8TH INTERNATIONAL WILDLAND FIRE CONFERENCE
GOVERNANCE PRINCIPLES: Towards an International Framework

Integration of residential structures loss functions into wildfire risk assessment

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Impacts of wildfires in the wildland urban interface (WUI)


Chile: At least 23 dead and state of catastrophe declared after hundreds of wildfires rage

By Angela Symons with AP, AFP • Updated: 27/03/2023

Wildfires in Spain have forced more than 1,500 people to flee their homes and firefighters were still battling blazes in Valencia's Castellon province into Sunday. More than 4,000 hectares of land have been engulfed by the fire.

- Globally, communities are being im… wildland fires year-round
- In Canada, several communities had many structures destroyed by fires: Fort McMurray, Alberta (2016), or Lytton, British Colombia (2021)
- Many have also been affected by smoke or evacuation orders
- **There is a need to better identify areas at risk of being impacted by wildfires, in order to better plan actions (e.g., adaptation/mitigation, evacuations, and suppression)**


www.lapresse.ca/actualites/2021-07-07/incendies-en-colombie-britannique/les-residants-de-lytton-ont-du-fuir-en-vitesse.php


https://www.thecanadianencyclopedia.ca/fr/article/fort-mcmurray

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Wildland fire risk to residential structures

Objective

Fill the knowledge gap of quantitative assessment of wildfire impacts on residential structures at the wildland urban interface (WUI):

1. By developing a methodological framework for simulating spatial wildfire risk assessment of residential structures;
2. By developing empirical response functions representing expected structure loss rates at the community scale as a function of **fire intensity** and **distance from fire edge**.

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Framework for spatial incident-level wildfire risk modelling to residential structures at the wildland urban interface

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The structural wildfire risk framework (SWRF)

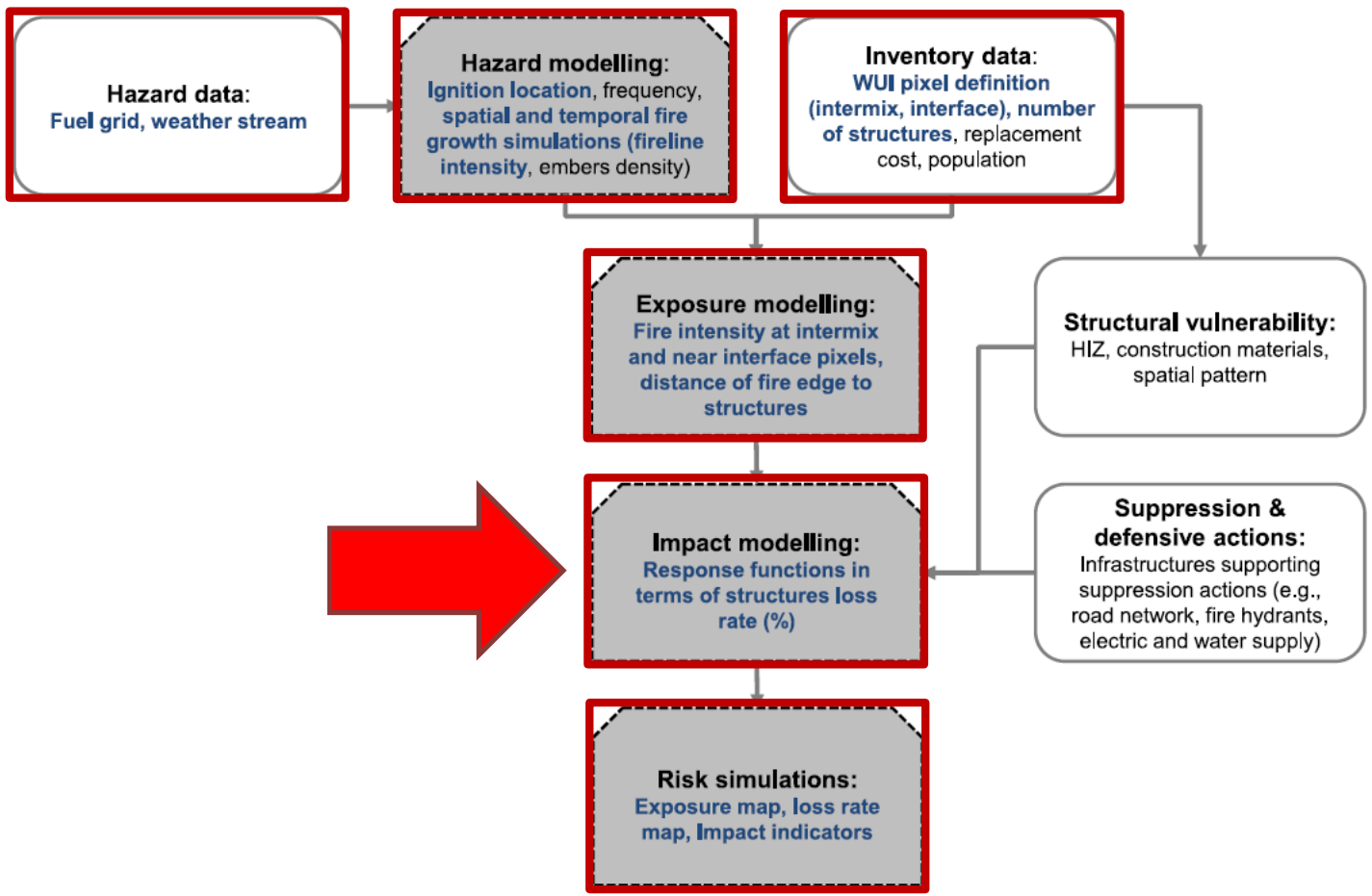
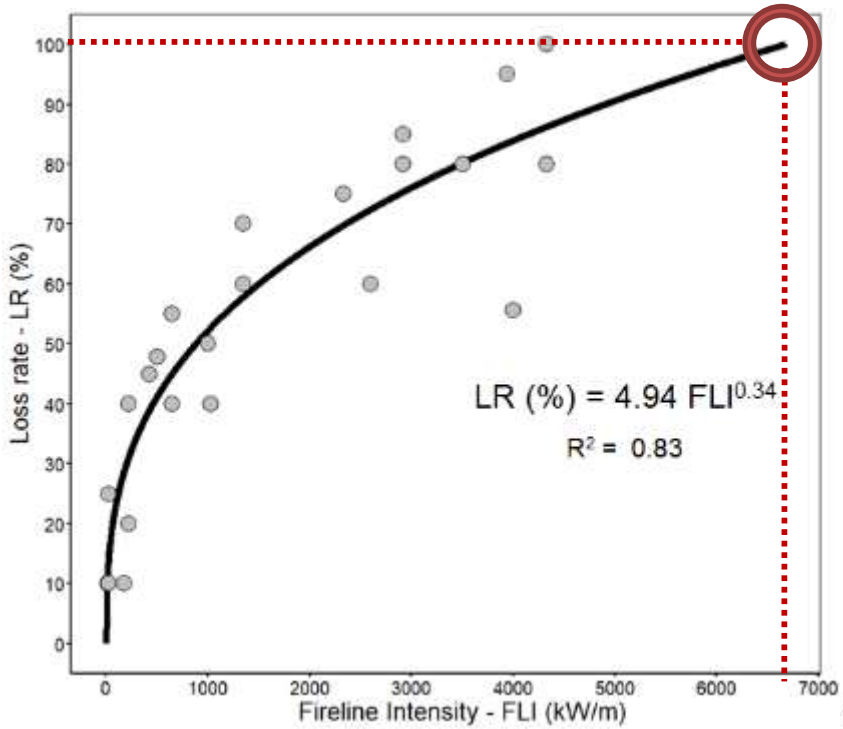


Fig. 1. Components and structure of the framework for quantitative wildfire risk assessment to residential structures. The bold blue parameters are included in the presented case study implementation. The grey boxes represent components focused on modelling compared to the white boxes with components focused on information and data. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

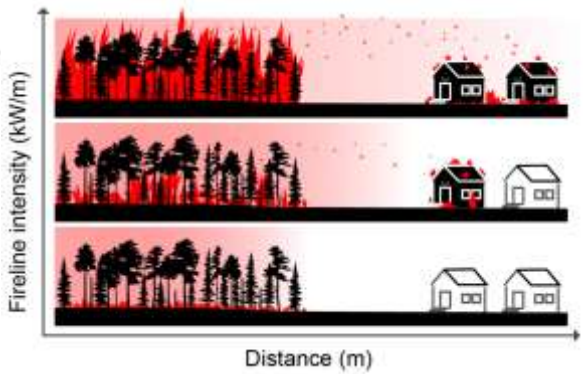
The empirical response functions

Based on data from the literature

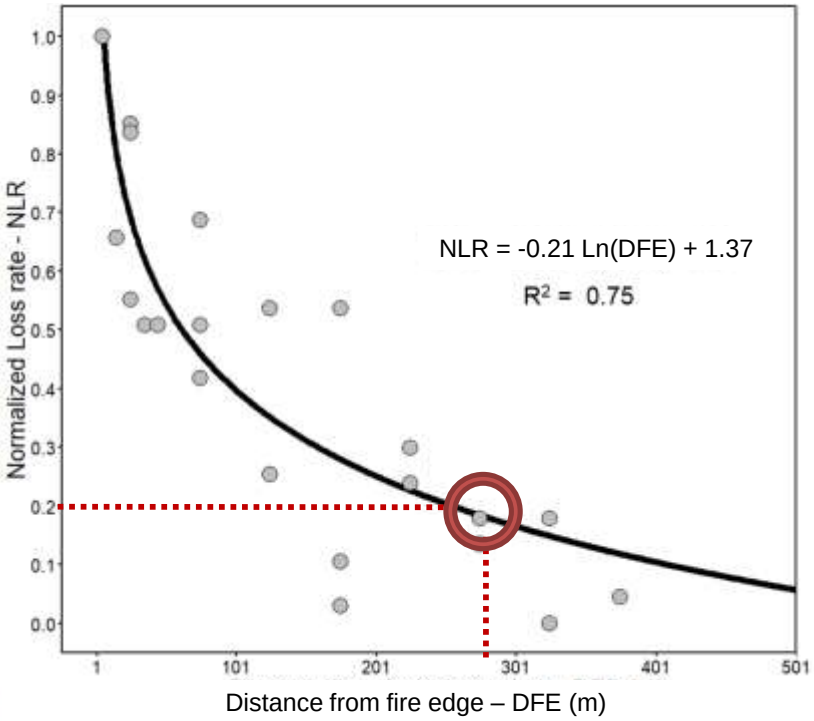
Direct exposure pixels (Intermix)



LR ≈ 20%



Indirect exposure pixels (Interface)



Abo El Ezz et al., (2022), *Fire Safety Journal*

FireLossRate: an R package for computing wildfire impacts on structures at the WUI

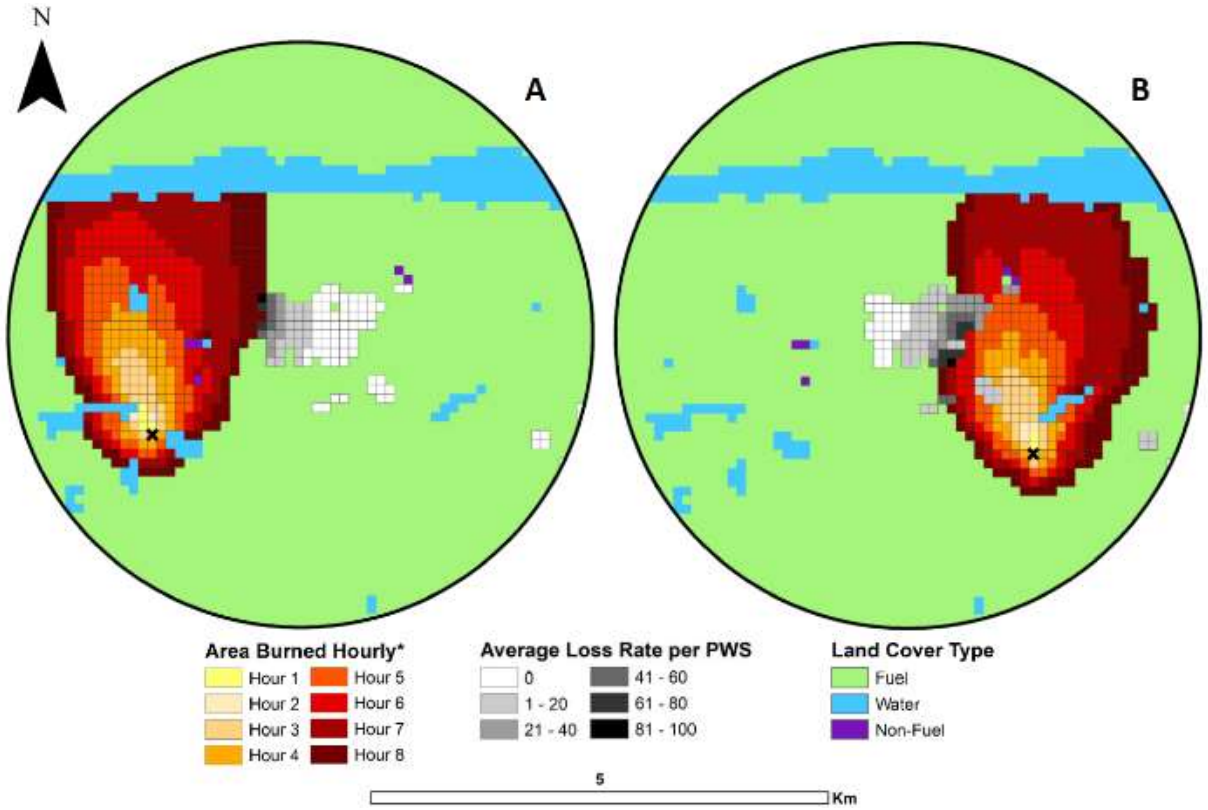
- **To facilitate the use of the response functions and their implementation into the developed framework**
- **This package uses spatial information on forecasted fire line intensity and residential structure inventory data**
- **To compute a loss rate for each pixel containing at least a structure, namely a Pixel with Structures (PWS)**
- **The following impacts indicators can then be produced:**

Deterministic single event

1. **Number of exposed structures**, i.e., the count of PWS with a non-negative loss rate.
2. **Number of lost structures**, multiplying the structure count of each PWS by the associated loss rate.
3. **Average exposure loss rate**, dividing the number of lost structures by the number of exposed structures.
4. **Average community loss rate**, dividing the number of lost structures by the number of total structures.
5. **Number of times a PWS was exposed**, i.e., within a defined maximum distance from the fire's edge.
6. **Number of times a PWS was damaged by fire**, i.e., with a loss rate ≥50% following Federal Emergency Management Agency guidelines (FEMA, 2010).

Probabilistic framework

Case-study results of impact modelling for deterministic events



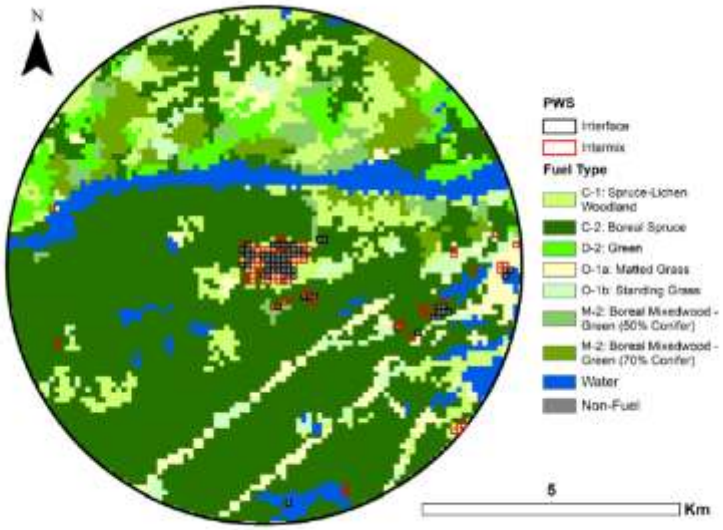


Fig. 5. Fuel types based on the FBP System and non-fuel pixels in a 5 km buffer surrounding the case study town. PWS are pixels with structures differentiated between interface and intermix types. Pixels are 100 m by 100 m in size.

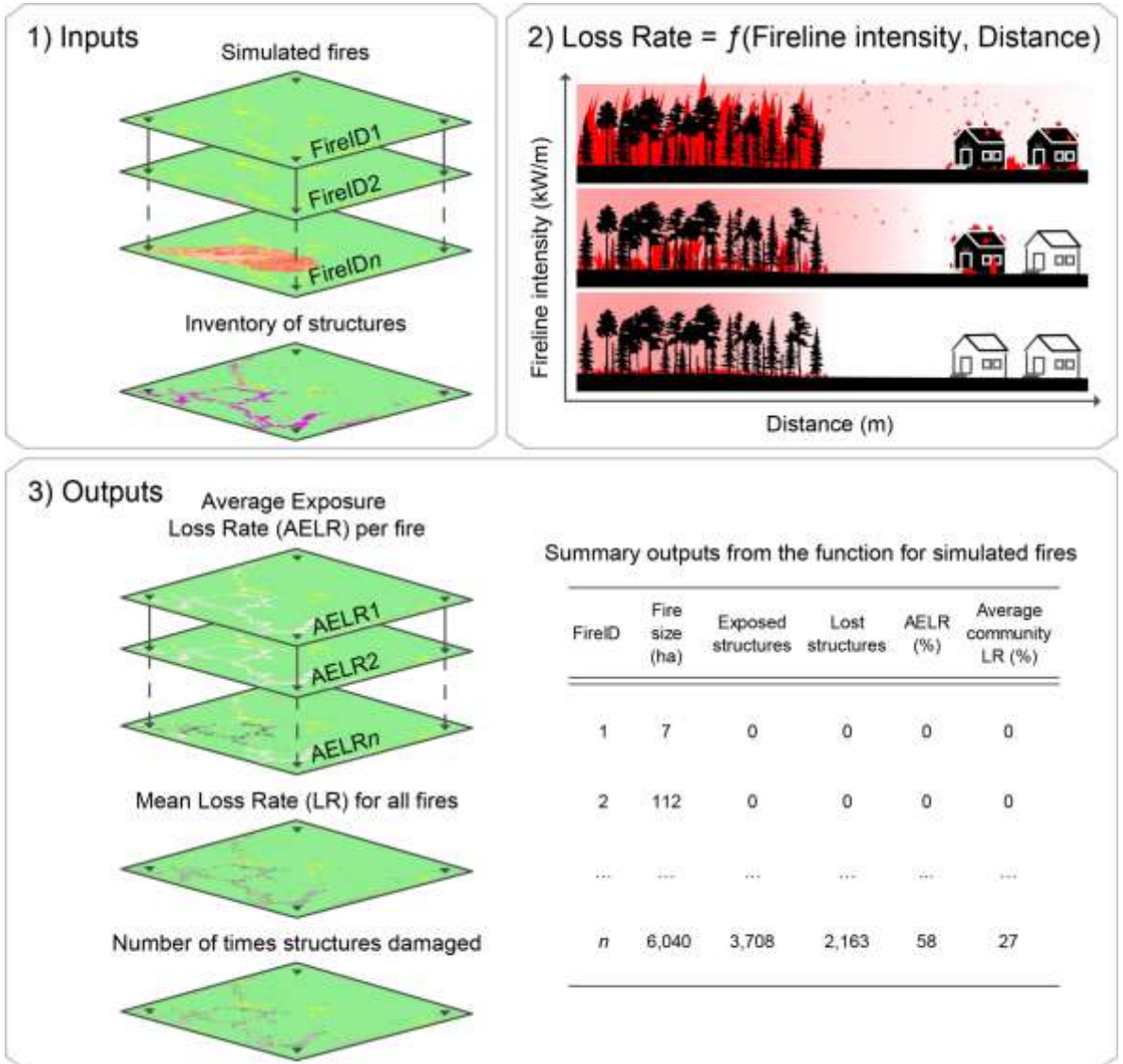
Impact indicators	Scenario A	Scenario B
Number of exposed structures	133	255
Number of lost structures	28	101
Average exposure loss rate	21%	34%
Average community loss rate	7%	25%

Abo El Ezz et al., (2022), *Fire Safety Journal*

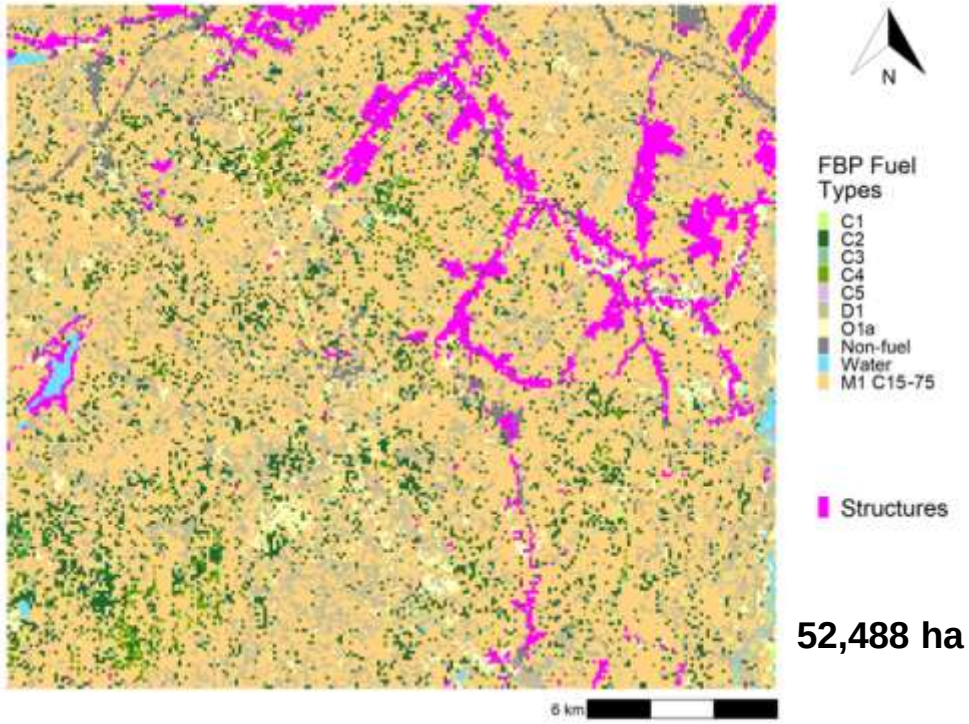
Probabilistic framework

(Nicoletta et al., submitted to MethodsX)

- **A more comprehensive wildland fire risk assessment of residential structures at the scale of a community or region**
- **Thousands of fire simulations with the BurnP3 software**



Probabilistic framework Case-study



52,488 ha

Figure S1. Fire Behaviour Prediction (FBP) fuel types and residential structures. C2 = Boreal Spruce, C3 = Mature Jack and Lodgepole Pine, C4 = Immature Jack and Lodgepole Pine, C5 = Red and White Pine, C6 = Conifer Plantation, D1 = Leafless Aspen, O1a = Matted Grass, M1 C15-75 = Boreal Mixedwood – Leafless (15-75% Conifer) (Forestry Canada Fire Danger Group, 1992).

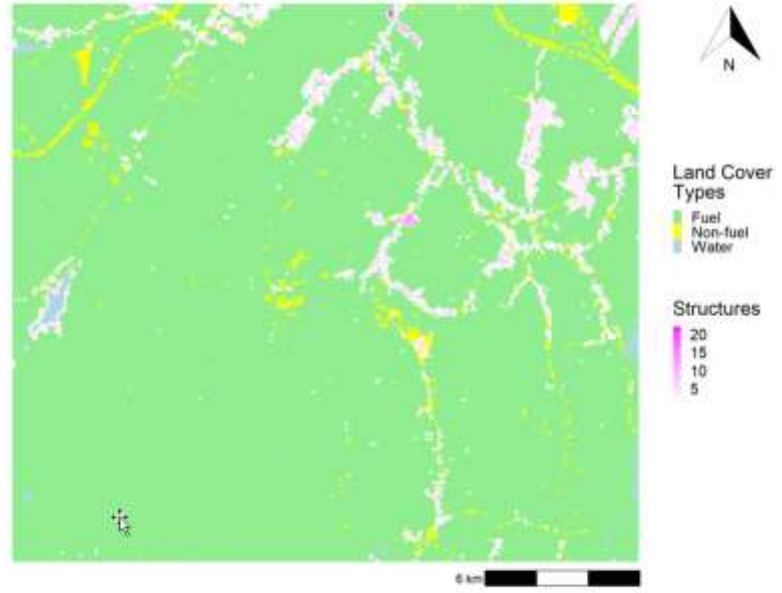


Figure S2. Land cover types and number of structures per Pixels with Structures.

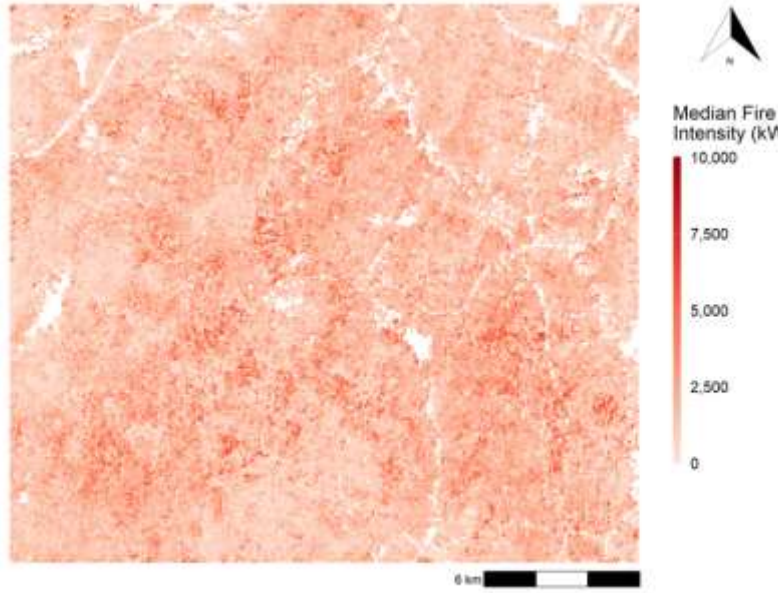
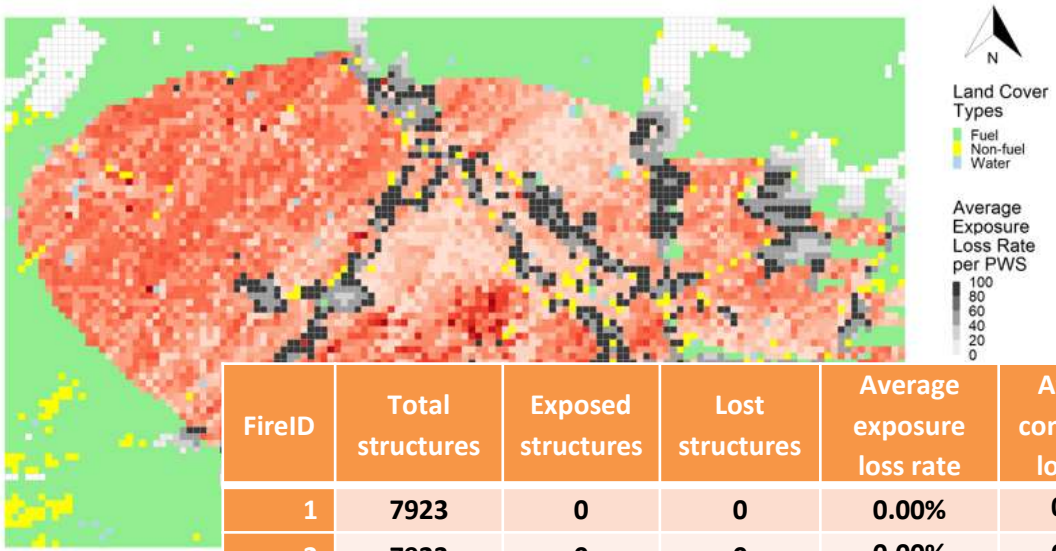


Figure 3. Median Fire Intensity across the 5,000 iterations of the Burn-P3 simulation.

Probabilistic framework Results



FireID	Total structures	Exposed structures	Lost structures	Average exposure loss rate	Average community loss rate
1	7923	0	0	0.00%	0.00%
2	7923	0	0	0.00%	0.00%
3	7923	0	0	0.00%	0.00%
4	7923	0	0	0.00%	0.00%
5	7923	0	0	0.00%	0.00%
6	7923	181	5	2.76%	0.06%
7	7923	8	0	0.00%	0.00%
8	7923	1	0	0.00%	0.00%
9	7923	9	0	0.00%	0.00%
10	7923	204	18	8.82%	0.23%

Figure 4. Average ex
the simulated fire anc
cover types with eithe

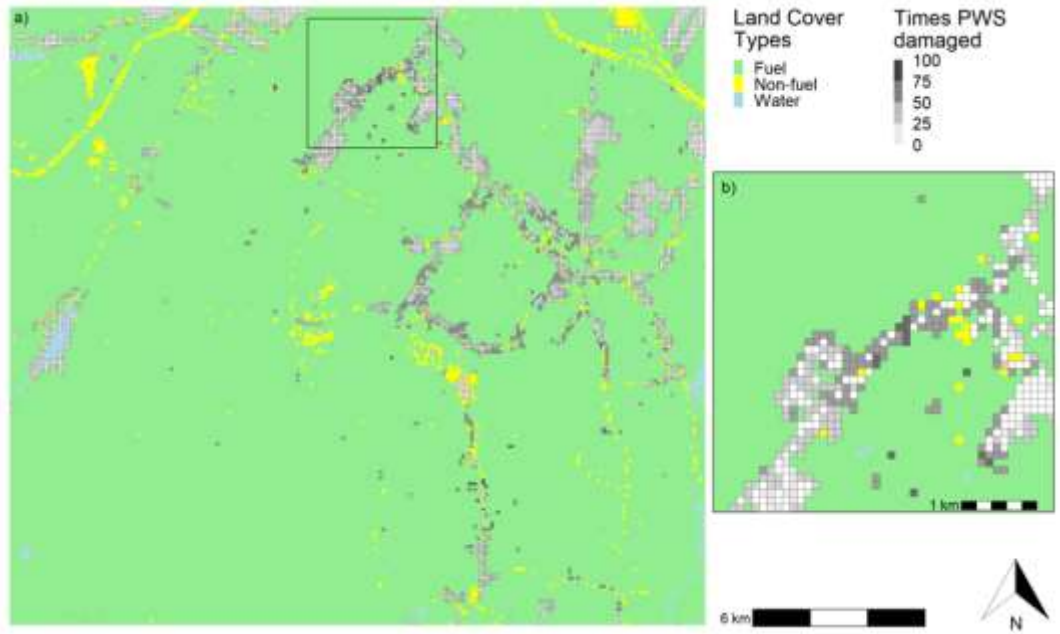


Figure 6. a) Number of times Pixels with Structures (PWS) were damaged by fire, assuming that a structure was damaged if the associated loss rate was ≥50%, and b) zoom of the area shown in the black rectangle. Land cover types were either fuel (forests and grasslands), non-fuel, or water.

Number of times PWS were damaged over 5,000 fire iterations

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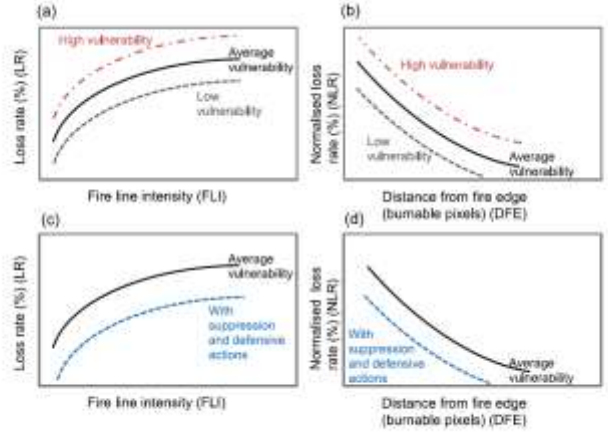
Concluding remarks

- The single fire incident case study, shows how the package enables the calculation of potential impacts to structures, as a function FLI and DFE.
- The package also enables probabilistic fire growth modelling as exemplified by the multiple fire incidents case study.
- Offering a comprehensive assessment of fire risk to structures through the inclusion of fire occurrence and likelihood derived from a simulation-based burn probability model.
- The FireLossRate package summarizes of a suite of statistics in tabular and graphical formats that can be useful for a range of stakeholders including public safety and land managers.
- Mapping areas with higher risks to structures offers insights to a range of concerned parties, e.g., from governments to homeowner, on where to prioritize structural retrofitting or mitigation efforts.
- Such information can support the design of new neighborhoods and housing developments that are less exposed to fires.
- Given the flexibility of the FireLossRate package, we encourage users to explore novel approaches to output their results according to their specific uses or applications that may not be limited to

FIREHAWK
A Rapid Risk Evaluator for Wildfires in Canada
Un évaluateur rapide des risques pour les incendies de végétation au Canada



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Thanks!

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https://twitter.com/LFCFireLab
https://app-firehawk-web-cwfis-dev.azurewebsites.net/en/

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