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Projecting Future Wildfire Spread Potential in British Columbia, Canada

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Introduction

Wildfire spread in Canada is largely driven by weather[1]. Hotter, drier conditions result in higher spread potential, and fires that occur on days of extreme fire weather are more likely to threaten human lives and infrastructure[2]

Under climate change, research suggests that western North America will experience more frequent and severe extreme fire weather events[1]

In this study we use General Circulation Models (GCMs) to investigate trends in the frequency and magnitude of extreme fire weather events in Wells Gray Provincial Park, British Columbia (BC) over the next century.

We assess trends in the annual extreme values (95th percentile) of the Canadian Fire Weather Index (FWI) System. As a proxy for extreme fire weather events, we also investigate the frequency of weather-based Potential Spread Days (PSDs) identified using FWI System variables.

Study Area

Wells Gray Provincial Park[3]

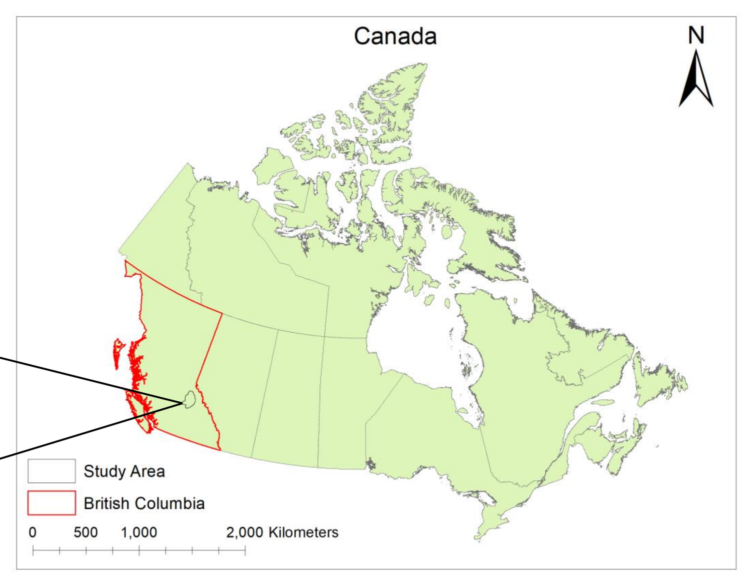

Figure 1. Location of the study area in Canada

- 1.2 million hectares (ha) in south-central British Columbia, Canada
- Dominated by coniferous species, with some mixedwood forests occurring in southern areas and alpine zones at higher elevations
- 3257 fires have been recorded in the study area since 1950, 79% of which were caused by lightning
- Divided into zones based on the Biogeoclimatic Ecosystem Classification (BEC) System, which is used in BC to classify ecosystems based on climatic conditions, vegetation, and soils

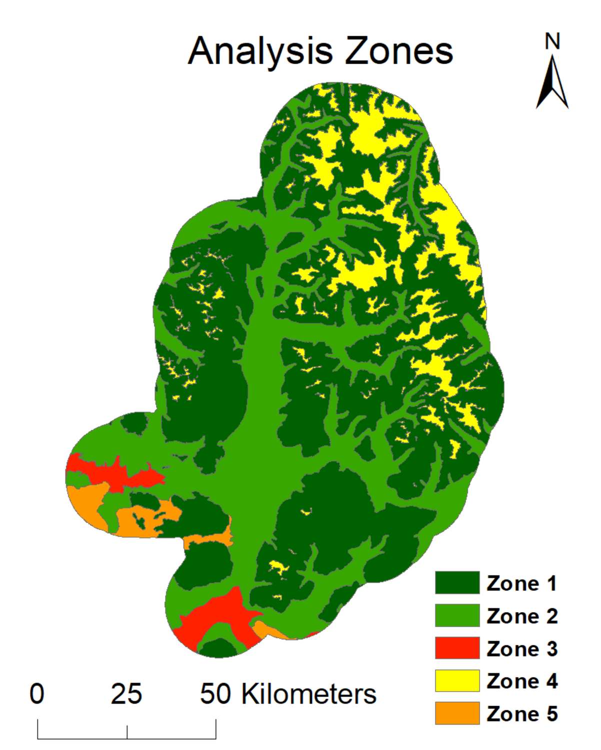

Figure 2. The study area was divided into zones based on the BEC System, taking into account elevation and climatic factors

Zone	Total Area (ha)	Elevation Range (m)	Average Fire Season Temp (°C)*	Average Fire Season Precip (mm)*
1	649,110	945-2512	10.0	745
2	392,257	482-1658	11.8	700
3	35,759	390-1348	14.6	555
4	121,647	1850-3312	7.8	780
5	28,230	770-1683	13.3	530

*Based on mean daily 1991-2021 values for April to November

Methods

1) Definition of PSDs

- PSDs are defined using the Initial Spread Index (ISI) of the FWI System as days in which ISI > 8.7 [4]

2) Weather Data

- Past (1991-2021) weather variables generated using ERA5-Land climate reanalysis data[5]
- Future (2041-2100) monthly weather variables generated using the mean of a 13-GCM ensemble selected from ClimateBC according to the Intergovernmental Panel on Climate Change (IPCC)'s shared socioeconomic pathway scenario SSP5-8.5[6]
- Temporal downscaling achieved by generating anomalies between the past and projected future monthly averages of temperature and precipitation. The anomalies are then applied to the ERA 5-Land daily data
- Weather variables are converted to FWI values using 'FWI' function of the 'R' package 'cffdrs'[7]

3) Change Analysis

- Plot 95th percentile FWI variables and frequency of PSDs in each time period

Results

We found increases in the number of PSDs over time in every zone.
The highest numbers of spread days occurred in zones 3 and 5, with PSD frequency doubling for the 2071-2100 time period, going from an average of 8(9) PSDs per year in the baseline time period (1991-2021) to 16(18).
We also found increases in the 95th percentile of ISI and FWI values in every zone over time, with the highest values occurring near the end of the century (2071-2100)

PSD Frequency

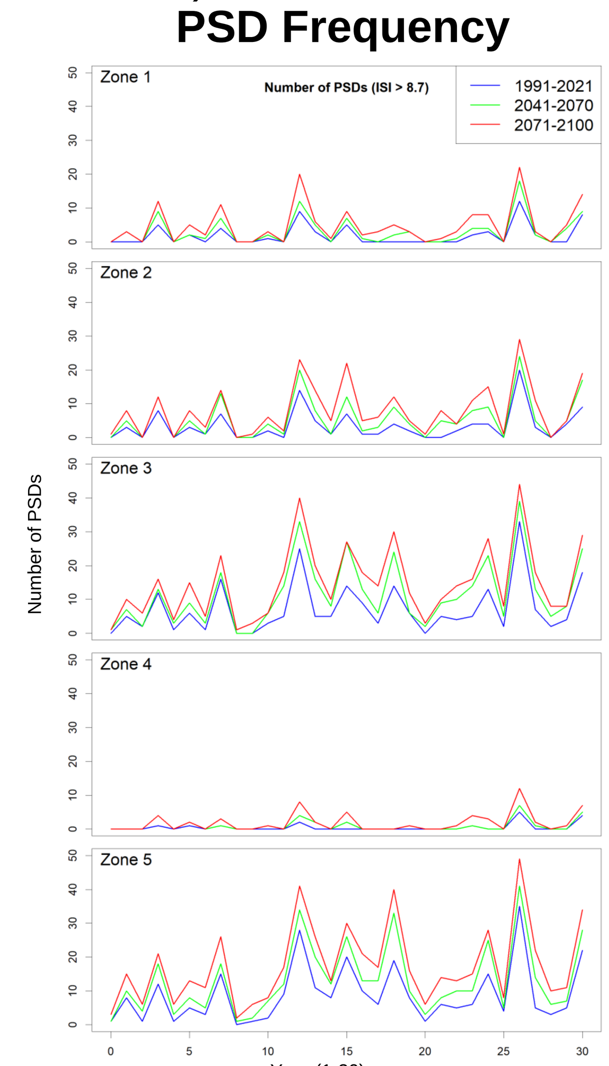

Figure 3. Number of PSDs (ISI>8.7) by year over three 30-year time periods for each zone

95th Percentile ISI

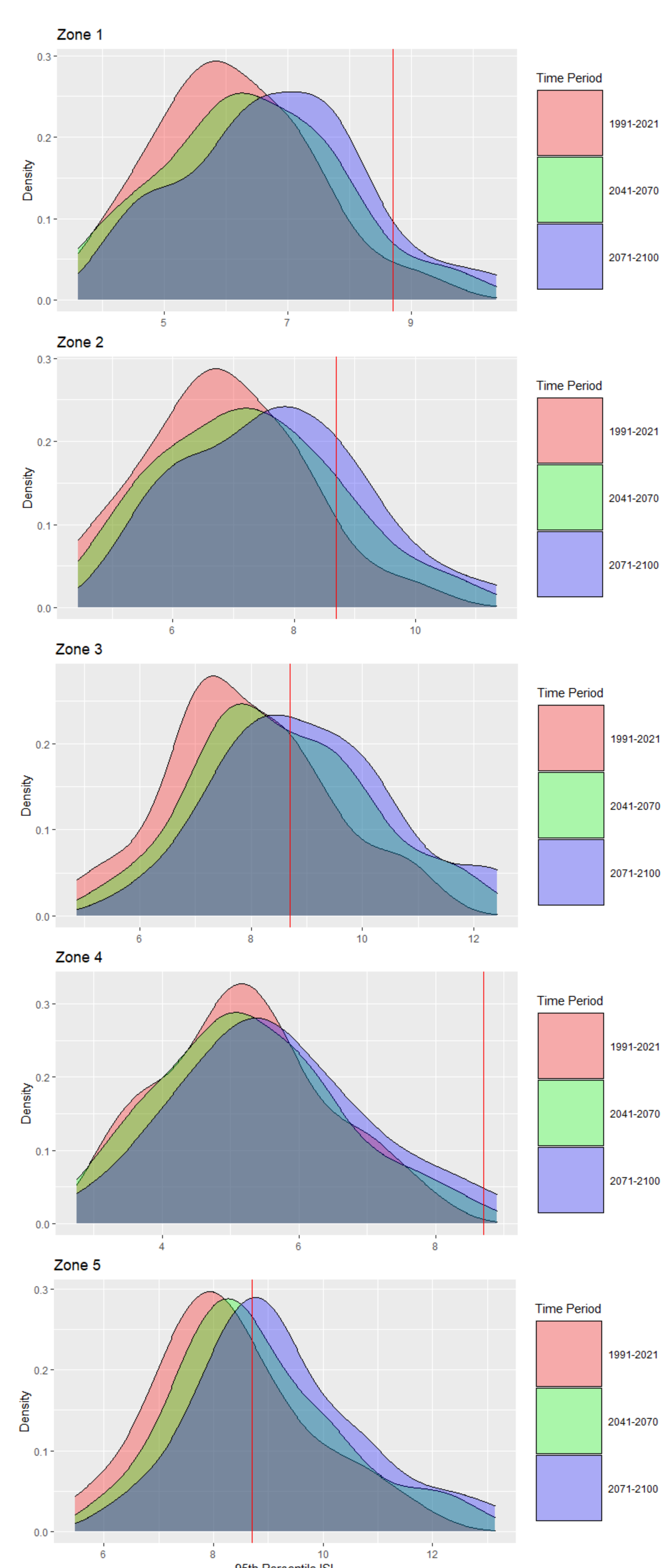

Figure 4. Kernel density curve of the annual 95th percentile of ISI values in each zone across three 30-year time periods. The red line indicates the PSD threshold value of 8.7

95th Percentile FWI

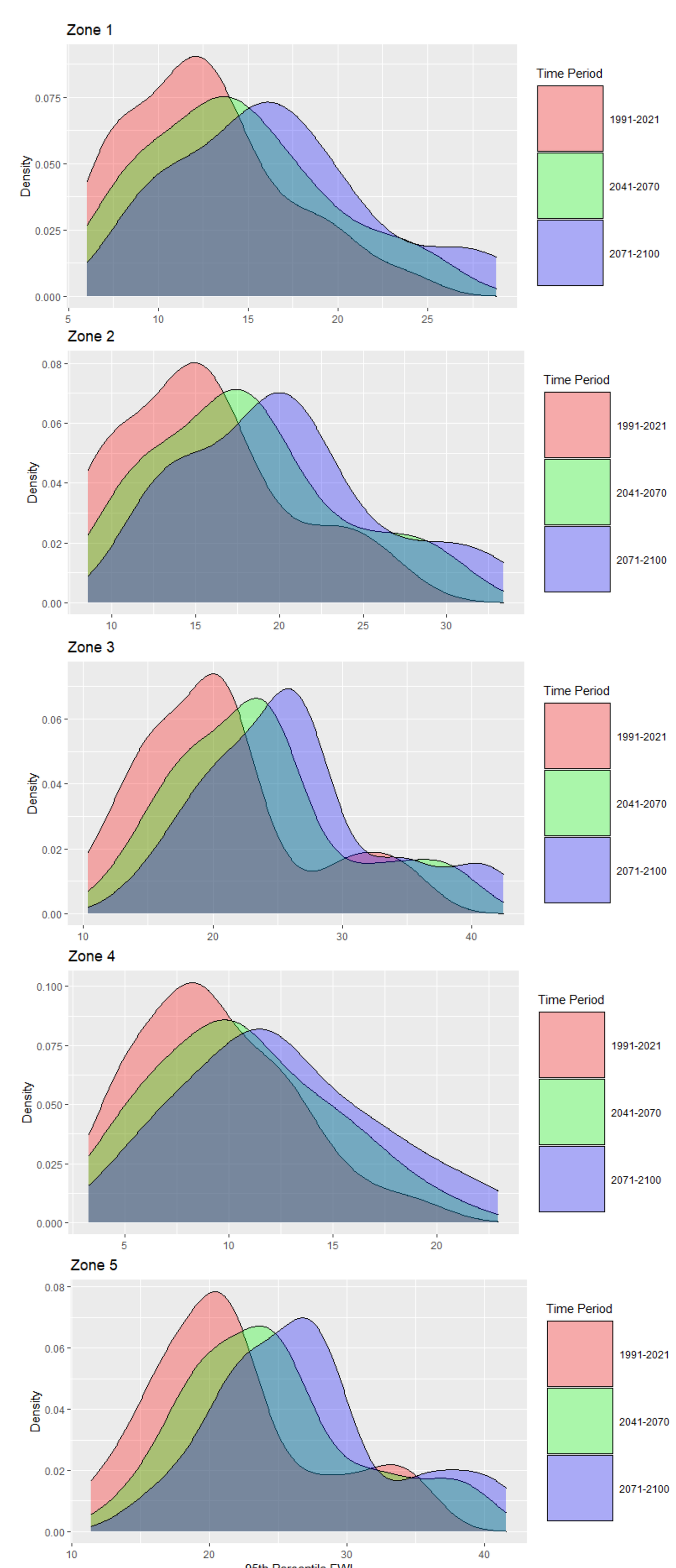

Figure 5. Kernel density curve of the annual 95th percentile of FWI values in each zone across three 30-year time periods.

Discussion

- Extreme fire weather events can cause fire suppression techniques to reach their limits of effectiveness[4]
- An increase of these events with climate change may result in more frequent threats to public safety and local economies
- We found increases in the 95th percentiles of FWI variables and the frequency of spread days over time, indicating that in the future, our study area will experience more frequent days with extreme fire weather, and when they occur the weather conditions will be more extreme than in the past
- Investigating these trends will assist with long-range strategic planning of fire management agencies, demonstrating the need to increase fire management capability and invest in community protection programs

Next Steps

- Run analysis for 3 additional GCMs to get a more representative spread of possible climate futures
- Expand analysis to include SSP1-1.9 and 2-4.5 (low and medium-emissions scenarios)
- Assess temperature and precipitation trends across time periods and scenarios
- Analyze patterns of days with minimal precipitation (drying days) across scenarios and time periods

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References

1: Wang X, Parisien MA, Taylor SW, Candau JN, Stralberg D, Marshall G, Little JM, Flannigan MD. Projected changes in daily fire spread across Canada over the next century. Environ Res Lett [Internet]. 2017a [cited 2023 April 28];12:025005. Available from: https://doi.org/10.1088/1748-9326/aa5835
2: Beverly J, Bothwell P. Wildfire evacuations in Canada 1980-2007. Nat Hazards [Internet]. 2011 [cited 2023 April 23];59:571-596. Available from: https://doi.org/10.1007/s11069-011-9777-9
3: World Adventurists. Chasing Iconic Waterfalls in Wells Gray Provincial Park [Internet]. 2022 [cited 2023 April 28]. Available from: https://worldadventurists.com/chasing-iconic-waterfalls-in-wells-gray-provincial-park/
4: Podur J, Wotton MB. Defining fire spread event days for fire-growth modeling. Int J Wildland Fire [Internet]. 2011 [cited 2023 April 28];20:497-507. Available from: https://doi.org/10.1071/WF09001
5: Muñoz Sabater J.ERA5-Land hourly data from 1950 to present [Internet]. Copernicus Climate Change Service (C3S) Climate Data Store (CDS); 2019 [cited 2023 March]. Available from: https://cds.climate.copernicus.eu/cdsapp#!/dataset/10.24381/cds.e2161bac?tab=overview
6: ClimateBC [Internet]. Wang, T; 2023 [cited 2023 April 24]. Available from: https://climatebc.ca/
7: Wang X, Wotton MB, Cantin AS, Parisien MA, Anderson K, Moore B, Flannigan MD. cffdrs: an R package for the Canadian Forest Fire Danger Rating System. Ecol. Process [Internet]. 2017b [cited 2023 April 28] 6:5. Available from: https://doi.org/10.1186/s13717-017-0070-z

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