Using the Hydroclimate Network to Investigate the Link Between Wildfires and Solar Radiation

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Introduction: One of the first steps in this project was to research environmental issues that the people of California are faced in a changing climate and design a research question and hypothesis. The project was self-designed compared to a more traditional summer intern project which has a more defined project/project title at the start of the internship. Since my interests included rising temperature, working with data, and natural disasters response, the starting point of the project was to look at wildfires and its relationship with hydrometeorological variables. Given the 9-week time span, my field research trip, and data available, I decided to focus on the Yosemite National Park Region retrieving solar radiation data from the CW3E Hydroclimate Network (HCN) along highway 120. I developed the research question: *"Is there a direct relationship between the rising number of fires and solar radiation?"* and the hypothesis: *"As wildfires become more frequent, they produce increasing layers of smoke that will decrease the solar radiation."*

Methods: The data sources were HCN stations and CalFire. The software programs that were used to view and manipulate the data were Microsoft Excel and QGIS. CalFire provided shapefiles of California fire history. The HCN stations provided hydrometeorological variables including solar radiation. QGIS was used to view the acres burned and the number of fires statewide, and to create a dataset over the region of interest (Yosemite). This step isolated that area's fire characteristics that I analyzed using Excel. At this point, I clipped the HCN solar radiation big data for years with high and low fire activity. Then graphs were plotted to see the trends, patterns, and relationships with the number of fires, acres burned, vs. solar radiation. The one-minute solar radiation data for high and low fire years was subset from the entire station dataset. This meant dealing with hundreds of excel data cells. Through excel formulas the max solar radiation per day throughout the year was plotted. We then chose to limit the analysis to solar radiation was overserved within only the fire season. (May through September)

Results/Data Analysis: The statewide fire data has records from 1983 - 2020 (37 years). The average number of fires was 70,296, the lowest being 18,229 fires in 1983 and highest 96,385 in 2006. Average number of acres burned was about 5,223,975, lowest being 1,148,409 acres in 1984 and highest 10,125,149 acres in 2015. One interesting thing about this data set was even though the number of acres burned had an increasing trend over time, the number of fires did not reflect this (***Figure 1 &2***). Plotting the 37-year span by century, we see that a similar amount of fires occur within the 20th and 21st century but more acres are burned in the 21st century. Looking at the region of interest (Yosemite), I chose HCN stations at the furthest West (W), East (E), and in the middle of the transect, providing a decent spatial range throughout the region. Those stations were Priest Reservoir (W), Lee Vining (E), and Hodgdon Meadows (***Figure 3***). The stations' available period of record is 2009 to 2020 thus the time span that I chose to look at was 2009-2019. The regional fire data set with period of record 1908-2020 showed that the

region will experience on average ~ 12 fires and ~ 40, 000 acres burned per year. High fire (HF) years were defined as the three years with the highest number of fires between 2009 – 2020 (2014, 2016, and 2017); and low fire (LF) years were defined as the three years with the lowest number of fires between 2009-2020 (2009, 2010, 2011). Looking at the solar radiation time series during fire season of HF/LF fire years gave me a mix of results with regards to my hypothesis. In the years of 2011 (LF) and 2014 (HF) at Priest Reservoir there was more solar radiation in the HF year, contradicting the hypothesis of HF years having less solar radiation.(***Figure 4***) At Lee Vining, comparing 2009 (LF) with 2014 (HF) supported the hypothesis, because lower solar radiation values were observed in the HF year of 2014 than the LF year. (***Figure 5***) Other HF/LF years were examined, and those datasets are archived on CW3E's google drive.

Further Action: This project could be continued by looking at all of the HCN stations within the transect, or other hydrometeorological variables observed at HCN stations, including wind direction, precipitation, soil temperature and air temperature all which may influence or be influenced by wildfires. For example, it would be interesting to investigate whether high soil temperatures leave vegetation more prone to wildfires. We could also look at all HF and LF years together. It would also be interesting to look further into the results that contradicted our hypothesis. The next section of this study would be to see how this affects low-income communities and minorities groups. These groups and communities are least to understand and receive this data that can help them withstand wildfires. They lack the resources, financial aid, and education to prevent damage to either their health or property. They don't understand the scientific information due to language barriers and do not have the funds to prevent property damage. All these further steps will help understand how the increasing wildfire affects the landscape and people, and how to mitigate the negative effects.

Figures

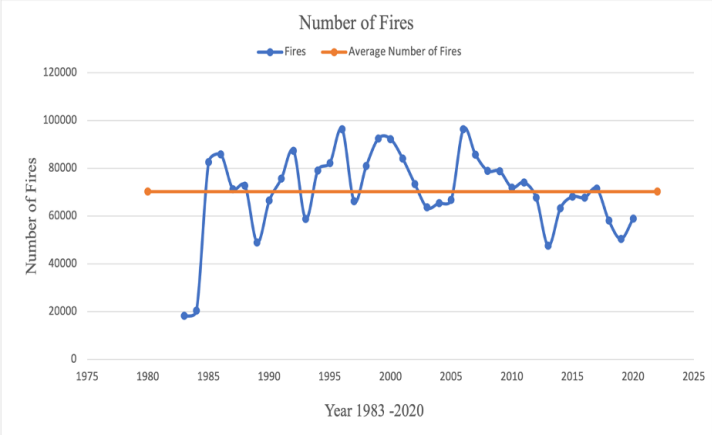

Figure 1: Number of fires in each calendar year within the state of California.

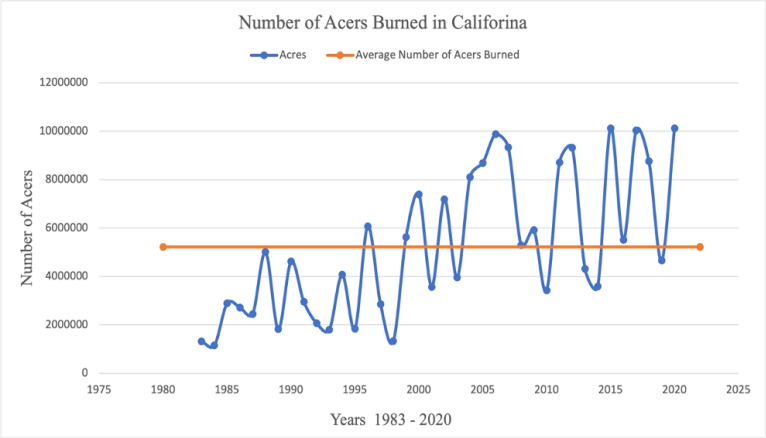

Figure 2: Acres burned in each calendar year within the state of California.

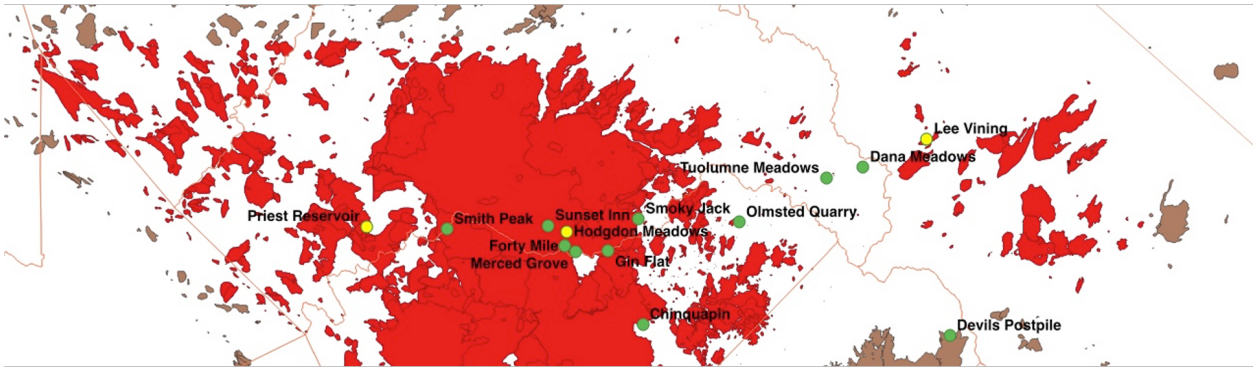

Figure 3: Fires occurring between 1908-2020 within the Yosemite National Park Region (region of interest for this study). Red indicates that the fires fell within the area defined by the study. HCN stations are shown with station name; a yellow dot indicates the station was used in the study.

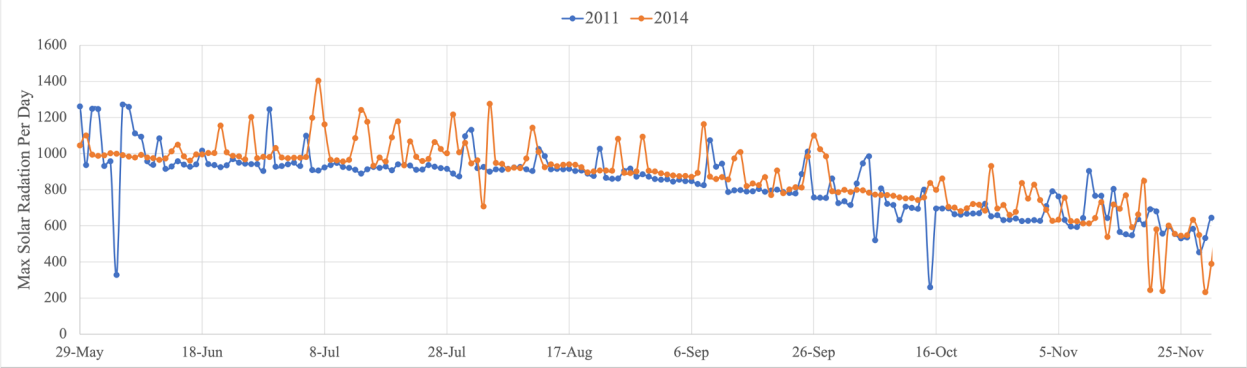

Figure 4 : *Low Fire Vs. High Fire* Priest Reservoir, Western Hydroclimate Station, during fire season in 2011 (LF) and 2014 (HF).

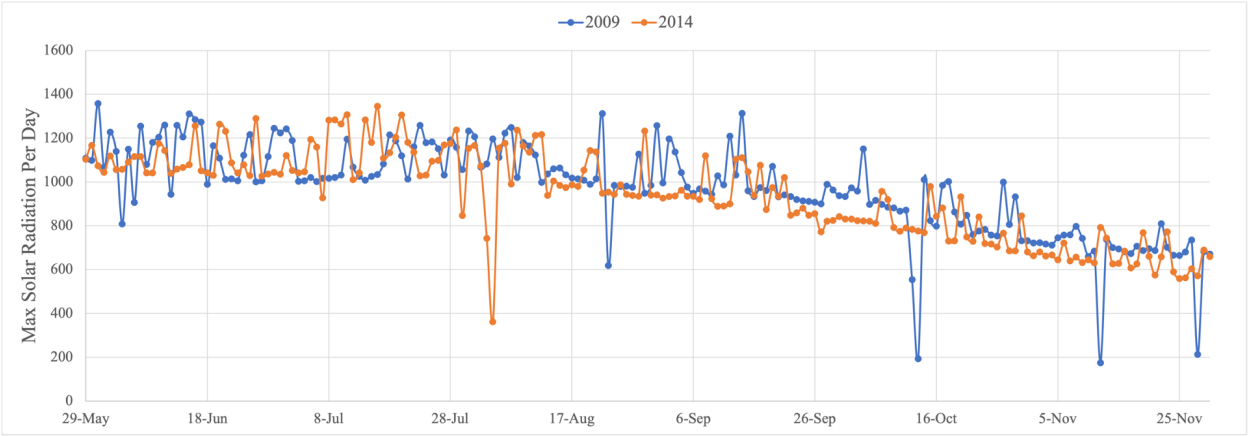

Figure 5: *Low Fire Vs. High Fire* Lee Vining, Eastern Hydroclimate Station, during fire season in 2009 (LF) and 2014 (HF).