Projected Changes in Large Fire Size, Frequency, and Seasonality in the Clackamas River Watershed: Progress Report

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Progress Report Summary

OVERVIEW

There have been few large fires (> 100 acres) in or near the watershed in recent history. Notably, the 36 Pit fire (2014) burned over 5,000 acres in the middle of the watershed and the B & B Complex (2003) burned over 80,000 acres in the southeast of the watershed. Wildfires in general, but especially large wildfires, are uncommon in the region in part because of active suppression, but also because of limitations imposed by climate. Historically, large fire activity has been closely associated with uncommon windows of especially dry climate conditions immediately preceding and during the fire event. Climate change is predicted to increase the number of days each summer during which fuels are sufficiently dry and on which large fires are possible. Understanding future fire activity can inform strategic efforts to plan for wildfire risk and associated impacts to watershed services. The purpose of this wildfire risk assessment is to help water resource managers better understand (1) current wildfire risk in the Clackamas River watershed, (2) the magnitude of plausible changes in wildfire frequency, size, and season during the 21st Century, and (3) the effects of large wildfire activity on essential watershed processes and infrastructure.

KEY FINDINGS

1. Currently there is less than 1% chance of a fire growing larger than 50,000 acres; projections indicate that by mid-century that probability will be 5%, nearly 7x greater than today.

2. Conservatively, we estimate that the average annual area burned inside the watershed will increase 4x to over 13,000 acres.

3. Fire season length is not predicted to change significantly, but within each fire season we predict more days of high and extremely high fire danger.

Progress Report

MOTIVATION

Large wildfires (>100 acres) are generally infrequent in west-side Cascade forests like the Clackamas River watershed (CRW). However, as the Eagle Creek fire of 2017 demonstrated, large fires do pose significant risk to water provision and other essential watershed processes. Because the CRW provides drinking water to more than 300,000 residents and because climate change is expected to make the region more susceptible to large wildfires, we wanted to establish plausible changes in future large fire activity.

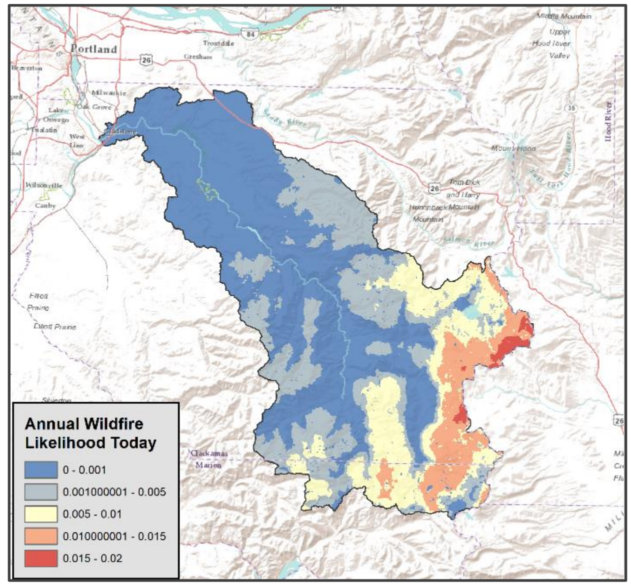

Figure 1. Current annual burn probabilities for large fires in the Clackamas River watershed. Burn probability is the likelihood that a given location will experience fire. The fire may start in that location, or it may migrate in from a fire started elsewhere.

RESEARCH QUESTIONS

Our research analyzes both current and future large fire activity in the CRW. Specifically we asked the questions:

1. How will future climate conditions likely affect the probability of a large fire occurring in the watershed;
2. How will large fire size, frequency, and seasonality change in the future; and
3. How might large fires in the future impact essential watershed processes?

RESEARCH APPROACH

To address our research questions we used the large fire simulator FSim. FSim uses statistically plausible daily weather scenarios to simulate ignitions, fire growth, and suppression in order to simulate possible fire seasons. We calibrated our FSim model using historic daily weather from a Remote Automated Weather Station located in the CRW, and recent historic large fire occurrences (1992-2015) in the CRW and immediately surrounding area. Additionally, FSim uses nine unique spatial data sets that describe the terrain and fuel. For each climate scenario and each time period we ran 10,000 samples of a plausible fire season. Outputs from each sample include simulated burn perimeters, fire severity metrics, and annual burn probabilities (Figure 1).

We selected three Global Climate Models (GCMs) to develop future fire weather scenarios. Predicted changes in precipitation for the CRW are not significantly different from current precipitation amounts and patterns so we modeled only changes in temperature and relative humidity. Based on GCM predictions, we modified the daily historic weather in order to simulate future fire weather conditions. Everything else in FSim – i.e. the spatial pattern and frequency of large fires, and the fuelscape – remained the same.

FINDINGS

Current Conditions

In a 3.14 million acre area surrounding the CRW, approximately 4.5 times as large as the CRW, the average large fire size is 4,700 acres. On average, large fires occur in the greater CRW region about two to three times a year. The upper watershed is most susceptible to large fires (Figure 1), likely for several reasons. First, the upper watershed is heavily forested and once fires begin, they are difficult to suppress and can potentially grow quite large. Second, lighting fires that ignite at the top of the watershed are less likely to be discovered as quickly as human-caused ignitions lower in the watershed. Later discovery gives time for the fire to grow to a size that makes suppression impossible or unsuccessful.

Future Fire Conditions

Fire Weather & Season

Preliminary results indicate that the overall length of fire season will not change significantly before the end of the 21st-Century, but that fire conditions in late summer will become more severe. Fire danger can be characterized by the Energy Release Component (ERC) which represents the amounts of energy available to a fire should it ignite. ERC is determined based on weather conditions and the fuel types. ERC exceeding the 80th percentile is considered a large fire danger, exceeding the 90th is high danger, and exceeding the 97th is extreme danger.

Using three GCMs in three time periods we see that there is a range of potential future changes to the number and magnitude of fire danger days (Figure 2). On average, fire danger is predicted to increase the number of high fire days by 10 in mid-century and 22 days by the end of the century.

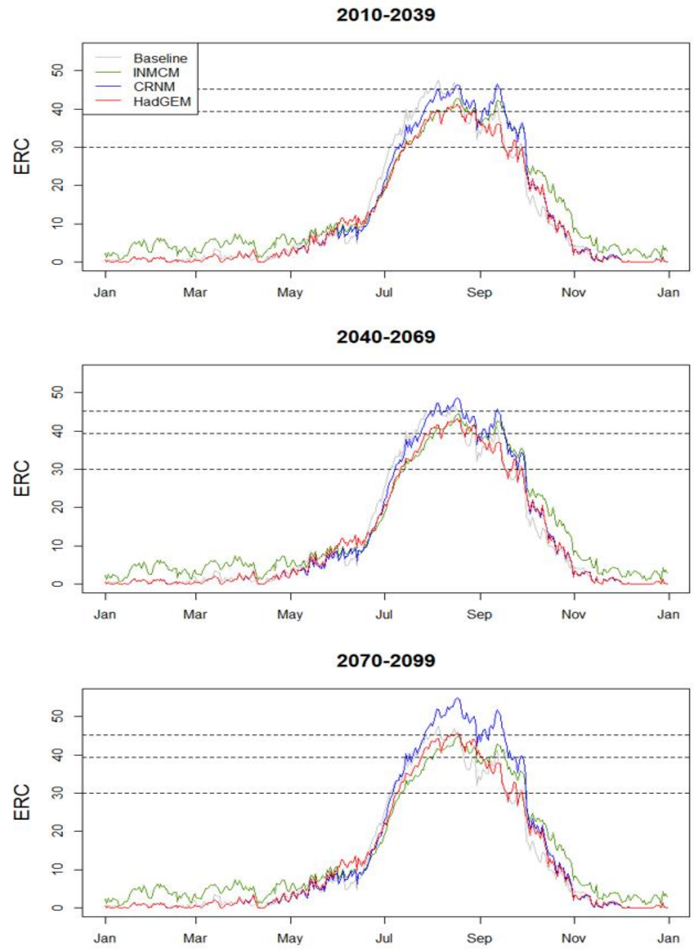

Figure 2. Mean daily ERC based on observed weather from 1992-2015 at the Red Box Remote Automated Weather Station (Baseline), and two future periods in which historic weather was altered to reflect predicted future climate (2010-2039 and 2040-2069). Dotted lines represent the 80th, 90th, and 97th percentiles. Percentiles are calculated from historic fire-climate data.

Fire Size (for the CRNM GCM only)

To date we have been able to run simulations of future fire activity using the CRNM GCM only. Under that climate model, predictions indicate that average large fire size will increase to more than 13,000 acres leading to more than four times more acres burned on average each year by mid-21st century, approximately 15,000 acres in the greater CRW region. Additionally, as climate enables larger fires, the chance that watershed will experience catastrophic fires increases. By mid-century, the chance of fire exceeding 50,000 acres inside the watershed will be 5% which is seven times greater than today.

Burn probabilities are predicted to increase under CRNM climate predictions, more than doubling in some parts of the watershed (Figure 3). Notably, hotbeds of historic ignitions like Timothy Lake and areas immediately adjacent to roads and rivers are predicted to see the largest increases in burn probability. Human-caused ignition locations are unlikely to change significantly, so those locations in the CRW that have previously experienced high numbers of ignitions will likely continue to, but in the future the surrounding vegetation will be much more susceptible.

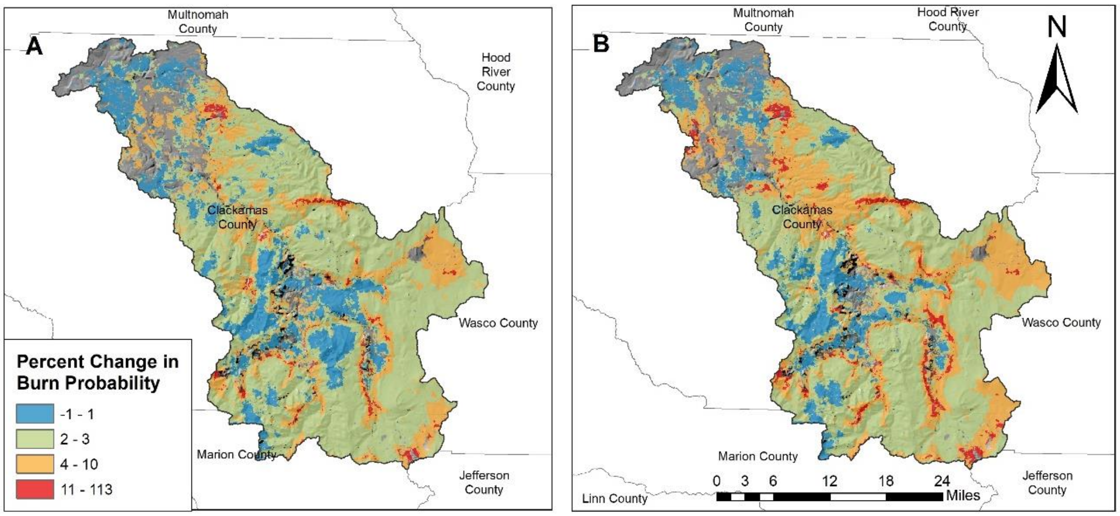

Figure 3. Changes in annual burn probability for two time periods under the CRNM climate conditions. (A) 2010-2039, and (B) 2040-2069.

CONCLUSIONS & NEXT STEPS

Preliminary evaluations of a range of future climate conditions indicates that the CRW will be increasingly susceptible to large fires throughout the 21st Century. Increased susceptibility is likely to translate into more, larger fires compared to today. Although most parts of the watershed will feel the effects of increased fire activity, the upper watershed and areas with relatively high human-caused ignitions will experience the largest change in fire activity.

The findings presented here are preliminary because they do not account for the full range of climate conditions the CRW may experience. Continued work will focus on modeling wildfire under different climate scenarios as well as assessing the role that future changes in ignition patterns may play in the CRW. Ultimately, our goal is to evaluate future impacts of wildfires on water resources. We anticipate that increased large fire occurrence will cause impacts to water quantity and quality, and will work with hydrologists to determine the magnitude of future risk.