2024 Fort Nelson Wildfire
Burn Severity Analysis

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Date: 12/12/2025

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Introduction

In this pilot study, the wildfire around the Fort Nelson region in British Columbia that occurred in May 2024 was analyzed. The aim of this study was to characterize the severity distribution of the wildfire.

On 10 May 2024, citizens of Fort Nelson were ordered to evacuate due to a nearby wildfire at Parker Lake (CBC News, 2024). The order was dropped 16 days later on May 26th with the quelling of the Parker Lake fire. In total, 4,500 residents evacuated and ten properties were damaged and four homes were destroyed. Furthermore, the Fort Nelson First Nation cultural sites sustained significant damage (CBC News, 2024).

In order to spatially and spectrally assess the damage as well as observe the effects of the fire in the surrounding areas, a burn severity analysis is conducted. Remote sensing is used to carry out this analysis due to significantly large regions, namely the Parker Lake, Patry Creek and Nogah Creek regions (BC Wildfire Service, 2025). In particular, due to the size of the Nogah Creek fire, remote sensing is essential to asses the damage. For this reason, dNBR is used in tandem with Sentinel-2A MSI (Level-2A) satellite data.

Data and Methods

Data sources

There were three main data sources used in this analysis. First, the BC Wildfire Service fire perimeter shapefiles were used to isolate the fire perimeter in the Fort Nelson region. In this case, the 2024 fire perimeter was used (BC Wildfire Service, n.d.). Next, the Sentinel-2A MSI (Level-2A) Copernicus satellite was used. This satellite collects bands of light which are crucial for NBR calculations, namely Shortwave Infrared (SWIR) and Near Infrared (NIR). The resolution of the SWIR band is 20m while the resolution of the NIR band is 10m. Moreover, the dataset is convenient to import into the Google Earth Engine (GEE) software (Google, 2025). Finally, the ESRI Topographical map was used as a base map when creating the maps. This was used to contextually highlight the topographical features included within the fire perimeter (ESRI, 2022).

Methods

QGIS and GEE were used to generate the results of this analysis. Starting from the shapefile dataset, the fire perimeter was isolated and projected into the EPSG:4326 coordinate reference system due to the UTM/9 projection used in the original dataset. Once this was imported into GEE, pre and post composite layers were generated. To do this, the fire event date was taken as 10 May 2024 because this was when the fire had largely progressed while additionally having favorable weather conditions for image availability. In fact, the month of May was sparsely cloudy (Weather Spark, 2025). The pre-fire period was between 20-40 days before this date. This was done for snow minimization. The post-fire layer was taken similarly but from 1-60 days after this date. This was chosen due to smoke concerns affecting the composite while cloud masking later in the process.

Next, a Scene Classification Layer (SCL) on the Sentinel-2A MSI (Level-2A) satellite was used to remove clouds. The mask kept layers: 2,4,5,6,7 and 11 respectively keeping the shadow, vegetation, non-vegetation, water, unclassified and snow pixels (sentinelhub, 2025). The inclusion of snow was intentional since the post-fire composite would be affected if snow pixels in the pre-fire composite were not taken into account. To create the composites themselves, the median was taken for each layer. This step also dealt with boundary pixels because the combination of masking and compositing automatically excluded them from the dataset. The area is large enough that the data lost by this step is assumed to be minimal. To calculate the burn severity, the NBR and dNBR were determined as rasters from these composites (see Figure 1). Bands B8 and B12 were used to find the NIR and SWIR values respectively. The SWIR band was implicitly resampled by GEE to 10m as the resolution of the B8 band is 10m. Next, the burn severity was found using the United States Geological Survey (USGS) table in Table 1 (Kay & Benson, 2006).

$$\text{dNBR or } \Delta\text{NBR} = \text{PrefireNBR} - \text{PostfireNBR}$$

Figure 1. Equations for NBR and dNBR used to find burn severity. NIR is the peak reflectance of the Near Infrared band (750-900nm) and SWIR is the peak reflectance of the Shortwave Infrared band (2.09-2.35μm) (United Nations, 2025)

	Severity Level	dNBR Range (scaled by 10^3)	dNBR Range (not scaled)
	Enhanced Regrowth, high (post-fire)	-500 to -251	-0.500 to -0.251
	Enhanced Regrowth, low (post-fire)	-250 to -101	-0.250 to -0.101
	Unburned	-100 to +99	-0.100 to +0.99
	Low Severity	+100 to +269	+0.100 to +0.269
	Moderate-low Severity	+270 to +439	+0.270 to +0.439
	Miderate-high Severity	+440 to +659	+0.440 to +0.659
	High Severity	+660 to +1300	+0.660 to +1.300

Table 1: Burn Severity class table obtained from calculating dNBR, USGS style (United Nations, 2025).

Lastly, the burn severity was grouped by class so that the land area of each class could be found. This was done by calculating the area of each pixel, 100 m^2, with class c and summing the total area for each class. The data was then used to create a table and percentage histogram to display these results using a python script. Furthermore, the fire perimeter layer, dNBR layer and burn severity layer were processed using QGIS with a Transverse Mercator Projection, in accordance with the basemap.

Results

To begin with, the original fire perimeter will be discussed and can be found in Figure 2. The total area covered by this perimeter is 9630 km^2 . There are three main regions of note. The first main region is the small perimeter nearest to Fort Nelson. This region comprises the extent of the Parker Lake fire. This fire has an area of 123 km^2. North of Fort Nelson is another key region. This fire is known as the Patry Creek Fire named after the creek running from Patry lake. The dividing line comes from the Fort Nelson river. This is a holdover fire from 2023. Its area is 1708 km^2. Finally, the region to the east of Fort Nelson is known as the Nogah Creek Fire. This is another holdover fire from 2023 and has the largest area of 5084 km^2 (BC Wildfire Service, 2025). The remaining area is divided into scattered isolated fires like the 2 regions west of Nogah Creek.

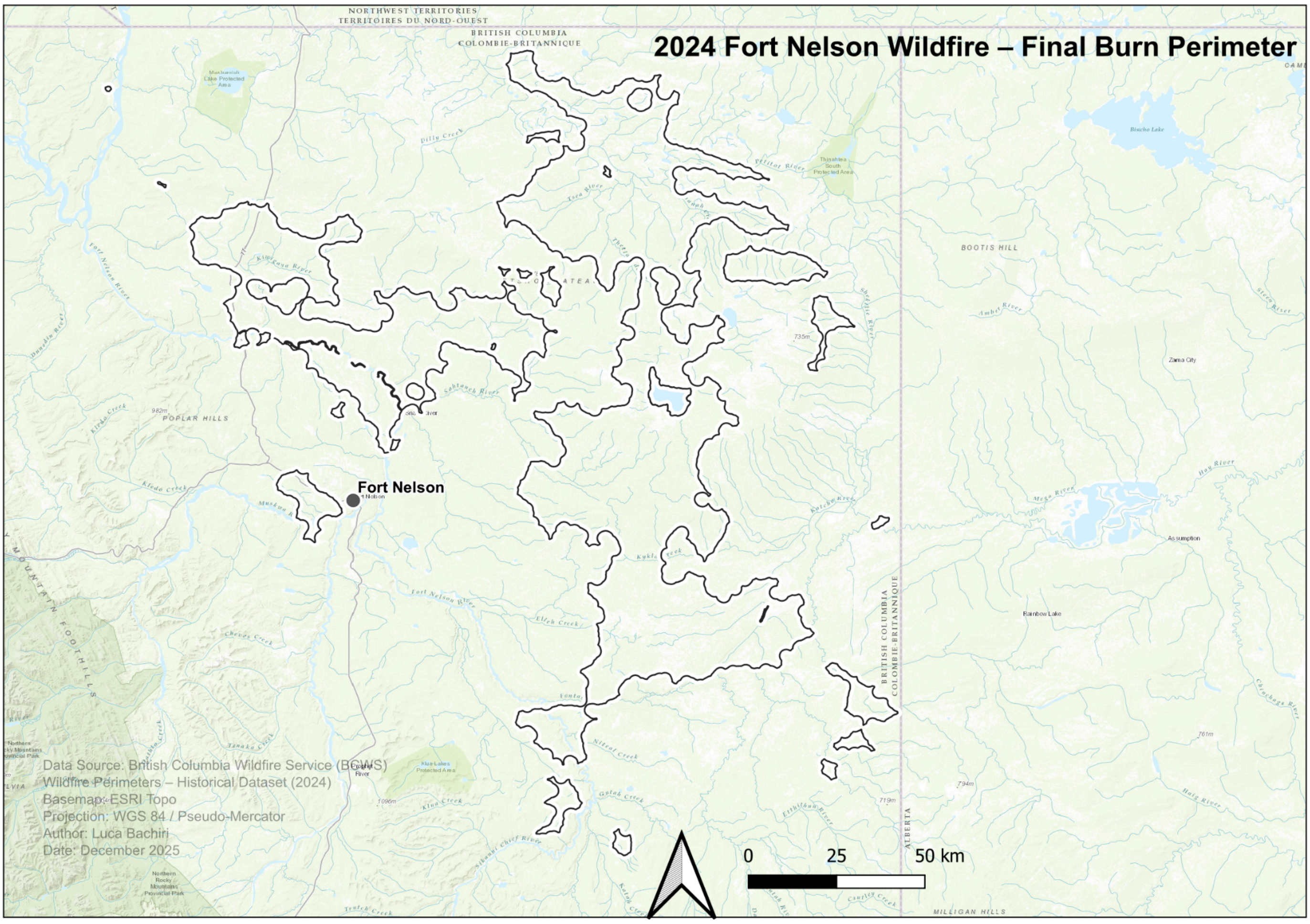

Figure 2. Fire perimeter map for the Fort Nelson region in British Columbia in 2024

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Next, the dNBR map in Figure 4 will be discussed. The dNBR ranges from 1.12 to -0.45 indicating that there were significant burns as well as indicating regrowth within the perimeter. The regions most affected by the burn are the Parker Lake region, the Patry Creek area closest to the Fort Nelson River and the north and middle Nogah Creek region. The areas that have since regrown are the south Nogah Creek region and the north and middle Patry Creek region.

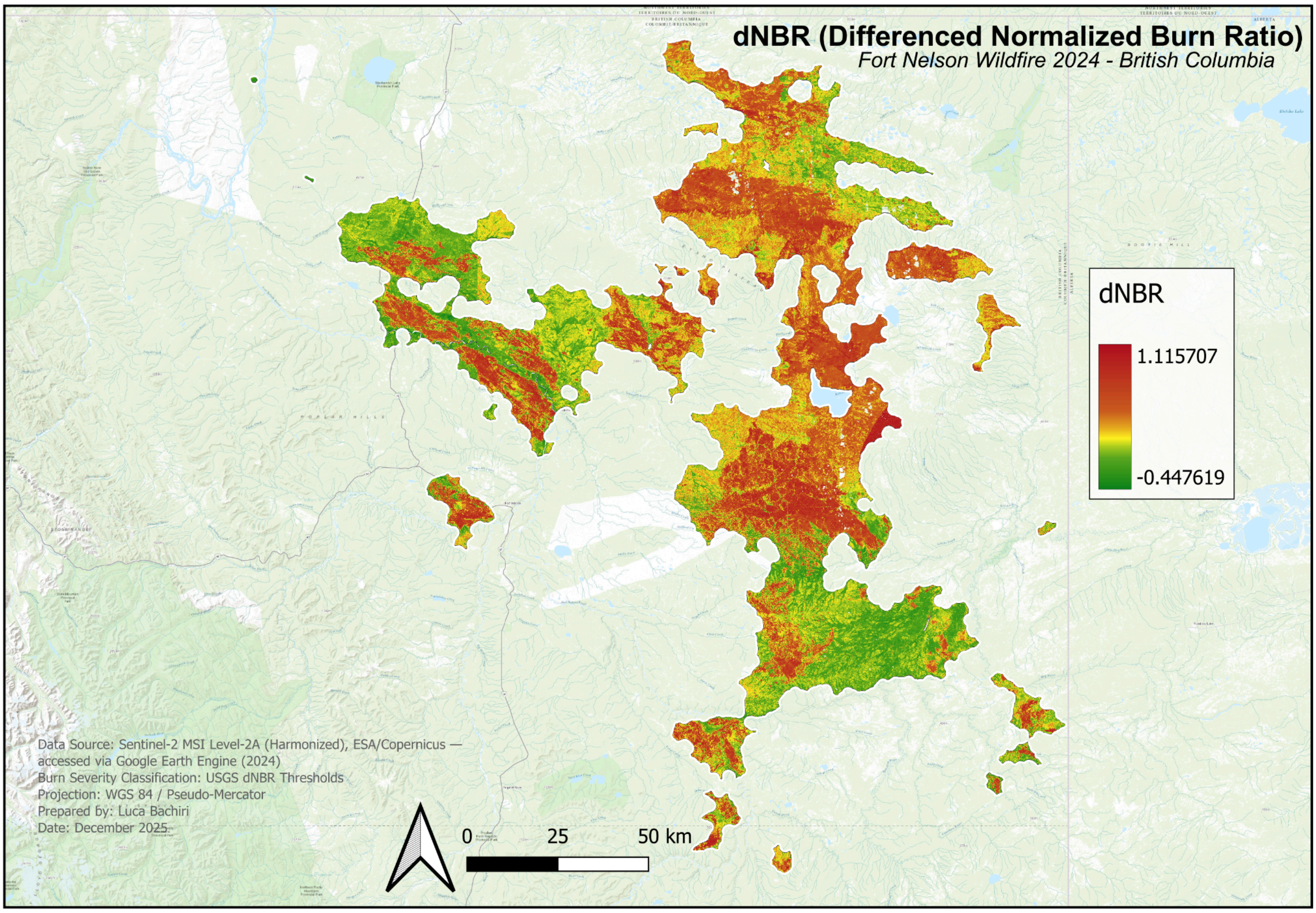

Figure 3. dNBR map showing regions within the fire perimeter and their dNBR value.

The last map discussed is the burn severity map in Figure 4. A large majority of the area has been burned at least a small amount. Due to issues with 0 values in QGIS, the negative portion of the USGS table was dropped, removing regrowth from the visualization. Regrowth regions may still, however, be found in the dNBR map. A key observation is the large amount of extreme severity zones. Importantly, the region surrounding Parker Lake has a large area of extreme severity. On top of that, it can be seen that the holdover fires in Patry Creek and Nogah Creek have a large amount of moderate to extreme severity regions.

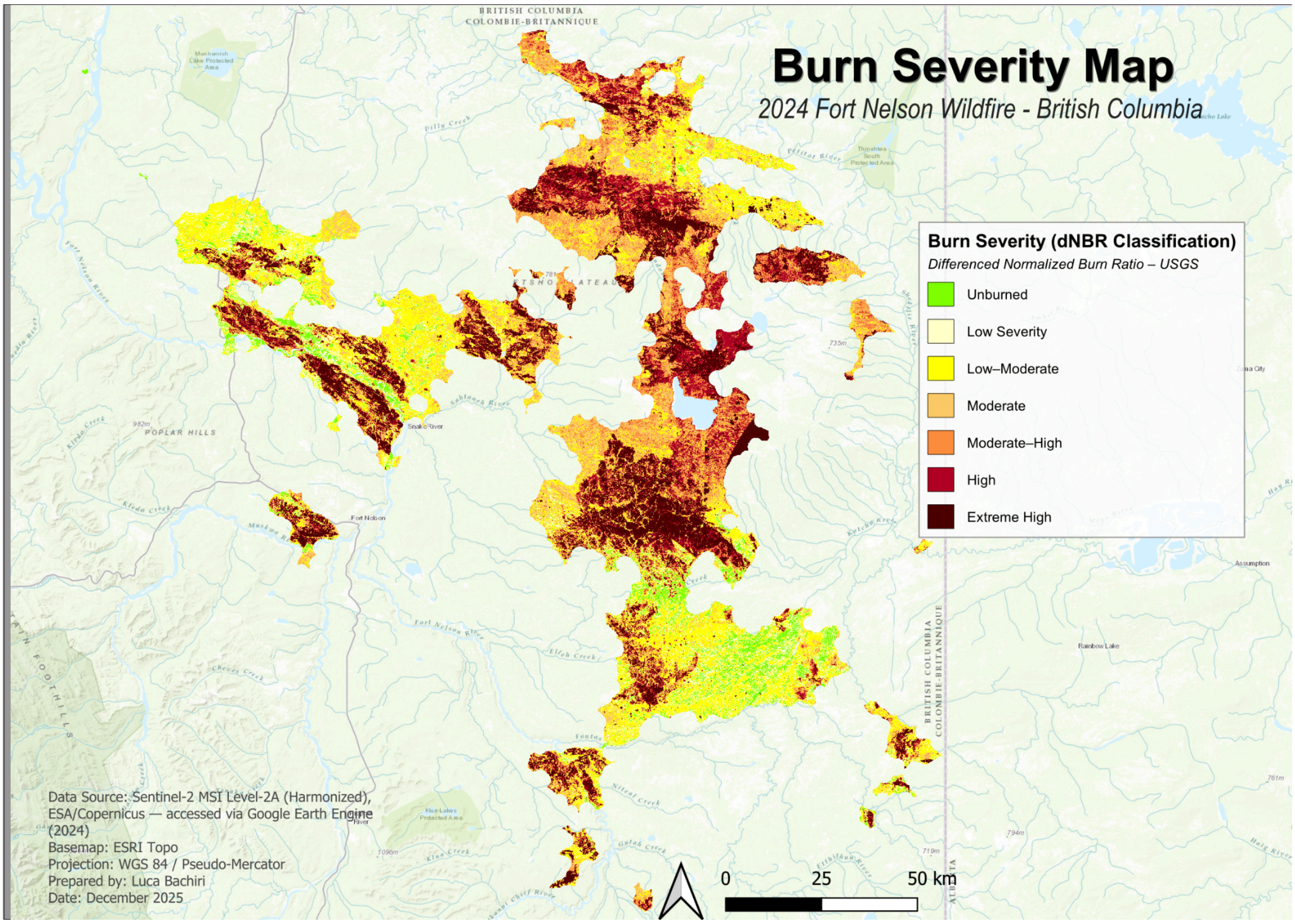

Figure 4. Burn severity map within the fire perimeter. Burn severity levels are classified using the USGS scheme found in Table 1

The table and bar chart in Figure 5 display the land area covered by each burn severity class. The bar chart displays the percentage of the total area covered by each class. As can be seen from the distribution, only around 15% of the land was unharmed by the fire. The remainder of the area is burned with the majority of this area consisting of low severity and moderate-low severity, covering around 47% of the total area. On the other hand, 16% of the total area consists of extremely high severity burns. Overall, the distribution is highly varied.

Burn Severity Area Summary

Severity Level	Area (km²)	Percentage (%)
High Regrowth	44.97	0.47
Low Regrowth	485.52	5.04
Unburned	860.69	8.94
Low Severity	2469.25	25.64
Moderate-Low Severity	1701.22	17.66
Moderate-High Severity	1269.72	13.18
High Severity	1239.36	12.87
Extreme Severity	1560.22	16.2

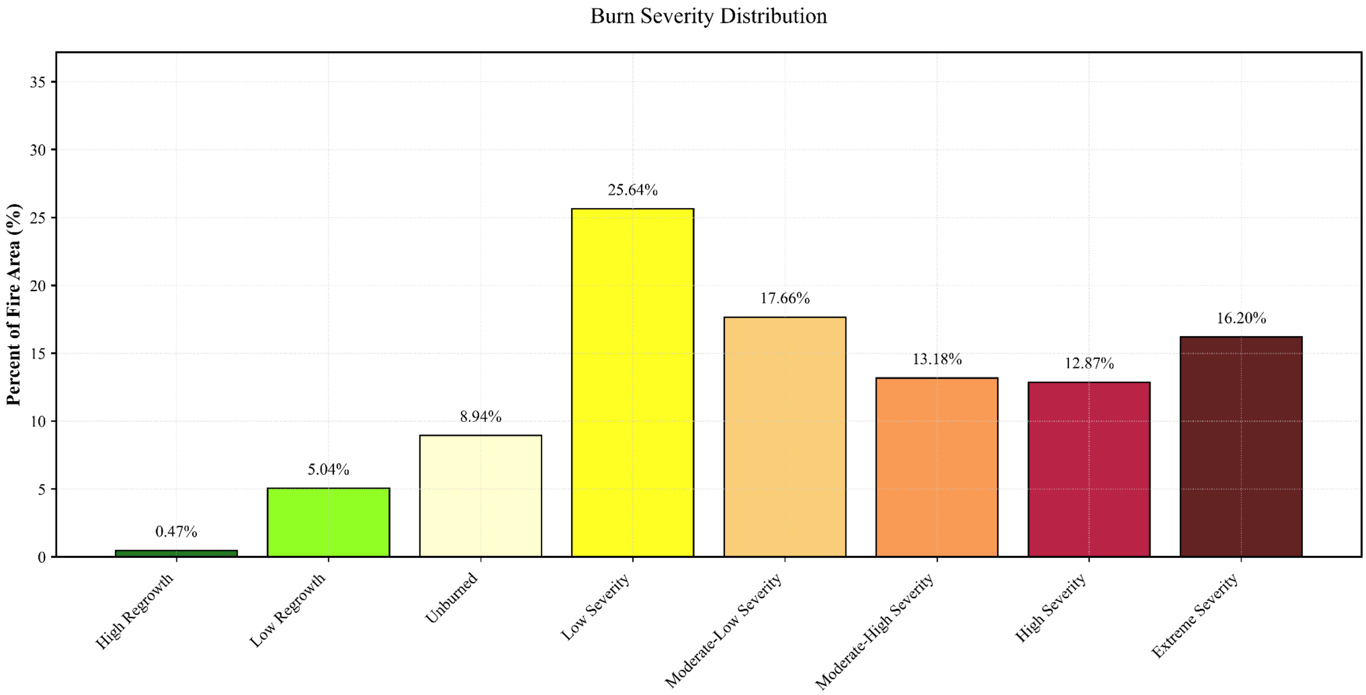

Figure 5. Top: Burn severity class table including area in km^2 as well as percentage of total area for each class. Bottom: Same data expressed in the form of a color coded percentage bar chart.

Discussion

There are several things to note when discussing the maps so far. First, the regions themselves are important. The Parker Lake fire has the smallest perimeter due to its proximity to the town of Fort Nelson itself. Conversely, the Nogah Creek fire has a considerable perimeter due to its occurrence in a more rural region of British Columbia. This larger perimeter may be caused by the rural nature of this region in comparison with the other two regions. This can also be seen with the Party Creek fire given that the 77 highway passes through that region, meaning more attention would be focused on controlling its fire perimeter.

The burn distribution may be explained by two possible explanations. First, due to the time of the fire, May, the region was incredibly dry. This meant that the fires would not burn out too easily due to this weather (Weather Spark, 2025). Second, rural fires are much harder to fight, especially due to the lack of infrastructure in the Nogah Creek region. This may contribute to the extremely high burn severity that is found in the north and middle portions of the region.

Several limitations should be noted for this analysis. The pre-fire composites ran into an issue with snow. During April and especially March, the northern region of British Columbia is covered in snow which is typically dropped when masking, however since the mask used includes snow, its effects on the data are still present. Due to this, the pre-fire dates may not give an accurate pre-fire NBR. Moreover some regions were not properly marked on the dNBR map in Figure 3. This is presumably due to smoke clouds which persisted over a long duration, specifically due to long burning holdover fires. This small loss of data affects the burn severity distribution. Additionally, the inclusion of the Patry Creek and Nogah Creek regions were affected by holdover fires that swelled up around July which is around the end date of the post-fire composite. This means that the data range used may bias the dNBR accuracy, affecting the burn severity map.

Besides, there are a couple remote sensing limitations. As previously mentioned, the SWIR readings were resampled to 10m. This may affect the area calculations however since the total area is 9000 km^2 which is orders of magnitude greater than the pixel size of $100m^2$, therefore the effect is negligible. Another issue is radiometric noise. Although the median composite should smooth out this bias, the dNBR values may still be affected. Similarly, the median composition method causes a similar effect as it smooths out fast recovering regions and is greatly affected by the amount of viable images. Despite this, the large time range used for the post-fire composite was used to deal with this issue. Finally, these dNBR changes can affect the burn severity classification as can be seen by the thresholds in Table. This means that the percentages in Figure 5 have small uncertainty associated with them.

There are two main avenues for further research. One avenue is investigating the regions themselves. By analysing the topography and vegetation as well as weather conditions throughout the burn dates, further insight on the individual fires themselves may be discovered. The second avenue is analysing the holdover fires over time. In their report (BC Wildfire Service, 2025), the BC Wildfire Service noted that the fires in Patry Creek and Nogah Creek started from overwintering fires in 2023. By analysing these regions year by year, there may be insight into the ignition points of the region and stop the fires before they can even ignite.

Conclusion

In summary, this pilot study used Sentinel-2A MSI (Level-2A) imagery with dNBR calculations to create a burn severity map for the May 2024 wildfire in the Fort Nelson region of British Columbia. The burn severity between all three regions analysed showed a generally heterogeneous distribution with only a small minority of the total area unburned or undergoing regrowth. This pattern is best seen in Nogah Creek where the north and middle regions had high burn severity while the south portion was mainly unburned or undergoing regrowth. Remote sensing was used in this study due to the large fire perimeter as well as the rural nature of the region. There were various constraints with this analysis arising from snow cover and smoke masking as well as the temporal window chosen. Further research avenues include region-specific topographic and vegetation analysis and time-series analysis of the holdover fires in Nogah and Patry Creek.

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