The Health Impacts and Economic Burden of 2018 California Camp Fire Smoke on Southwestern Canada

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A Final Essay

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Abstract

In recent years, the dense smoke from California wildfires can spread to almost the entire North America, which has had an enormous negative impact on air quality. PM2.5 (fine particulate matter) is one of the main components of wildfire smoke. Numerous studies proved that PM2. 5 would lead to many health problems, caused a series of health and economic losses, from increased asthma attacks to hospital visits or death. In this study, we discuss the economic loss in Southwestern Canada led by the asthma mortality rate, which was caused by an increase of PM2.5 concentration level in western Canada due to wildfires in California. As the mortality rate increases, the economic loss increases as well with economic models. Hence, an aggressive policy of controlling wildfire to mitigate the PM2.5 and reduce the economic loss should be released, not only improve the air quality in North America but also avoid several hundred thousand premature death.

Chapter1: Introduction

1.1 Research Background

In recent years, California has experienced a substantial increase in the quantity and intensity of wildfires. The smoke from the deadly 2018 California Camp Fire, one of the most destructive wildfires in California, produced dangerous levels of pollutants, which drifted thousands of miles to Southwestern Canada and posed risk to the health of residents in three selected provinces, including Saskatchewan, Alberta, and British Columbia (California Air Resources Board (CARB), 2021). These pollutions, especially PM2.5, will increase the occurrence frequency of asthma attacks and heart attacks (Canada, H., 2021).

1.2 Scientific Gap

Currently, the cross-regional study of the impacts of wildfire smoke is still a blank. Although there are vast pieces of literature focused on the health effects of wildfire within the occurrence place, only a few studies have quantified the health effects and economic loss attributed to wildfire smoke in other affected regions. More importantly, some of the articles were written in 2000.

1.3 Research Aim:

The aims of this study are to analyze the asthma mortality rate and economic loss attributed to the 2018 California Camp Fire smoke in Southwestern Canada and propose suggestions on policy to mitigate the risk of exposure to wildfire smoke and reduce the loss on economic.

Chapter 2: Methodologies

2.1 ArcGIS and Data Sources

Firstly, to analyze the health impacts and economic burden of the 2018 California Fire to Southwestern Canada, ArcGIS Online is used to access the fire zone of the California Camp Fire and the spreading of smoke. Then, the area that air quality is negatively influenced by the wildfire smoke has been analyzed by comparing the "Wildfire vs Smoke" map and the "PM2.5" map. After that, compute the asthma rates of each Canadian province and contrast them with its geographical location, to discover the relationships between wildfire smokes with the asthma rates.

The "Wildfire vs Smoke" map's data are retrieved from the NOAA Office of Satellite and Product Operations. The dataset is from 2018-11-07 to 2018-11-25, the duration of the Camp Fire, which is one of the worst wildfires in California. The "PM2.5" map is from EPA (Environmental Protection Agency). The table of 2017-2019

asthma rates of the Canadian province rests on the statistical data released on Statistics Canada, Canadian Community Health Survey (CCHS).

2.2 Economic model: Health Impact Assessment & Economic Loss Assessment

Health Impact Assessment: an epidemiological exposure-response equation is used to assess the acute health effects of asthma caused by PM2.5 pollution caused by wildfire smoke.

$$\text{Mort} = y_0 * [(\text{RR}(c)-1)/\text{RR}(c)] * \text{Population}$$

Mort represents the mortalities caused by asthma (per 10 thousand) .y_0represents the standard death rate of respiratory disease (per 10 thousand population), Pop is the exposed population number(per 10 thousand of the population), RR(c) represents the relative risk of death from disease at a given concentration c. Where, RR(c) can be pulled from the previous study which is calculated by the Integrated Exposure-Response (IER) model developed by the Global Burden of Disease Study (GBD) (Cohen et al., 2017).

Assessment of economic loss of health

In this study, the risk of premature death was monetized using the E represents economic value

$$E\_l = E\_base * (I\_year/I\_base)$$

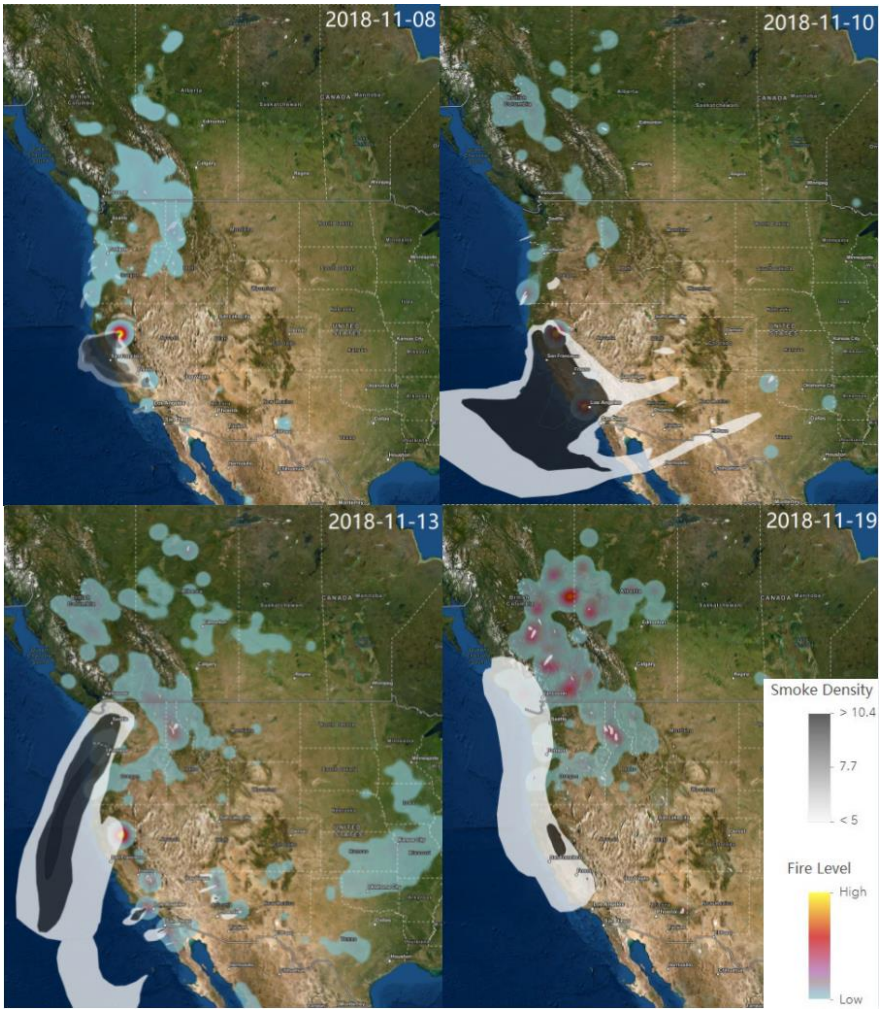
E_lbase is the baseline average economic loss of one wildfire in 2018. I_year is the production of disposable income of a certain person in a specific year (Canadian dollar) and rate of disposable income of a certain person in a specific province over the nation in that year; Ibase is the disposable income of the benchmark person in 2018 (Canadian dollar), that is, the disposable income of Canada, the whole country in 2018.

$$\text{Economic loss} = E\_l * \text{Mortality}$$

Multiply and formula (3) to directly obtain the health economic loss ΔE of PM2.5 pollution.

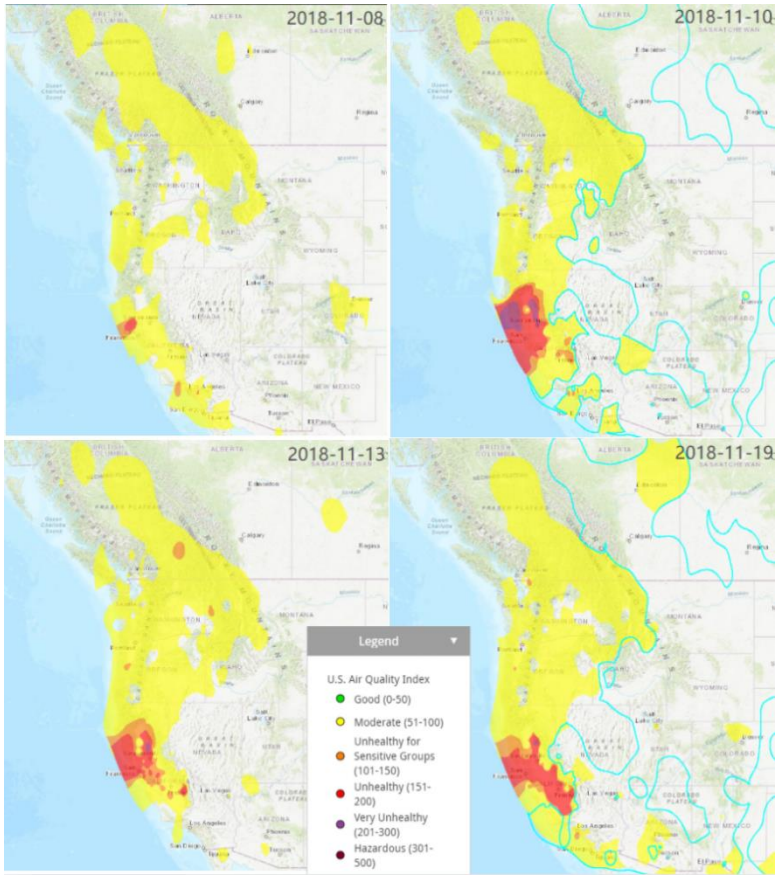
Chapter 3: Result

3.1 Spatial distribution of 2018 Camp Fire smoke & PM2.5 Concentration



("Wildfire vs Smoke" Map, ArcGIS Online)

From the "Wildfire vs Smoke" maps, the smoke density and fire level can be displayed by the darkness and colour. The darker the area, the higher the Smoke Density; the more concentrated the yellow area, the higher the wildfire level. The Camp Fire started on November 8th, 2018, and the smoke emitted from Camp Creek Road. The smoke covered most areas of California after 2 days. On November 13th and 19th, because of the monsoon, the smoke then went towards to the north and invaded Southwestern Canada, polluted the air in BC,AB and part of SK provinces.

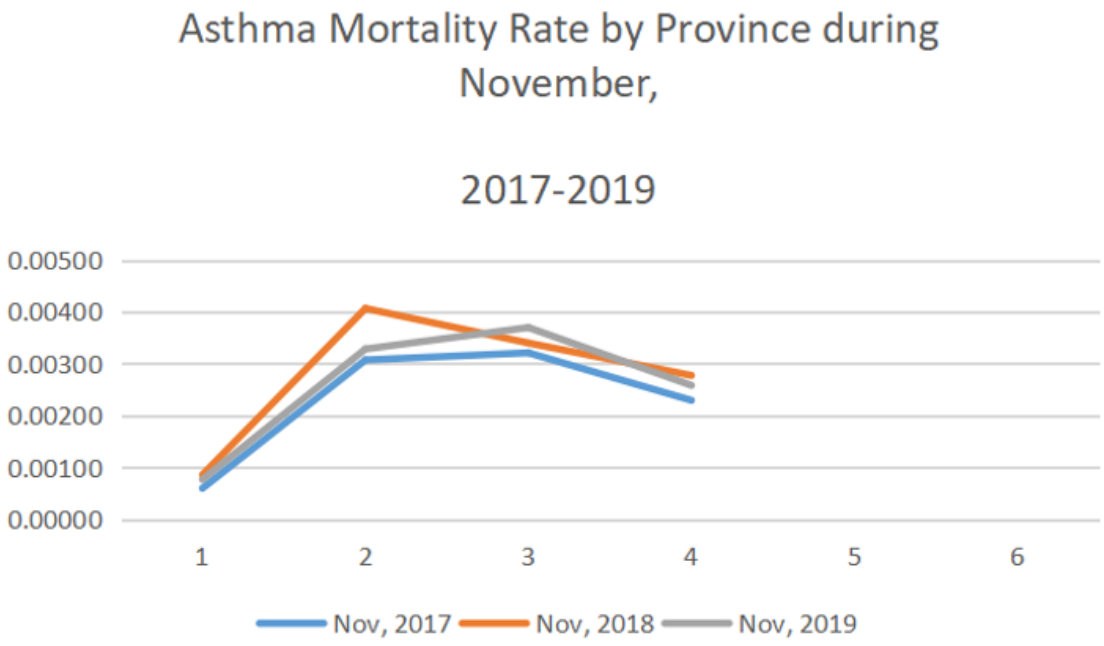


("PM2.5" Map, Environmental Protection Agency, 2021)

The "PM2.5" map is from EPA (Environmental Protection Agency), fine particulate matter is selected to determine the air quality, colour shows the air quality. On November 8th, 2018, the date the fire started, the air quality of California become worse and worse, and the air quality index was significantly affected when the smoke passed the rest of western North America. Thus, the air quality is negatively influenced by the wildfire smoke, and the smoke brought PM2.5. More importantly, PM2.5 will increase the occurrence rate of an asthma attack.

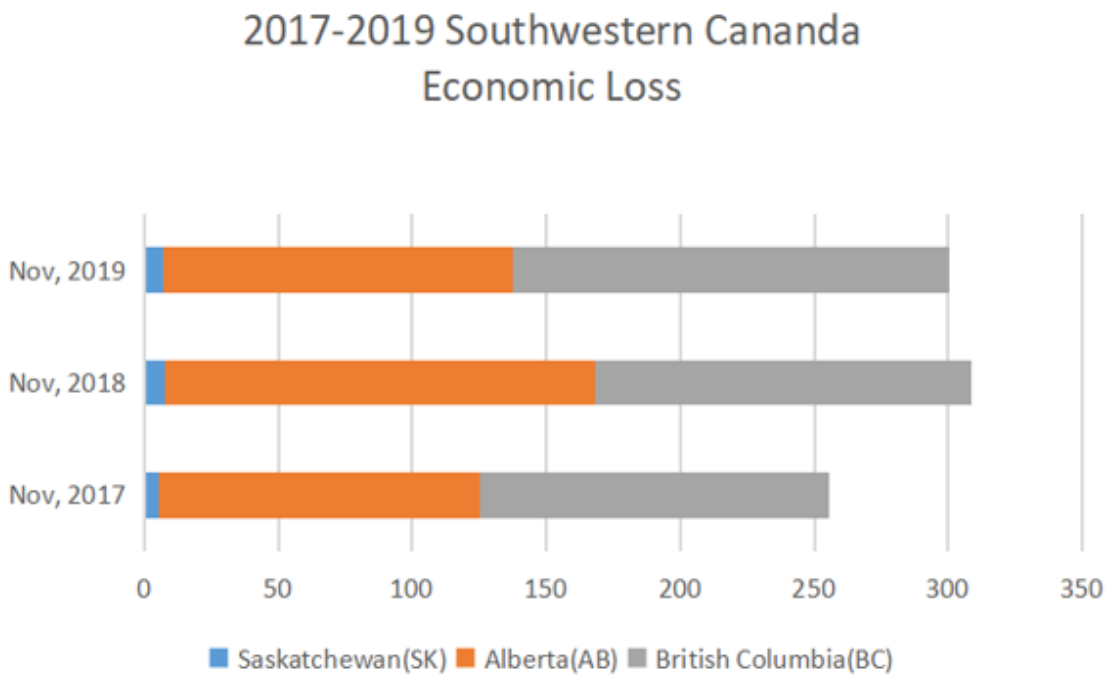
3.2 Asthma - mortality rate attributed to Camp Fire smoke

Asthma Mortality Rate by Province during November, 2017-2019			
Province	Nov, 2017	Nov, 2018	Nov, 2019
Saskatchewan(SK)	0.00060	0.00086	0.00077
Alberta(AB)	0.00307	0.00406	0.00328
British Columbia(BC)	0.00321	0.00340	0.00370
Southwestern Canada Average	0.00229	0.00277	0.00258



3.3 Economic loss attributed to mortality rate

Province	Nov, 2017	Nov, 2018	Nov, 2019
Saskatchewan (SK)	5.476511187	7.797290092	7.197841966
Alberta (AB)	119.3755738	160.1120424	130.487198
British Columbia (BC)	130.4226227	140.8422787	162.7030615



Chapter 4: Discussion

The average economic loss in 2018 is the greatest among 2017-2019.

The Mortality rate in 2018 is the most in between 2017-2019 in both BC and Alberta as the wildfire in that year is the greatest in Northwest America among 3 years. BC has the greatest economic loss as geographically it is the nearest province to California where the wildfire originates, and its population density is the highest among the three provinces. The government of BC has more prevalence of air pollution caused by wildfire as an emergency response in 2018, which has a significant influence on the mortality rate and leads to less economic loss. Moreover, the air pollution and population density increase between 2018 and 2019 generally which contributes to higher mortality in 2019 as well. A further modification is required to get more accurate data for mortality caused by wildfire only.

To reduce the risk of exposure to wildfire smoke and eliminate economic loss, the government should plan for more fiscally manageable responses. The government of

Canada has issued an air quality health index that residents can access freely to check the special air quality statements or other indicators of smoke levels in different provinces. Moreover, Canada and the United States has signed an Air Quality Agreement to reduce the emission of Sulphur Dioxide and nitrogen oxides in 1991 (Government of Canada, 2020). Since then, the Canadian government and the United States continue to meet their commitments. More national ambient air quality standards for pollutants such as ozone and particulate matter (PM2.5) are included to address the transboundary air pollution issues, including wildfire-smoke pollution, to protect the residents' health and reduce an economic loss (Government of Canada, 2020).

Additionally, mitigating the frequencies of wildfire occurrence is the best way to avoid the spreading of smoke and exposure to smoke from sources. Indoor air filtration and behaviour adjustment can contribute to reducing the occurrence of wildfire from an individual perspective in the short term. However, California Camp Fire was promoted by electrical transmission lines due to the drought conditions such as low humidity, warm temperatures and spread fast and strong wind (California Department of Forestry and Fire Protection, 2019). Hence, from a long-term perspective, curtail the consumption of fossil fuel is crucial for the suppression of wildfire sparked by climate change-induced drought conditions.

Chapter 5: Conclusion

Hence, PM2.5 concentration Level, asthma mortality rate and economic loss in Alberta and British Columbia are relatively higher than in Saskatchewan during November 2018. Future studies of the impact of the California Camp Fire Smoke in Southwestern Canada could include more data for a longer period to assess the relationship between air pollution, mortality rate, population and economic loss.

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