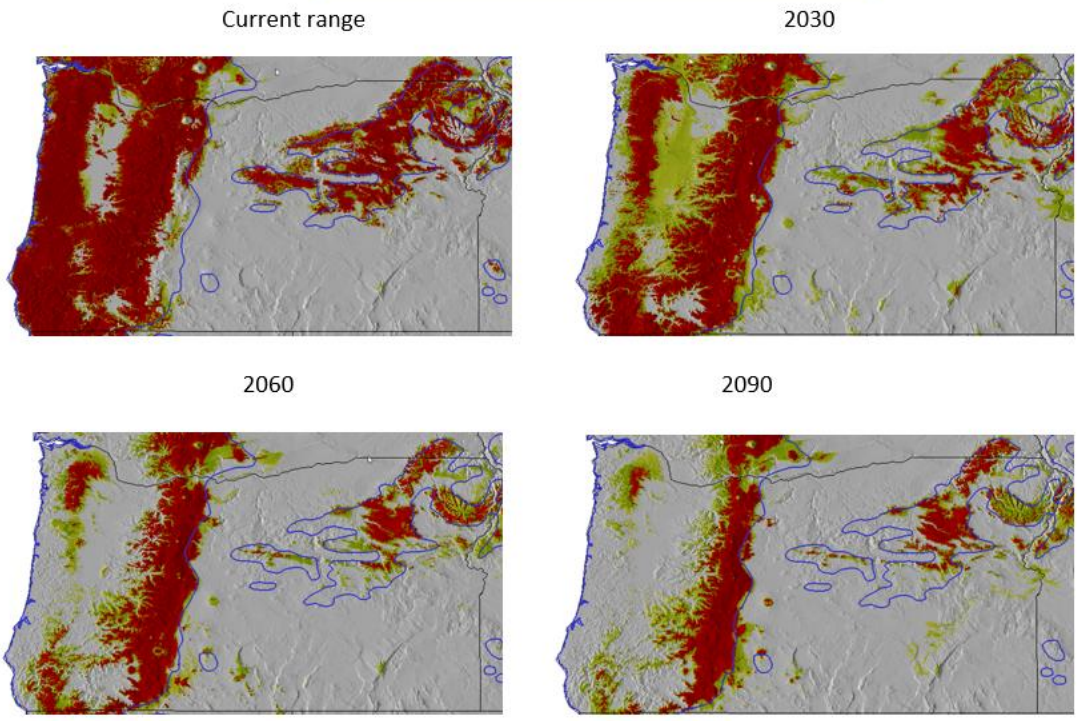


Figure 14 Western hemlock (*Tsuga heterophylla*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

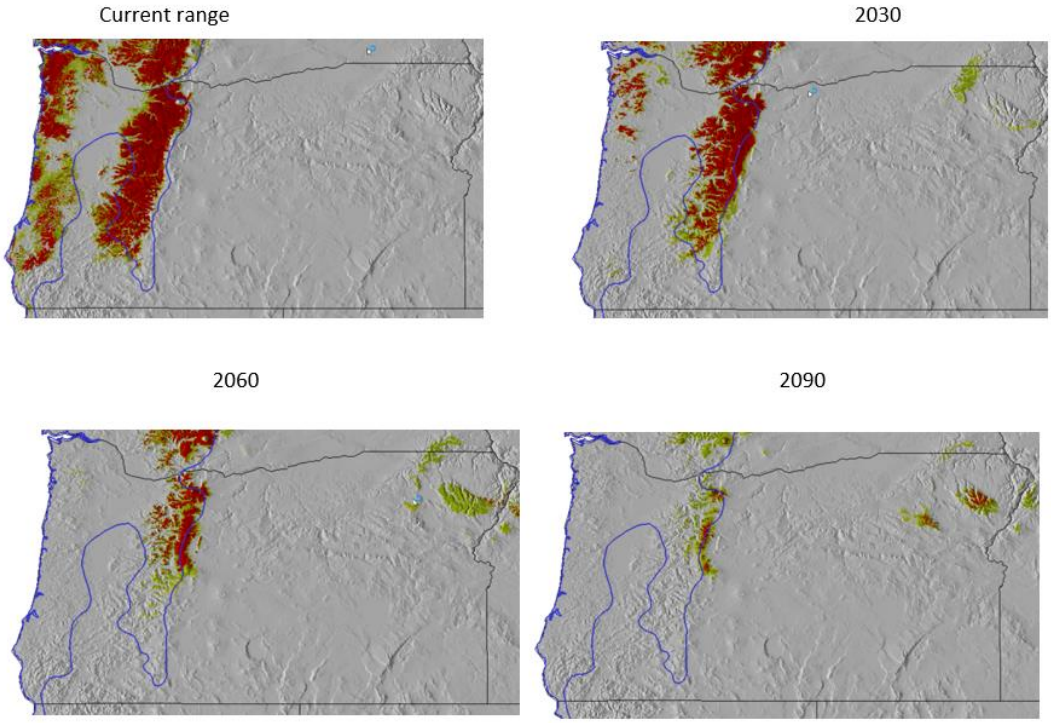


Figure 15 Sitka spruce (*Picea sitchensis*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

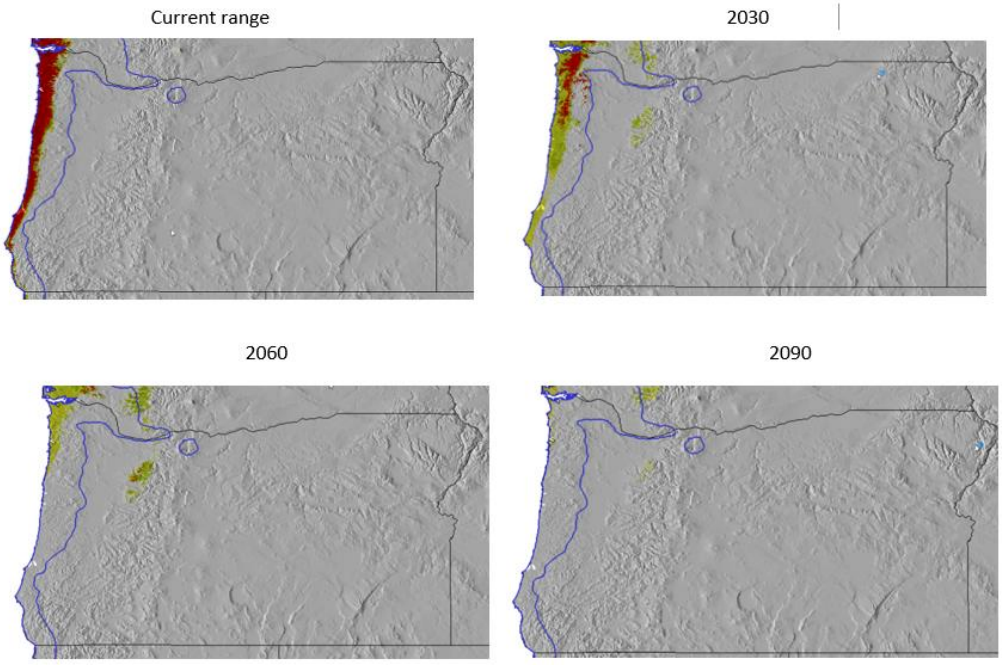
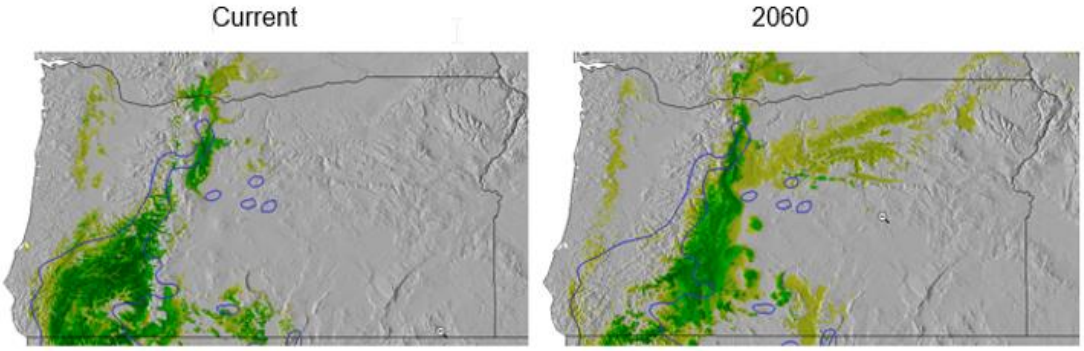


Figure 16 Incense cedar (*Calocedrus decurrens*) Current and Projected distribution http://charcoal.cnre.vt.edu/climate/species/



The evidence suggests that the viability and distribution of these species will be diminished over the coming century if climate change continues according to the 'business as usual' scenario. Given the ability of many Oregon forests to store carbon (Hudiburg *et al.* 2009), it is critical that climatic conditions not diverge such that these important species are compromised.

Coastal areas need be especially concerned about the threats climate change poses. Projected sea level rises on the Oregon coast range from 5" to over 6 feet. Even a change in seal level of 5" over the next century could be detrimental to coastal infrastructure and development. The Port of Portland continues to be one of the largest and most economically valuable ports not only on the West coast, but in the nation. If sea levels rise over 6 feet in the coming century, then major steps need to be taken to ensure that the port can handle such a change. If the port's infrastructure becomes compromised, this could be a devastating blow to economy of the region, the state, and the nation.

Likewise, Portland International A airport is also a major state and national point of entry. Increases in extreme weather events are expected to be a part of climate change, and these extreme weather events could shut down traffic in and out of the airport on a regular basis.

Climate change is here, it's happening, and it will to continue unless government officials at all levels decide to act now. If action is not taken to mitigate problems associated with climate change *before* they arise, then Oregon's 16th Senate district's economy could face dire consequences.

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.

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.

Potential Health Risks:

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: storms, floods, and sea level rise. The main health concerns resulting from these are: disruption in core services, injuries, displacement, landslides, income loss, economic instability, and mental health impacts. Communities that are especially vulnerable will be: low-income households, older adults, people living on steep slopes, farmers of fish and shellfish, first responders, and 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^{o}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 CO_2 added to atmosphere	Temperature increase
1850 – 2000	**1035**	**0.8^{o}C**
2000 – Now	**440**	**1.5^{o}C**
Allowed	**825**	**2^{o}C**
Fossil Fuel Reserves	**725**	**3 - 4^{o}C**
Accessible Reserves	**780**	**5 - 6^{o}C**
Additional Reserves	**1280**	**??**

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^{o}C to 1.6^{o}C (2.7 - 2.9^{o}F) (Dixon 2001). If we wish to avoid an increase over 2^{o}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 in excess of that agreed 2^{o}C upper limit. In relation to shooting beyond 2^{o}C, the World Bank (2012) acknowledged there is: "no certainty that adaptation to a 4^{o}C world is possible."

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

Contact your senate representative, Senator Betsy Johnson

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Website: http://www.oregonlegislature.gov/mitchell

Literature:

Brown L 2006 *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble.* W.W. Norton, & Co. N.Y. London 365 pp

Dalton, MM., PW. Mote, and A.K. Snover [Eds.] 2013. *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities.* Washington, DC: Island Press, 230 pp.

Dixon 2001 *Global Warming Commitment: Temperatures Would Rise Even with No Further Additional Greenhouse Gas Increases.* NOAA. http://www.gfdl.noaa.gov/cms-filesystem-action?file=/user_files/kd/pdf/onepageb01.pdf

Hudiburg T, Law B, Turner D, Campbell J, Donato D, Duane M. 2009. Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. *Ecological Applications* 19: 163 – 180.

IEA 2009, *World Energy Outlook*, International Energy Agency, Paris, France, 691 pp

IPCC 2013. Climate Change 2013: The Physical Science Basis; Summary for Policymakers WGI IPCC Switzerland.

Le Quéré C, Moriarty R. Andrews R, Peters G, Ciais P, Friedlingstein P, Jones S, Sitch S, Tans P, Arneth A, Boden T, Bopp L, Bozec Y, Canadell J, Chevallier F, Cosca C, Harris I, Hoppema M, Houghton R, House I, Johannessen T, Kato E, Keeling R, Kitidis V, Klein Goldewijk K, Koven C, Landa C, Landschützer, Lenton A, Lima I, Marland G, Mathis J, Letzl N, Nojiri Y, Olsen A, Ono T, Peters W, Pfeil B, Poulter B, Raupach M, Regnier P, Rödenbeck C, Saito S, Salisbury J, Schsuter U, Schwinger J, Séférian R, Segcshneider J, Steinhoff T, Stocker B, Sutton A, Takahashi T, Tilbrook B, van der Werf G, Viovy N, Wang Y 2014 *Global Carbon Budget 2014* Earth System Science Data 7: 521-610.

Melillo, JM., TC. Richmond, and GW Yohe, [Eds.] 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Miller SM, Wofsy SC, Michalak AM, Kort EA, Andrews AE, Biraud SC, Dlugokencky EJ, Eluskiewicz J, Fischer ML, Janssens-Maenhout G, Miller BR, Miller, JB, Montzka SA, Nehkorn T, Sweeney C. 2013, Anthropogenic emissions of methane in the United States. *Proceedings of the National Academy of Science*. 110 (50) http://calgem.lbl.gov/Miller-2013-PNAS-US-CH4-Emissions-9J5D3GH72.pdf

NASA Goddard Institute for Space Studies July 2017 *GISS Surface Temperature Analysis.* Retrieved from NASA Goddard Institute for Space Studies: https://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif and http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.D.gif

Oregon Health Authority 2014, Oregon Climate and Health Profile Report, Climate and Heath Program, Public Health Division, Oregon Health Authority: Summary provided by Emily York MPH, Climate & Health Program Coordinator, Oregon Public Health Division, Oregon Health Authority.

http://public.health.oregon.gov/HealthyEnvironments/climatechange/Documents/oregon-climate-and-health-profile-report.pdf

Quick M, 2014 *How Many Gigatons of Carbon Dioxide…?* http://www.informationisbeautiful.net/visualizations/how-many-gigatons-of-co2/

UN 2009 *United Nations Framework Convention on Climate Change: Copenhagen Accord*. United Nations, Stockholm, Sweden. http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf

USGS 2017 National Climate Change Viewer (NCCV) United States Geological Survey **https://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp**

Westerling A, Hidalgo H, Cayan D, Swetnam D,2006 "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity" *Science* 313 no. 5789: 940-943.

World Bank 2012, *Turn Down the Heat: Why a 4^{o}C Warmer World Must be Avoided*. The World Bank, Washington DC. 84pp

World Bank 2013, *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience*. The World Bank, Washington DC. 213pp

World Bank 2014, *Turn Down the Heat: Confronting the New Climate Normal*. The World Bank, Washington DC. 275pp