QuickNotes

Science summaries from fRI Research

Introducing: Spatio-temporal variability in post-mountain pine beetle outbreak fuels in Jasper National Park using terrestrial laser scanning and bi-temporal, multi-spectral airborne LiDAR

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Jasper National Park, like other National Parks found in the Eastern Slopes of Western Canada, has undergone fire suppression activities since the early 20th century. This has resulted in the homogenization of forest species composition, age, and structure. This legacy, along with warmer and drier atmospheric conditions over recent decades, has resulted in a high susceptibility to mountain pine beetle (MPB) outbreaks within the Park. Consequently, there has been a dramatic visual transformation of lodgepole pine within forests surrounding the Jasper town site.

MPB attacks trees by boring into cambium causing a disruption in the movement of water to branches and foliage. This results in green leaves (green attack phase) turning red from drying (red attack phase), and ultimately dropping (gray attack phase) over time. Dead trees will eventually start to break down and fall. The resulting increase in vertical complexity and surface fuel loads, needles and downed (coarse and fine) woody debris, lead to greater wildfire risk. Despite the increased fire risks, relatively little is known about fire behaviour in MPB-disturbed ecosystems, especially concerning the variability of the fuel structures associated with attack phases in the landscape.

Federal-Provincial MPB Research Partnership

Mountain Pine Beetle remains a severe threat to Alberta's pine forests despite the province making positive progress in controlling its spread within the province and reducing the risk to the rest of Canada.

Natural Resources Canada and Alberta Agriculture and Forestry have provided funding to a suite of projects with the goals of limiting the spread of Mountain Pine Beetle and mitigating damages where it has already invaded.

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While it is critically important to understand the interactions between MPB and fire behaviour, especially for communities that experience both disturbances, the ability to measure changing wildfire fuel attributes in the field is expensive and time consuming. Remote sensing approaches, such as lidar (light detection and ranging), provide an opportunity to quantify the spatially contiguous range of 3D structures associated with fire fuels across broad areas that may be impossible to fully characterise using traditional field plot or sampling data collection methods.

Objectives

This research will examine changes in forest stand structure and fuel loads for wildfire associated with time since MPB outbreak using bi-temporal (2018 and 2021) airborne lidar data, including a novel three-wavelength multispectral lidar, optical structure from motion and multispectral imaging from Remote Piloted Aircraft Systems (RPAS), terrestrial lidar data at the plot level, and forest plot measurements following the Next Generation Canadian Forest Fire Danger Rating System (NG-CFFDRS). The objectives are to:

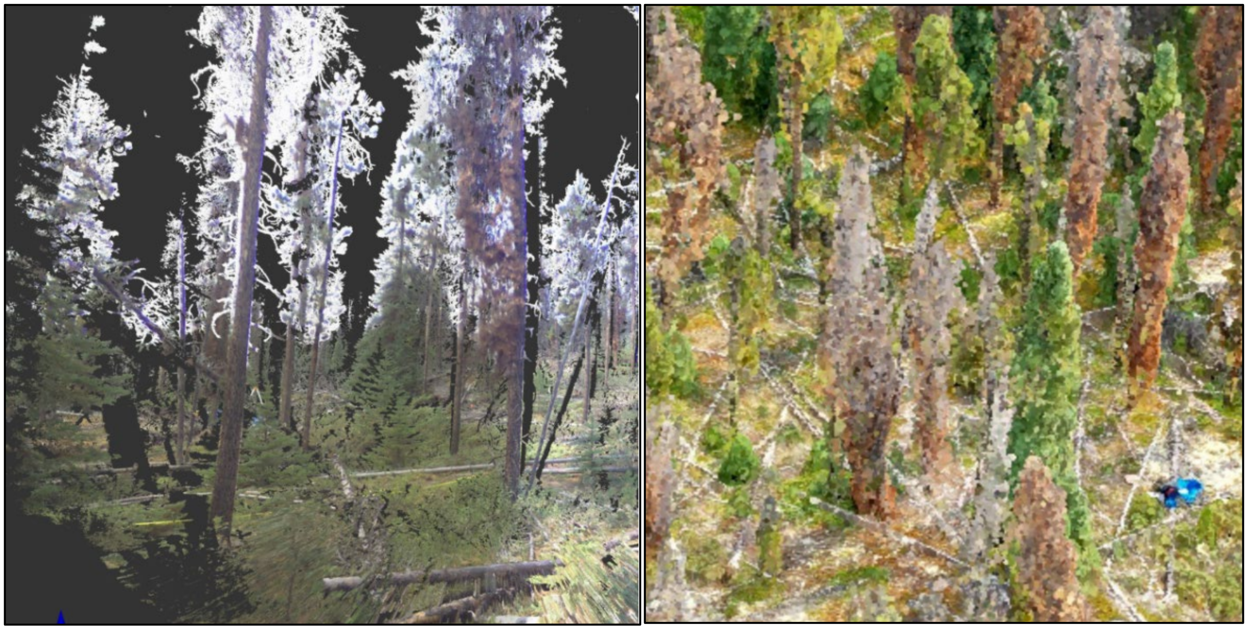
1. Quantify coarse and fine fuels of unaffected stands and for each attack phase by examining a) changes in site-specific fuel structures through time or with attack phase across site types; and b) how time-coincident sites of differing attack phase vary in terms of three-wavelength laser pulse intensity signatures.
2. Explore: a) relationships between outbreak duration and severity with spatial and vertical structures and fuel connectivity across attack phases; and b) how these relationships vary with in situ environmental drivers to determine or modify fire risk
3. Apply the outputs from 1 and 2 to create a predictive model of fuel composition, structure, and load as functions of environmental drivers, outbreak severity, and time since MPB disturbance.

Piper Navajo used by ULethbridge for lidar surveys (top); ULethbridge WEDC Teledyne Optech Inc. Titan lidar installed in aircraft for forest structure surveys (bottom).

Expected Outcomes

Through this project, we will develop innovative methods (including novel technologies, data fusion, and machine learning imputation) to identify fire fuel type, composition, and quantity using spatially continuous remote sensing and plot-level field data streams. We will also calculate multiple metrics (e.g., component fuel load) to quantify variation in vertical and horizontal (fully 3D) fuels that contribute to fire risk in Jasper National Park. Using these metrics, we will be able to map zones of high and low fire risk, and how such risk varies with in situ forest structure attributes and environmental drivers. The research will result in academic publications, conference presentations, and a fuel risk map for the areas surrounding the Town of Jasper to assist with future fire management.

For more information on this project, contact Dr. Laura Chasmer at laura.chasmer@uleth.ca.



Colourised point cloud of terrestrial lidar data (single scan) from Teledyne Optech Polaris illustrating MPB disturbance, downed woody debris, and ladder fuels within one of 17 NG-CFFDRS measured forest plots (left). Remote Piloted Aerial System (RPAS) structure from motion data from visible photography illustrating different attack phases, regeneration, and downed woody debris (right).

Implications for Land Management

This project will inform forest and fire managers on areas that have undergone MPB related changes in forest structures in Jasper National Park using the remote sensing technologies and methods developed in this study. Understanding the spatial distribution of fuel structures within Jasper National Park, and how these compare with Banff National Park for similar montane forests, will enable forest managers to identify areas of highest risk were they can target mitigating management strategies, such as prescribed burns or clearing of infrastructure set backs.

Expected Social, Economic, and Ecological Value

This project will enable better-informed management of forests susceptible to, or affected by, MPB attack in Jasper National Park and the Eastern slopes of the Rockies. Improved management practices will facilitate regeneration or more resilient, healthy, and heterogeneous forest ecosystems with the goal of reducing fire risks both of wildfire and MPB attack. This will deliver significant benefits not only to the Eastern Slopes program, but also aid national-level efforts to address the impacts of forest insect outbreaks on wildfire within the NG-CFFDRS. Further, innovations developed through this study, e.g. through the use of terrestrial lidar and possibly RPAS for fuel load and structure modelling, may be incorporated into new fuel plot measurement standard operating procedures across Canada.

Expected Completion Date

April 30th, 2024

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