Economic implication of a Wildfire Monitoring Satellite For Canada Including Water Treatment and Infrastructure cost

Susan Subedi*[1], Dan McKenney[2], Alfons Weersink[1], Getu Hailu[1]

[1]Department of Food, Agricultural and Resource Economics (FARE), University of Guelph

[2] Great Lakes Forestry Center, Natural Resources Canada

*Presenting author, Email: subedi@uoguelph.ca

1. Introduction

- Frequency of wildfire has increased in Canada in the past few years.
- Wildfire have a significant capacity to impact watershed conditions.
- Surge in wildfire has led to notable increase in various costs across multiple industries.
- Response to this imperative need, the WildFireSat project has been developed.
- Thorough assessment of its economic implications is crucial for understanding its potential benefit.

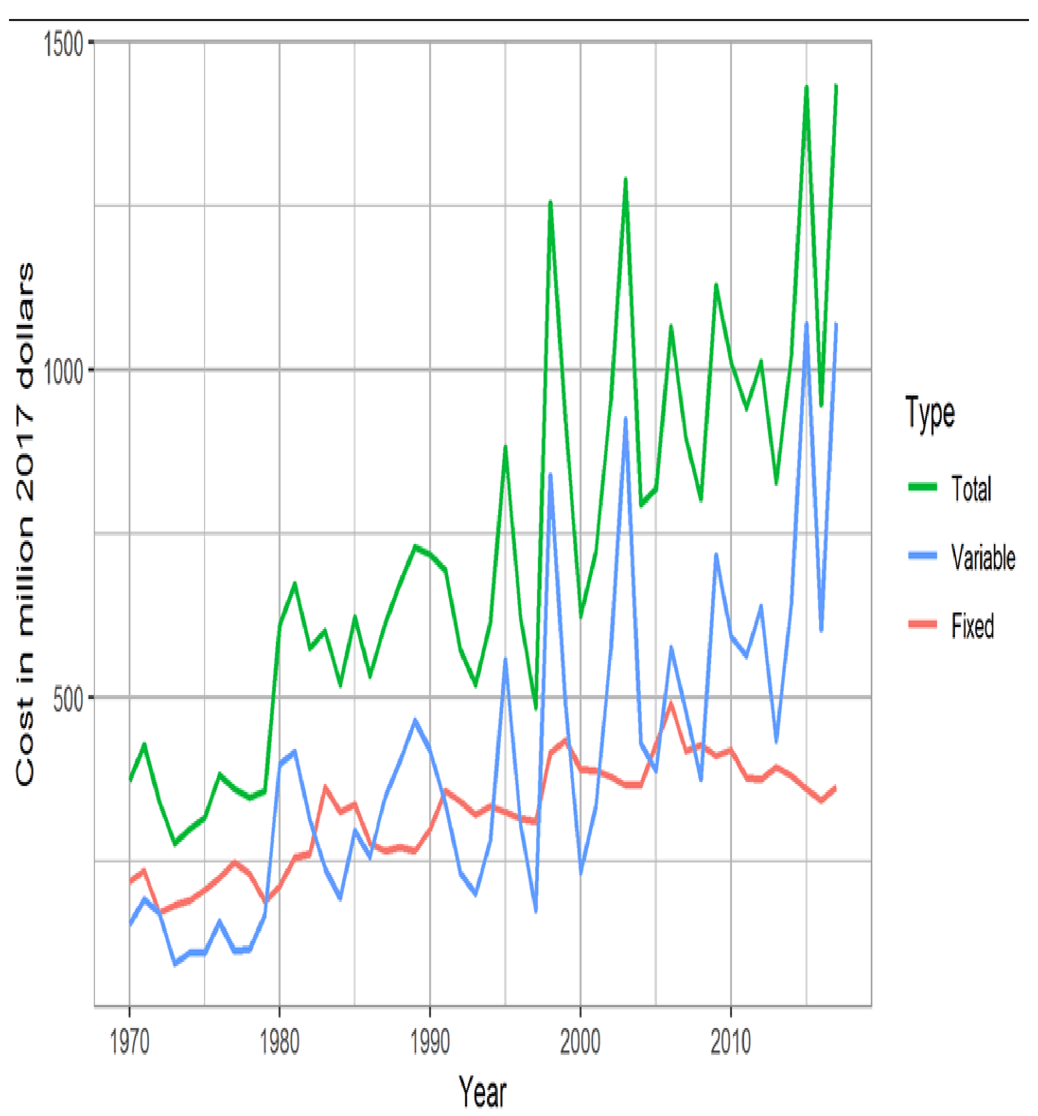

Figure1.1: Cost of wildland protection in Canada from 1970 to 2017 (in million 2017 Canadian dollars)(Source: NRCan, 2017)

Research Question

To identify and quantify the cost related to wildfire including water, suppression and evacuation cost, as well as losses in timber and property at a coarse spatial scale and integrate these costs into the existing wildfire satellite economics assessment models.

2. Data

We obtained data from the following sources:

- Monthly CMI (Climate Moisture Index) values obtained from different climate stations across Canada.
- Future CMI data was calculated based on CMIP5 data
- Forest area burned data obtained jointly from Natural Resources Canada, National Fire Data based and Canada One Water (CoW).
- Suppression cost data obtained from Canadian Interagency Forest Fire Center.
- Water cost data obtained from Statistics Canada.
- Evacuation cost data obtained from Canadian Forest Service.
- Satellite cost data obtained from Canadian Space Agency.
- Property & Structure loss data obtained from Insurance Bureau of Canada
- Data on timber loss was calculated based on the wildfire emission data provided by the Canadian Forest Service Carbon Accounting Team at Pacific Forestry Center.

3. Empirical Strategy

- Developed statistical model for each province:

$$\ln(W_i) = \beta_0 + \beta_1 * CMI_i + \varepsilon_i \quad (1)$$

W_i = natural log of the yearly burned area in watershed in year i

- Developed models for relationships between areas burned and wildfire costs:

$$\ln(S_i) = \beta_0 + \beta_1 \ln(W_i) + \varepsilon_i \quad (2)$$

S_i = natural log of the variable suppression cost in year i

$$\ln(C_i) = \beta_0 + \beta_1 \ln(W_i) + \varepsilon_i \quad (3)$$

C_i = natural log of the cost of water treatment and infrastructure cost in year i

$$\ln(T_i) = \beta_0 + \beta_1 \ln(W_i) + \varepsilon_i \quad (4)$$

T_i = natural log of the timber loss in year i

$$\ln(E_i) = \beta_0 + \beta_1 \ln(W_i) + \varepsilon_i \quad (5)$$

E_i = natural log of the evacuation cost in year i

3. Empirical Strategy(cont'd)

$$\ln(P_i) = \beta_0 + \beta_1 \ln(W_i) + \varepsilon_i \quad (6)$$

P_i = natural log of the property loss in year i,

- Utilized the future CMI projection combination with Eq(1)
- Computed estimates for area burned in each province from 2021 to 2050.
- Employed area burned estimates in Eq(2) to (6)
- Aggregated the provincial-level result.
- Decomposed total satellite cost into annual equivalent lump sum amount using:

$$\frac{\text{Total cost} * \text{Discount rate}}{1-(1+\text{Discount rate})^{\text{Life span}}}$$

- Annual total future wildfire cost will be juxtaposed against the anticipated annual satellite cost

4. Results

Table 1.1 Provincial CMI and Area burned linear regression model results

Province	β_0	β_1	F-stats	R^2	p-value
Alberta	8.9068	-0.1537	8.804	0.155	0.004**
British Columbia	9.9720	-0.1514	23.53	0.31	0.000***
Saskatchewan	9.756	-0.0532	1.135	0.0353	0.29
Manitoba	9.615	-0.232	10.47	0.287	0.003**
Quebec	11.22	-0.1665	6.155	0.1496	0.018*
Ontario	9.8115	-0.190	14.01	0.25	0.000***

Table 1.2 Provincial Area burned, and water cost linear regression model results

Province	β_0	β_1	F-stats	R^2	p-value
Alberta	4.58	0.007	0.021	0.003	0.88
British Columbia	3.900	0.0286	0.652	0.098	0.45
Saskatchewan	4.096	-0.022	8.47	0.585	0.027*
Manitoba	3.045	0.0404	0.475	0.073	0.516
Quebec	5.245	-0.004	0.369	0.058	0.565
Ontario	5.56	0.004	0.059	0.009	0.815

Table 1.3 Provincial Area burned, and suppression cost linear regression model result

Province	β_0	β_1	F-stats	R^2	p-value
Alberta	9.38	0.22	22.43	0.32	0.000***
British Columbia	9.45	0.240	32.92	0.41	0.000***
Saskatchewan	9.213	0.180	36.82	0.51	0.000***
Manitoba	9.45	0.110	12.6	0.29	0.00**
Quebec	10.62	0.064	19.38	0.31	0.000***
Ontario	10.55	0.11	19.24	0.30	0.000***

4. Results (cont'd)

Table 1.4 Provincial Area burned, and suppression cost linear regression model results

Province	β_0	β_1	F-stat	R^2	p-value
Alberta	-0.05	1.33	73.78	0.732	0.000***
British Columbia	-5.35	1.674	145.3	0.843	0.000***
Saskatchewan	-6.86	1.78	285.8	0.913	0.000***
Manitoba	-6.71	1.61	193.8	0.902	0.000***
Quebec	-10.02	1.90	105.8	0.796	0.000***
Ontario	-6.08	1.62	190.2	0.879	0.000***

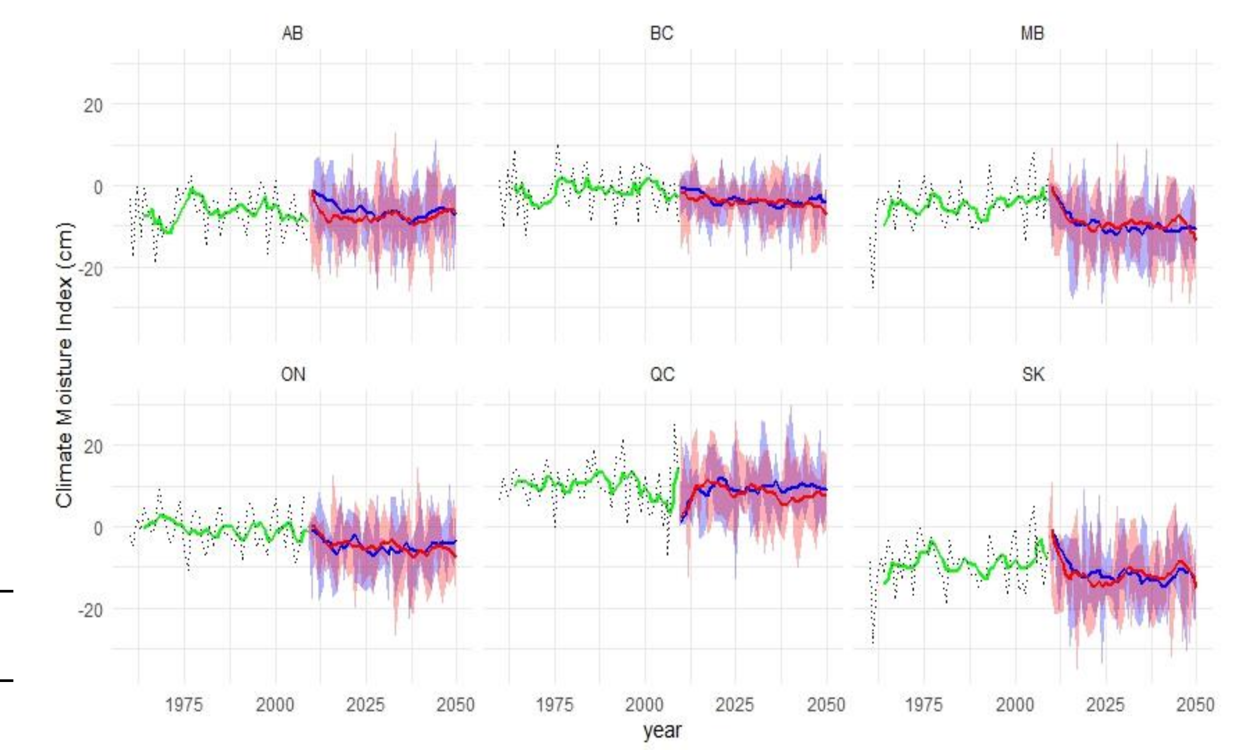

Figure1.2: Historical and future CMI under RCP2.6 and 8.5 for all GCMs

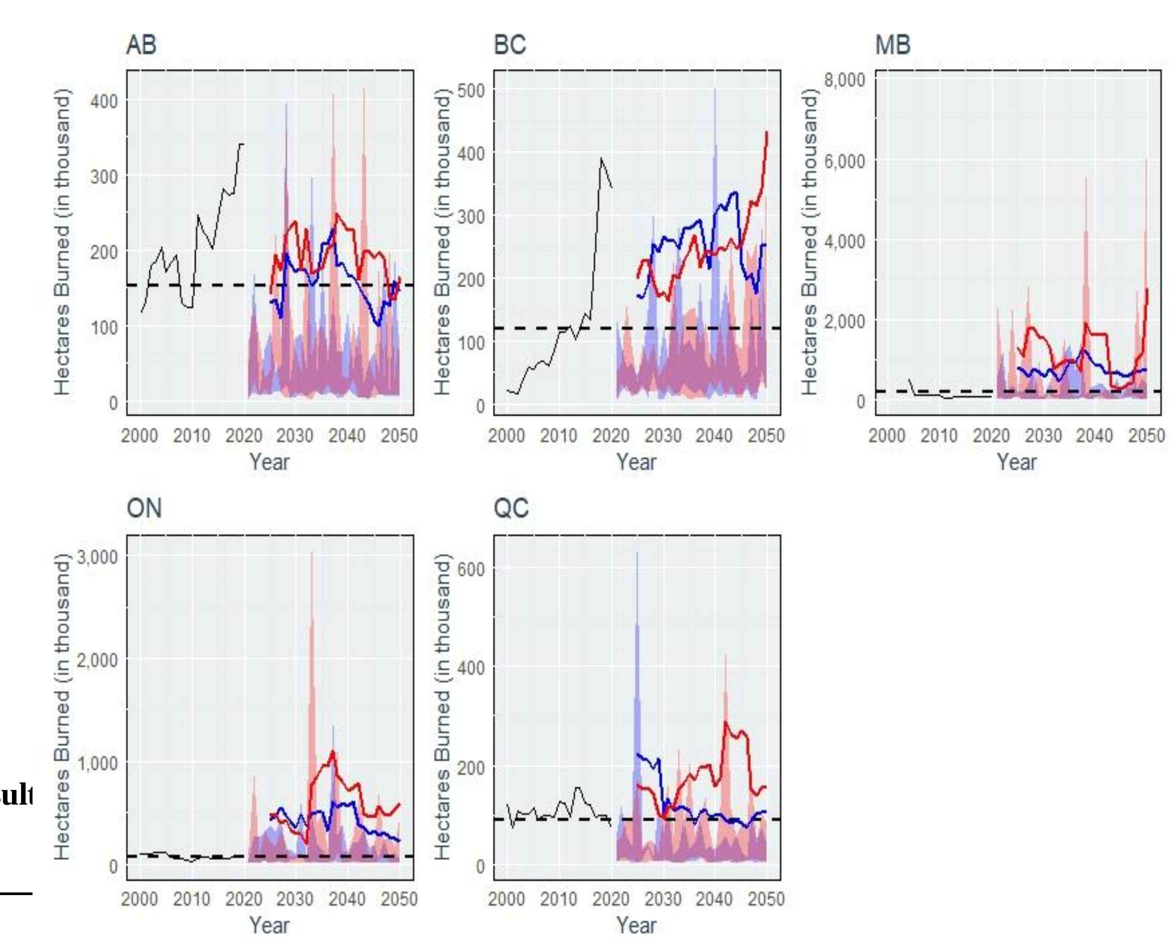

Figure 1.3: Area burned as forecast under RCP2.6 and 8.5 for all GCMs

5. Next Steps

- Carry out regression analysis for evacuation cost and structure loss and forecast.
- Forecast the suppression cost and timber loss
- Carry out cost-benefit analysis of possible cost savings in relation to investments into the satellite system.