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A Rogue Valley Climate Summary

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This brief summary of the climate trends and projections for the Rogue Valley is designed to stimulate reflection on the trends we are experiencing and the projections we might expect during the coming century assuming globally we follow the business as usual (BAU) scenario of accelerating greenhouse gas emissions from fossil fuel consumption and other human induced sources. Of course, if we reduce our emissions trajectory, Rogue Valley's future reality may not be as severe as these projections suggest.

Temperature:

Using Medford as an exemplar, data from the NOAA National Weather Service Office (Figure 1) reveal the trend for the Rogue Valley..

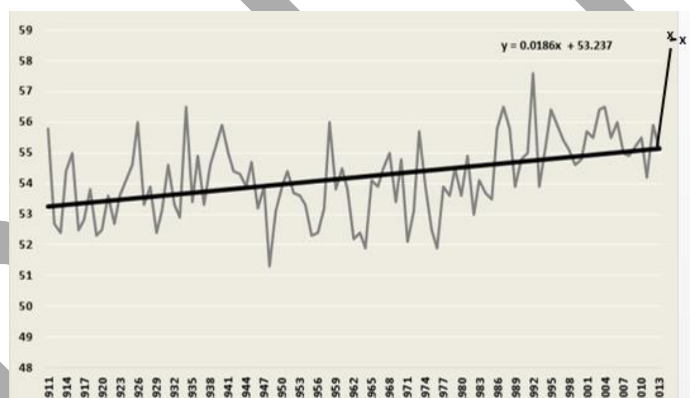

Figure 1. NOAA Temperature data for Medford reveal a warming of 1.8ºF per century from 1911- 2013, with 2014 and 2015 exhibiting considerably warmer averages above that trend.

Data from the United States Geological Survey (USGS) for Jackson County (Figure 2)) depict average annual maximum and minimum trends (in black) from 1950 until 2005 with projections until 2100 where red represents the BAU scenario (RCP 8.5) and blue a scenario (RCP 4.5) where emissions are substantially reduced to about 50% of the BAU warming impact. (http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp

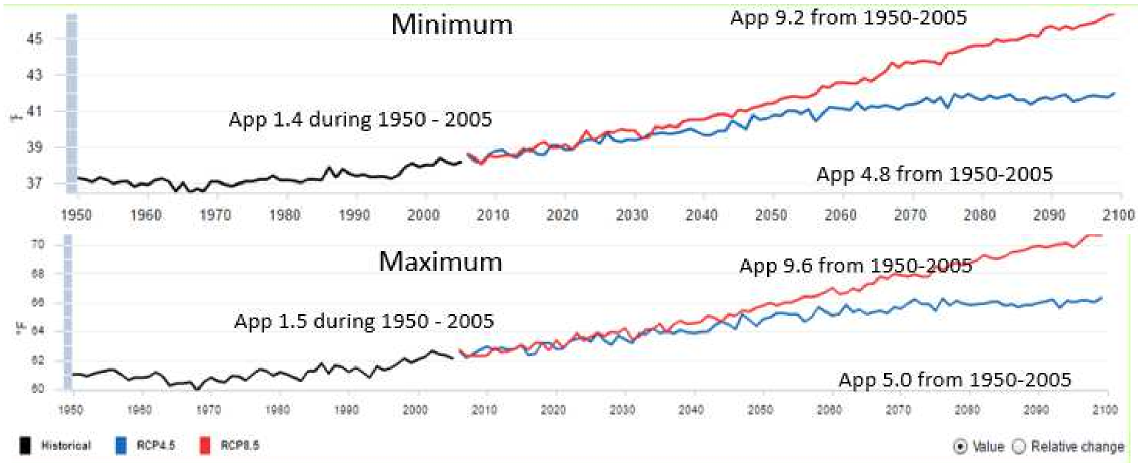

Figure 2. USGS min and max temperature trends and projections for Jackson County.

Figures 1 and 2 combine to indicate the historical trend for the region as typical of the global pattern in that the greatest warming has occurred since the late 1970s / early 1980s. Both data sets reveal a profound warming during the 20th century while Figure 2 (averaging the max and min projections) reveals a BAU increase by the end of the century of some 9.4°F compared to the second half of the 20th century. USGS data (from the same source) show similar patterns throughout the Rogue Valley. The only difference is that the Josephine County warming trend to date is a little over 1°F with a projected increase of 8.8°F while for Curry the trend is comparable and the projection is for an increase of 8.35°F. Klamath County, meanwhile, has warmed about 1.5°F and is projected to warm 9.9°F by century's end. The pattern wherein coastal counties with Maritime Climates exhibit less warming (trends and projections) than more inland counties extends across Oregon and California. Malheur County, for example, may warm 10.9°F by the end of the century.

Also important, from a temperature perspective, is the extent of heat waves. For example, the number of days over 100°F has increased in Medford from about 7 to 11 during the last century. Meanwhile, the region is expected to experience a further increase up to some 45 days over 100°F by the end of the century.

Precipitation

Typical of Mediterranean climes everywhere, the region experiences a pattern of winter wet summer dry conditions. Throughout the basin, the trend in average precipitation during the last century has been essentially flat. Figure 3 presents NOAA data for Medford.

USGS trends and projections for Jackson County, presented in Figure 4, indicate the same historic trend future – though both exhibit considerable year-to-year variability.

Precipitation trends and projections for Josephine and Curry counties exhibit similar patterns, though with higher annual averages towards the coast. Curry County receives three times the annual average of Jackson County.

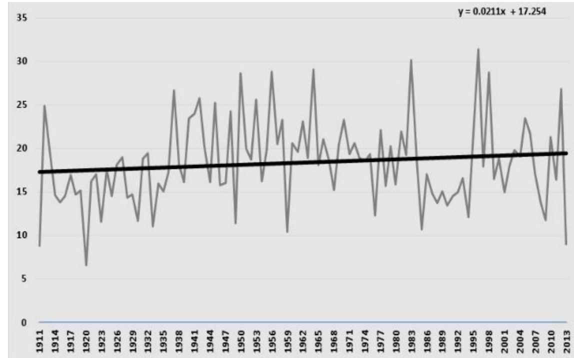

Figure 3. NOAA precipitation data for Medford reveal an insignificant (i.e. no) increase.

Although the annual average is expected to remain reasonably constant, two additional variables of importance are seasonal and intensity patterns. The trend in seasonality will likely lead to wetter winters and dryer summers. Meanwhile the trend we are already seeing towards precipitation falling in more intense events will also likely continue. These trends are unfortunate since the first leads to dryer conditions during summer and fall, exactly when natural and agricultural systems both need the moisture, while the trend towards increasing intensity of events means more floods and soil erosion rather than soil moisture recovery.

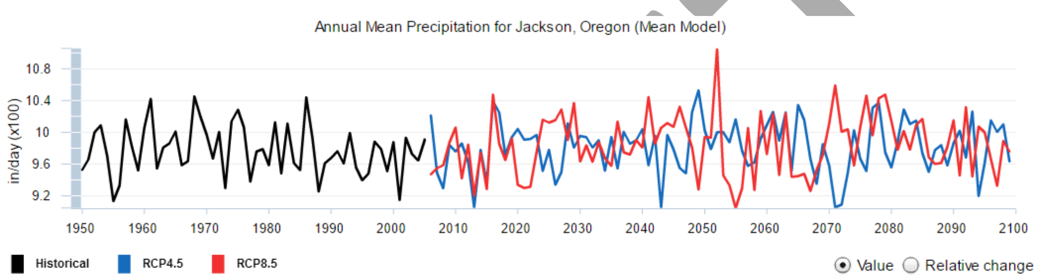

Figure 4. USGS precipitation trend and projections for Jackson County

A particularly important component of precipitation is snowfall, especially mid-high elevation snow water equivalent (SWE) accumulation. This is because the Pacific Northwest has historically used snowpack as its summer – fall reservoir.

Crater Lake (Figure 5) reveals the pattern in mid-elevation snowfall typical of the Southern Oregon Cascades. This pattern is also evident for Medford, and in the USGS data for Klamath, Jackson (Figure 6), Josephine, and Curry Counties where a decline from the 1970s is particularly evident.

The trend and projections throughout the Rogue Basin are similar, with SWE declining to some 10% of historical levels by the end of the century.

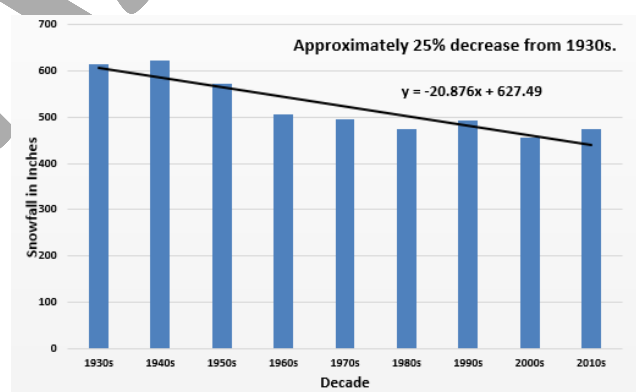

Figure 5. Crater Lake National Park snowfall data from the 1930s

Among the consequences of these trends and projections are stream flow adjustments. With reduced snowpack and earlier snowmelt, peak stream flow has already shifted earlier through much of the region and is expected to shift further forward, to the detriment of downstream systems that depend on summer and fall streamflow.

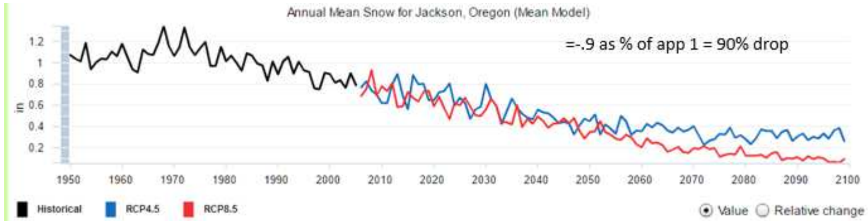

Figure 6. USGS Snow Water Equivalent trend and projections for Jackson County

The USGS also offers trends and projections for evaporative deficit (Potential Evaporation minus Actual Evaporation). The trend for Jackson County (Figure 7), showing a historic and projected increase, is typical.

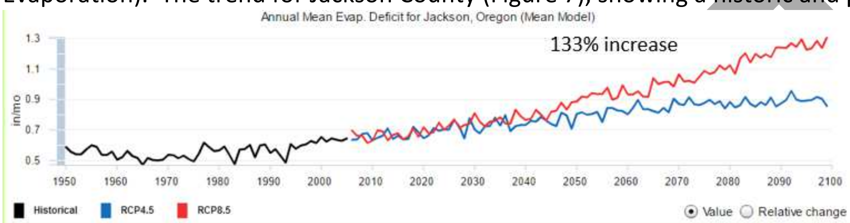

Figure 7. USGS Evaporative Deficit trend and projections for Jackson County

Given the above trends, it little surprise that the USGS trends and projections for soil moisture exhibit reduction. The trend and projections for Jackson County (Figure 8) are typical of the Basin. The decline in soil moisture storage, which again started in the 1970s/1980s, is likely to exhibit a drop of 20% by the end of the century.

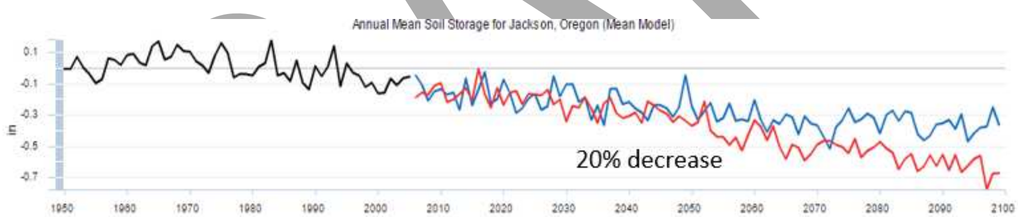

Figure 8. USGS Soil Moisture trend and projections for Jackson County

Impacts:

The main impacts of these trends are on biological systems since these are totally dependent on temperature and water availability for their viability.

Several decades ago, R.H. Whittaker (1975) developed a valuable chart (Figure 9) depicting the distribution of the world's natural systems (biomes) in relation to average annual temperature and precipitation. The distribution of biomes around the world is determined largely by these two variables (in combination with soil characteristics). The message is that if these variable are modified, even minimally for biomes on the edge of current conditions, the survival of current biomes and the species of which they are composed will likely be severely undermined to the point of their being eliminated at east regionally and maybe globally.

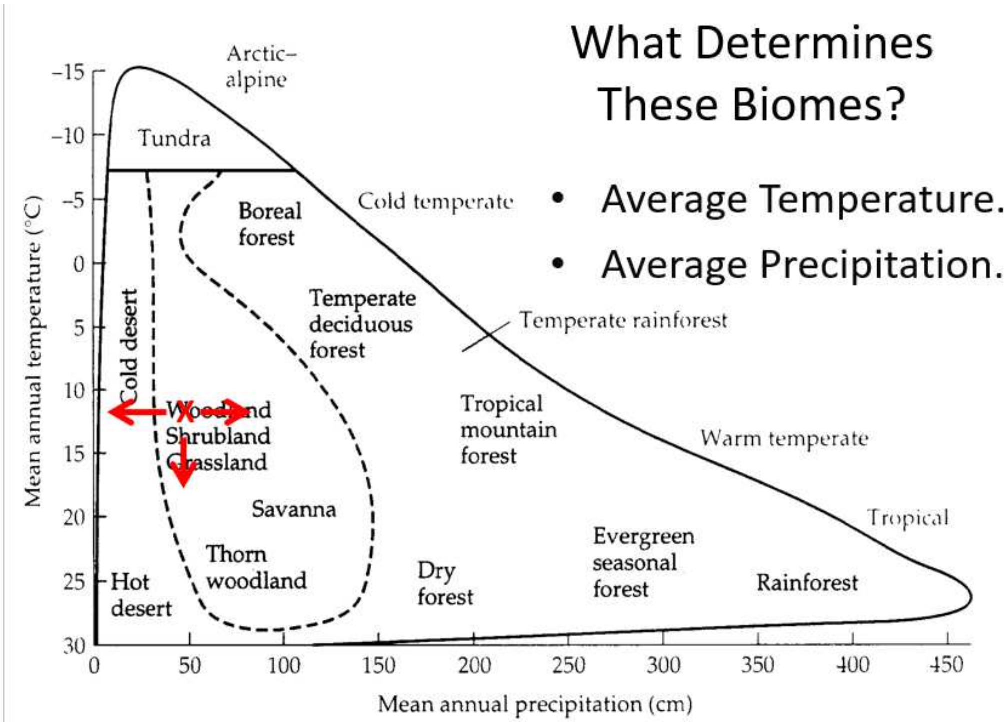

Figure 9. Whittaker 1975 chart depicting biome distribution in relation to temperature and precipitation

The relevance of threat to these natural systems posed by a changing climate is not limited to the loss of biodiversity (native flora and fauna, wildlife), our outdoor recreation areas, critical watersheds, and valuable resources such as forests, it also has direct relevance to us. This is because human agriculture is dependent on exactly the same two variables that control the success of biomes. The best illustration of this is the fact that the American grain belt down the central bank of states of the country exists where the natural biome of grassland / prairie historically existed. Thus, if we compromise natural biomes, we also compromise our own agriculture, and, of course, our own commercial forestry.

By modeling future conditions globally under different atmospheric greenhouse gas concentration scenarios, Williams and Jackson (2007) illustrated the problem clearly (Figure 10). They explored future carbon dioxide concentrations of 850 and 550 ppm (parts per million) compared to the historical (pre-industrial revolution) concentration of about 280 ppm and the current concentration of about 400 ppm. The concentrations they chose represent where we might reach by mid-century according the BAU scenario (850 ppm) compared to the scenario comprising a reduced emissions trajectory (550 ppm). Among the questions they posed was: is there anywhere, within 500 kilometers (about 300 miles) of their current location, that current biomes might find conditions appropriate? This value is a reasonable generalization for biomes since native flora have a limited

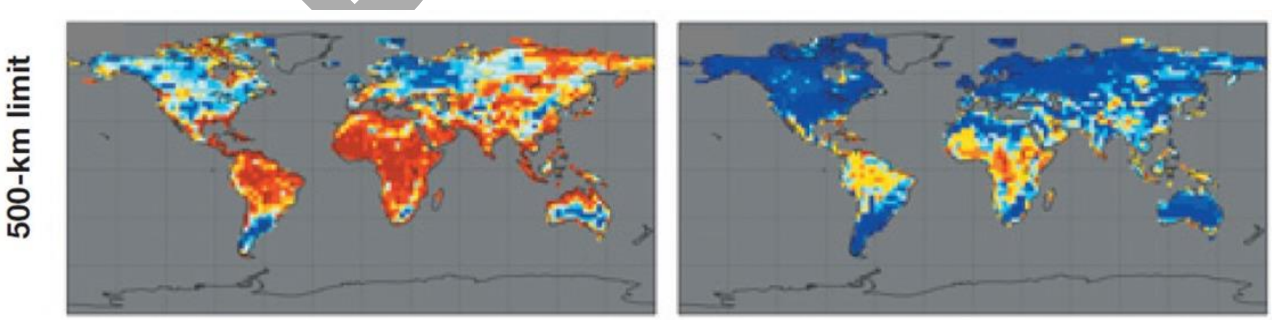

Figure 10. Williams and Jackson (2007) depictions of future biome survival probability under two atmospheric carbon dioxide concentration scenarios.

capacity for dispersal to new locations. This is controlled by the dispersal capacity of propagules (seeds and juveniles). Additionally, human infrastructure (cities, roads etc.) now present barriers to the natural dispersal potential of species. The results of their study are depicted in Figure 10. Areas that are red indicate there is no possibility that biomes will find a suitable location within the designated distance, while blue areas indicate a probability of 100%

It is critical to appreciate that the carbon dioxide concentrations are not themselves the cause of the pattern. Rather it is the global warming and climate change consequences of those concentrations that drive the projections. What these authors suggest is that the under the 850 ppm scenario most of northern (tropical / sub-tropical) South America and Africa will be devastated. Biomes of the coastal Southwestern and Southeastern United States and northern and southern Australia are similarly threatened as are the biomes of much of Asia.

The impact of future conditions on forests is of particular concern in SW Oregon. Westerling *et al.* (2006) identified warming during the growing season and timing of spring snowmelt as two variables that correlate with increased wildfire activity. As would be expected, warmer summers and earlier spring snowmelt correlate with high fire years since these lead to dryer conditions during late summer and fall. Rehfeldt et al (date) evaluated the impact of future conditions on the viability of western tree species. As an example, the current and future viability and range for Douglas fir (http://forest.moscowfsl.wsu.edu/climate/species/speciesDist/Douglas-fir/) in Oregon

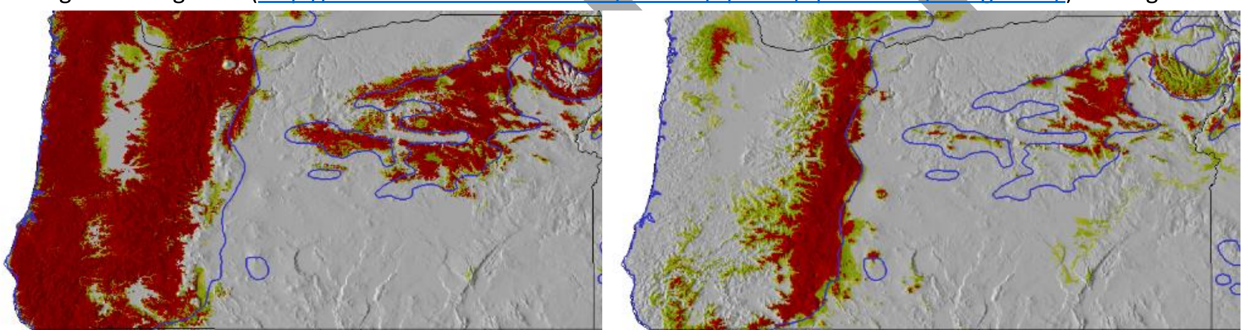

Figure 11. Douglas fir distribution and viability through 21st century. L current, R. 90 years

are presented in Figure 11. The color represents viability from 0.5 (yellow) through 0.75 (green) to 1 (Red).

According to Rehfeldt's models, by late century Oregon will be outside the range of the Lodgepole pine, while the range of Ponderosa pine will also be reduced.

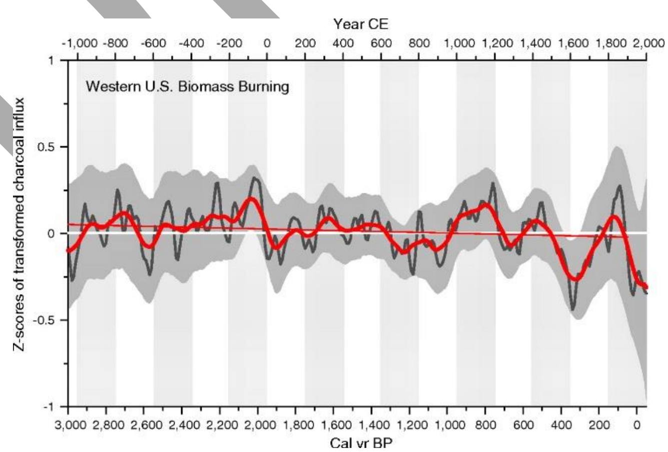

Figure 12. Relative changes in biomass burning in the western United States for the past 3,000 years

Given that many of the climate trends reported above can be traced back to the 1970s, it should be no surprise that the wildfire season in the western states has expanded some two and a half months since that decade. Data from the Interagency Fire Center indicate that the number of wildland acres burned has increased over this period. Climate central (http://www.climatecentral.org/western-wildfire-trends), meanwhile, reports that the number of western acres burning and the size of western fires has been increasing since that period. However, analyses that include earlier decades and centuries yield a slightly different perspective. Marlon et al (2012), for example, report (Figure 12) that we are currently experiencing an unusually low level of biomass burning. In fact, given the temperature and drought conditions present in the western forests, these authors conclude, that we are experiencing a profound fire deficit. Meanwhile, studies of burn scars in tree trunks reveal that the historical fire return interval through much of the Rogue Basin was less than a decade (Metlen and Borgias 2016). This represents a marked difference from current trends since fire suppression has been imposed, when the fire return interval has increased to between 40 and 10,000 years (Metlen 2015).

The impact of the changing climate on our freshwater systems should also be considered. As Myer (2014) reported, the water quality in many of our streams is already compromised. Depleted and warming water flow can only make matters worse – threatening our iconic fish species and the health of our waters for irrigation and consumption. Additionally, this warming will promote water-borne diseases.

Conclusion:

Projected future climate trends for the Rogue Basin are expected to represent a continuation of trends we have been experiencing for several decades. By the end of the century, assuming the business as usual scenario of accelerating greenhouse gas emissions, the climate will seriously compromise our natural (terrestrial and aquatic), agricultural and forestry systems.

Sources:

Hessburg et al 2016

Marlon et al 2012

Metlen 2015

Metlen and Borgias 2014

Rehfeldt et al et al

Westerling et al. 2006

Whittaker RH 1975

Williams and Jackson 2007