Wildfire Risk Mapping for Alberta

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Introduction

In recent years, the threat of wildfires across Alberta has become increasingly urgent—impacting not only our forests and wildlife but also nearby communities and infrastructure. As someone interested in applying geospatial tools to real-world problems, I wanted to explore how available provincial datasets could be used to model wildfire susceptibility with a more ecological lens.

This project focuses on developing a fire risk map by integrating multiple sources: vegetation inventory, elevation-derived terrain data (slope and aspect), historical wildfire perimeters, and municipal boundaries. At the heart of this analysis is the **Primary Land and Vegetation Inventory (PLVI)** (Alberta Government, 2025), which allows us to assess species composition, forest density, and disturbance history—factors known to influence ignition and fire behavior.

My goal with this project is not only to visualize high-risk areas but also to demonstrate how GIS workflows can support data-driven fire management planning in Alberta. Every step in this process—from classifying conifer-dominant stands to analyzing slope exposure—was grounded in provincial standards and research-supported assumptions.

Datasets

Before discussing the datasets for land areas, such as the Alberta Terrain, Municipalities, and Wildfire Perimeters, I would like first to address the Alberta Vegetation Inventory Standards (Alberta Environmental Protection Resource Data Div, 1991), as this will serve as our basis for determining Fire Risk Relevance and Modeling.

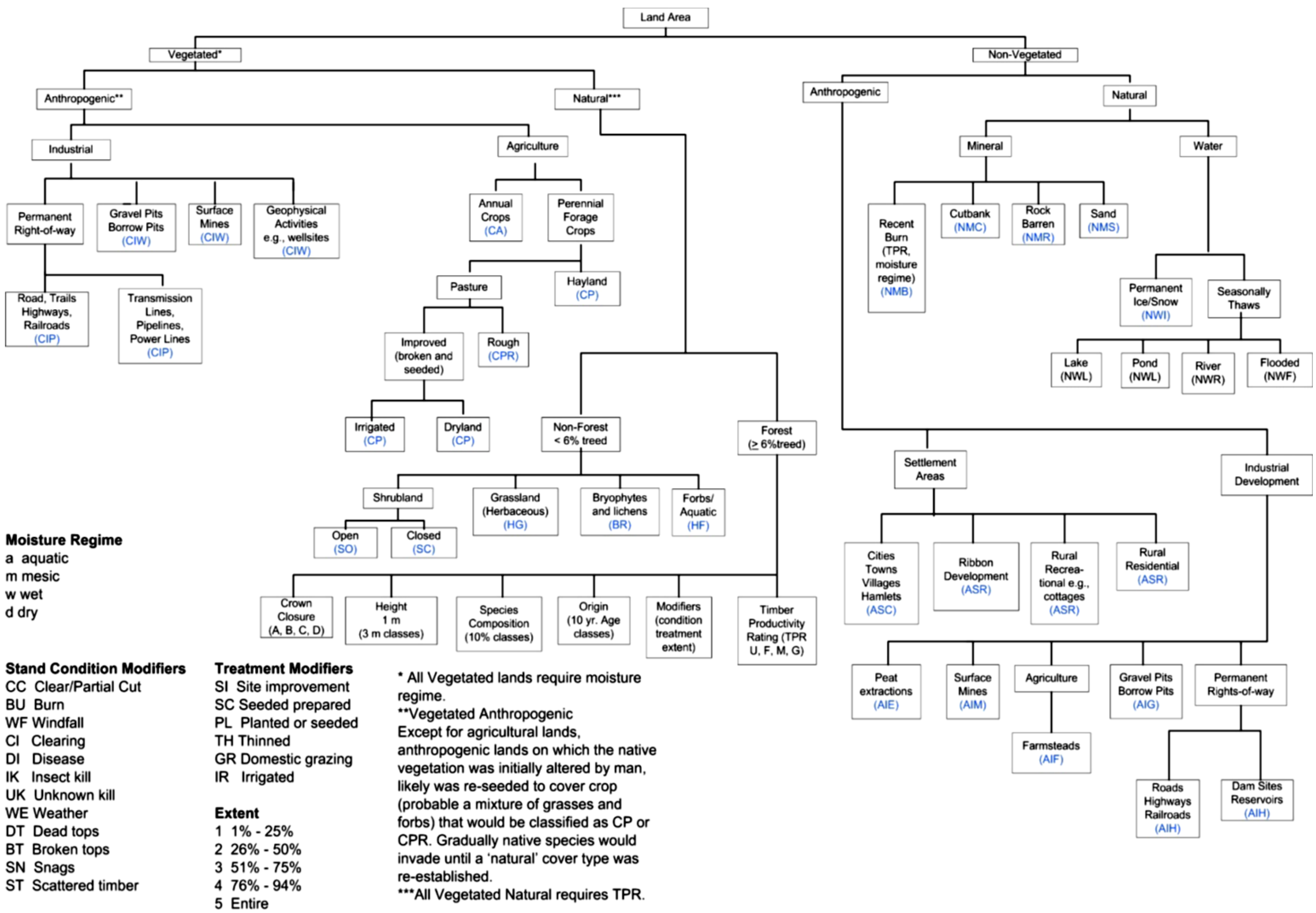


Figure 1: Alberta Vegetation Inventory Classification (Alberta Environmental Protection Resource Data Div, 1991)

The diagram shown provides a structured breakdown of Alberta's land classification system, which is used within the Primary Land and Vegetation Inventory (PLVI). This hierarchy helps distinguish land areas by vegetation cover, anthropogenic influence, and productivity. Of particular relevance to this wildfire risk model is the classification of vegetated natural lands, especially the forested stands with ≥6% tree cover. These forested areas—categorized further by species composition, density, and modifiers such as burn or disease—are key determinants of fuel load and combustibility. Understanding these distinctions allows us to assign fire susceptibility rankings more confidently, especially when identifying conifer-dominated stands (e.g., Spruce, Pine, Larch) that tend to carry higher wildfire risk.

Shapefile: Primary Land and Vegetation Inventory (PLVI)

The Primary Land and Vegetation Inventory (PLVI) shapefile, obtained from Alberta Open Data (Alberta Government, 2025), provides polygon-based mapping of land and vegetation attributes across Alberta's Grassland and Parkland Natural Regions. This dataset follows Alberta's standardized AVI data structure, with adaptations for areas where tree cover is sparse or absent. It includes detailed information on vegetation species, canopy composition, site types, and disturbance history, making it a critical input for assessing vegetation-based wildfire susceptibility.

It has the following attributes:

PLVI / AVI Field	Manual Definition (v2.1)	Purpose in Model
POLYGON_ID	Unique polygon number	Join / spatial ID
NSR	Natural Sub-region code	Ecological context
PRIME_CLS1–3	Primary cover class (forest, shrub, grass, etc.)	Broad fuel type
LAND_CLS1–3	Landform / land class	Moisture & fuel characteristics
SITE_TYP1–3	Site type (xeric, mesic, hygric...)	Moisture regime
SITE_PCT1–3	% of polygon occupied by that site type	Weighting of mixed sites
DENSITY1–3	Crown closure / canopy density class	Fuel continuity
CONIF_PCT1–3	% conifer in each stratum	Flammability indicator
LEAD_SP1–3	Leading tree species codes (e.g., SW, PL, AW)	Core of your fire-risk reclass
DIST1–3 / DIST_YR1–3	Disturbance type and year (fire, harvest, insect, etc.)	Time-since-disturbance logic
HARV_YR1–3	Year last harvested	Recent fuel reduction / regrowth stage
ECO_PH1–3	Ecological phase	Fine-scale ecosite variation
RNG_SITE1–3	Range site (grassland grazing class)	Non-forest fuel classes
IMAGE_YR	Year air-photo interpreted	Currency of mapping

Table 1: Primary Land and Vegetation Inventory (PLVI) Attributes (Alberta Government, 2025)

Fire Risk Relevance

The fields **LEAD_SP1, CONIF_PCT, and DENSITY** are most useful for fire risk modeling:

- **LEAD_SP1, LEAD_SP2, LEAD_SP3**: These tell us what species dominate. It is great for assigning fire susceptibility.
- **CONIF_PCT**: Higher % conifers = more flammable.
- **DIST_YR**: Useful to see time since last disturbance (e.g., recent harvest or fire may reduce fuel).

Classifying Fire Risk

To classify fire risk within ArcGIS Pro, I created a new attribute field named FireRisk in the vegetation dataset. This field was populated using a custom Python expression that evaluates dominant species, conifer percentages, and time since disturbance to assign fire susceptibility levels. The classification logic was implemented using the following script:

```
def classify_fire_risk(sp1, sp2, sp3, cp1, cp2, cp3, dist_yr):
    import datetime
    conifers = {'SW', 'SB', 'PL', 'JP', 'PW', 'LW'}
    deciduous = {'AW', 'BW', 'PB', 'PO', 'WI'}

    current_year = datetime.datetime.now().year

    # Normalize species
    species = {sp1.upper(), sp2.upper(), sp3.upper()}

    # Total conifer percent (handle None as 0)
    conif_total = (cp1 or 0) + (cp2 or 0) + (cp3 or 0)

    # Calculate years since disturbance
    if dist_yr and 1900 < dist_yr <= current_year:
        years_since = current_year - dist_yr
    else:
        years_since = None  # No reliable disturbance info
```

```
    # If recent disturbance within 10 years, reduce fire risk
    if years_since is not None and years_since <= 10:
        return 1  # Recent disturbance = lower risk

    if species & conifers or conif_total >= 60:
        return 3  # High risk
    elif species <= deciduous and conif_total < 25:
        return 1  # Low risk
    else:
        return 2  # Moderate risk

classify_fire_risk(!LEAD_SP1!, !LEAD_SP2!, !LEAD_SP3!, !CONIF_PCT1!, !CONIF_PCT2!, !CONIF_PCT3!, !DIST_YR1!)
```

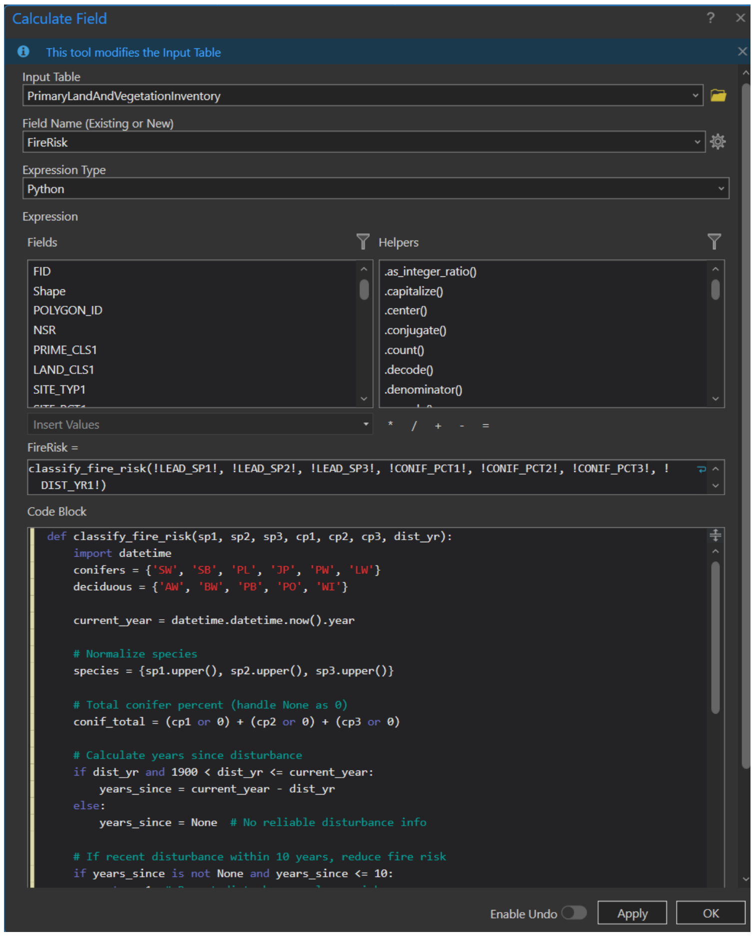


Figure 2: Calculate Field for the Vegetation Inventory

To validate the classification results, I also used Jupyter Notebook to run the same logic programmatically. The following code and resulting output were used to cross-check and ensure consistency in the fire risk assignments:

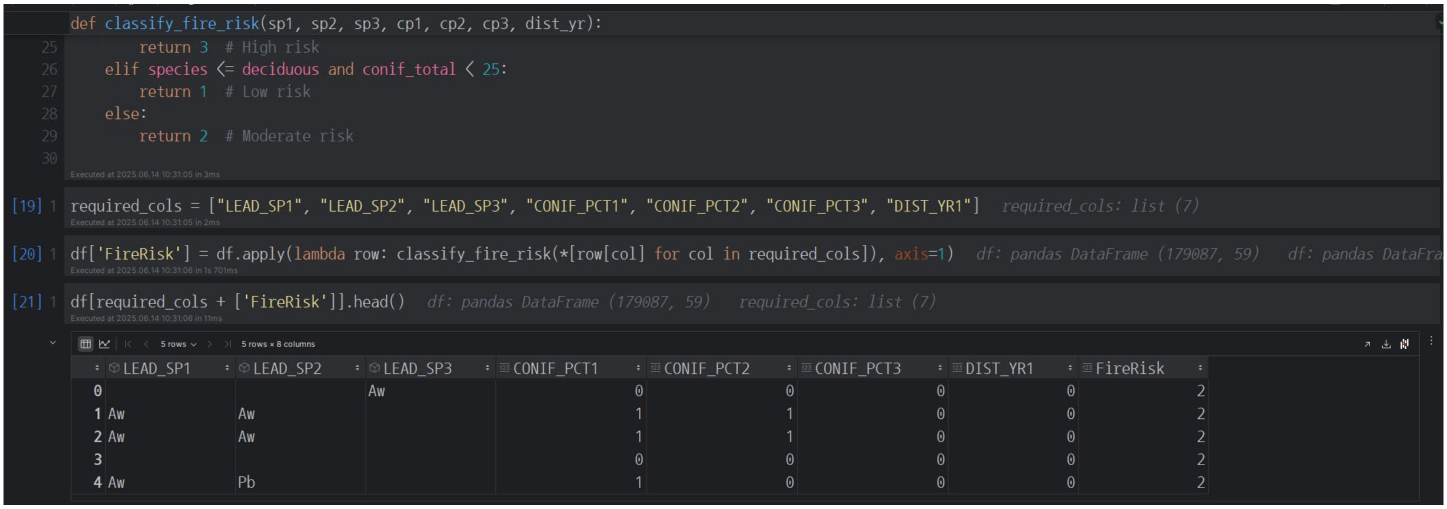


Figure 3: Jupyter Notebook Showing the Function for Classifying Fire Risk

Explanation of the classify_fire_risk() Logic

The classify_fire_risk() function was designed to assign a **fire risk level (1 to 3)** to each polygon in the Alberta Vegetation Inventory based on key vegetation characteristics known to influence wildfire susceptibility.

Why these inputs

The function uses the following fields from the PLVI dataset (Alberta Government, 2025):

- LEAD_SP1, LEAD_SP2, LEAD_SP3: Dominant species
- CONIF_PCT1, CONIF_PCT2, CONIF_PCT3: Percent coniferous cover
- DIST_YR1: Year of last disturbance (e.g., fire, harvest)

Coniferous-dominated stands — especially those containing species like spruce, pine, and jack pine — tend to have higher flammability due to resin content, needle litter, and canopy structure. In contrast, deciduous species such as aspen and birch generally exhibit lower flammability and slower fire spread. Additionally, areas with recent disturbance (e.g., fire, harvest) typically have reduced fire risk due to decreased fuel accumulation. These fields were chosen based on the **Alberta Vegetation Inventory Standards Manual** (Version 2.1) (Alberta Environmental Protection Resource Data Div, 1991) and supported by Canada's Wildland Fires information on Fire Ecology (Government of Canada, Fire ecology, n.d.).

Line-by-Line Breakdown

```
conifers = {'SW', 'SB', 'PL', 'JP', 'PW', 'LW'}
deciduous = {'AW', 'BW', 'PB', 'PO', 'WI'}
```

Code	Species Name	Description
SW	White Spruce (*Picea glauca*)	Common in boreal and foothill forests. Highly flammable due to dense needles and resin.
SB	Black Spruce (*Picea mariana*)	Moist areas and bogs; has a high surface and ladder fuel potential.
PL	Lodgepole Pine (*Pinus contorta*)	Very flammable; frequent in fire-prone areas of Alberta.
JP	Jack Pine (*Pinus banksiana*)	Extremely flammable; adapted to fire through serotinous cones.
PW	Western White Pine (*Pinus monticola*)	Less common; found in southwestern Alberta; moderate flammability.
LW	Western Larch (*Larix occidentalis*)	Deciduous conifer; although it sheds needles, it's grouped with conifers for structural reasons.

Table 2: Coniferous Species (Alberta Government, 2025) (Government of Canada, Fire behaviour, n.d.)

Code	Species Name	Description

AW	**Trembling Aspen** (*Populus tremuloides*)	Most widespread deciduous species in Alberta; lower flammability.
BW	**White Birch** (*Betula papyrifera*)	Also called paper birch; lower flammability and often used as firebreak.
PB	**Balsam Poplar** (*Populus balsamifera*)	Moist lowland species; lower ignition potential.
PO	**Bur Oak** (*Quercus macrocarpa*)	Fire-resistant bark; rare in Alberta; low flammability.
WI	**Willow** (*Salix* spp.)	Found in riparian areas; moisture-rich vegetation reduces fire risk.

Table 3: Deciduous Species (Alberta Government, 2025) (Government of Canada, Fire behaviour, n.d.)

```
species = {sp1.upper(), sp2.upper(), sp3.upper()}
```

- Normalizes the dominant species (LEAD_SP1 to LEAD_SP3) to uppercase and stores them in a set for comparison.

```
conif_total = (cp1 or 0) + (cp2 or 0) + (cp3 or 0)
```

- Adds up the **conifer cover percentage**. If missing (None), treats as zero.

```
if dist_yr and 1900 < dist_yr <= current_year:
    years_since = current_year - dist_yr
else:
    years_since = None
```

- Computes how many years have passed since the last disturbance.
- Ignores unreliable values like 0, NaN, or values before 1900.

```
if years_since is not None and years_since <= 10:
    return 1  # Low risk due to recent disturbance
```

- If a disturbance (e.g., clearcut, fire) happened recently, there's likely **less accumulated fuel**, so fire risk is reduced.

```
if species & conifers or conif_total >= 60:
    return 3  # High risk
```

- If **any** dominant species is a conifer or **conifer cover is ≥60%**, assign **high fire risk** (Alberta Environmental Protection Resource Data Div, 1991) .
- This threshold reflects findings in fire ecology, where conifer-dominated stands burn more intensely and more often.

```
elif species <= deciduous and conif_total < 25:
    return 1  # Low risk
```

- If **all dominant species are deciduous** and **conifer cover is low**, assign **low fire risk**.

```
else:
    return 2  # Moderate risk
```

- If mixed or uncertain, classify as **moderate fire risk**.

Counting How Many Polygons fall into each FireRisk Category

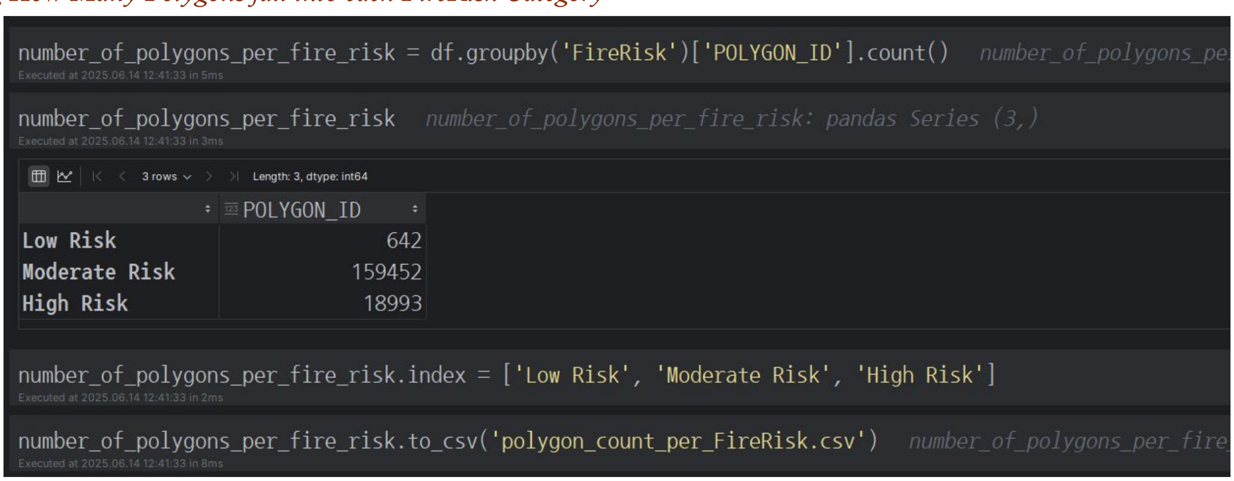
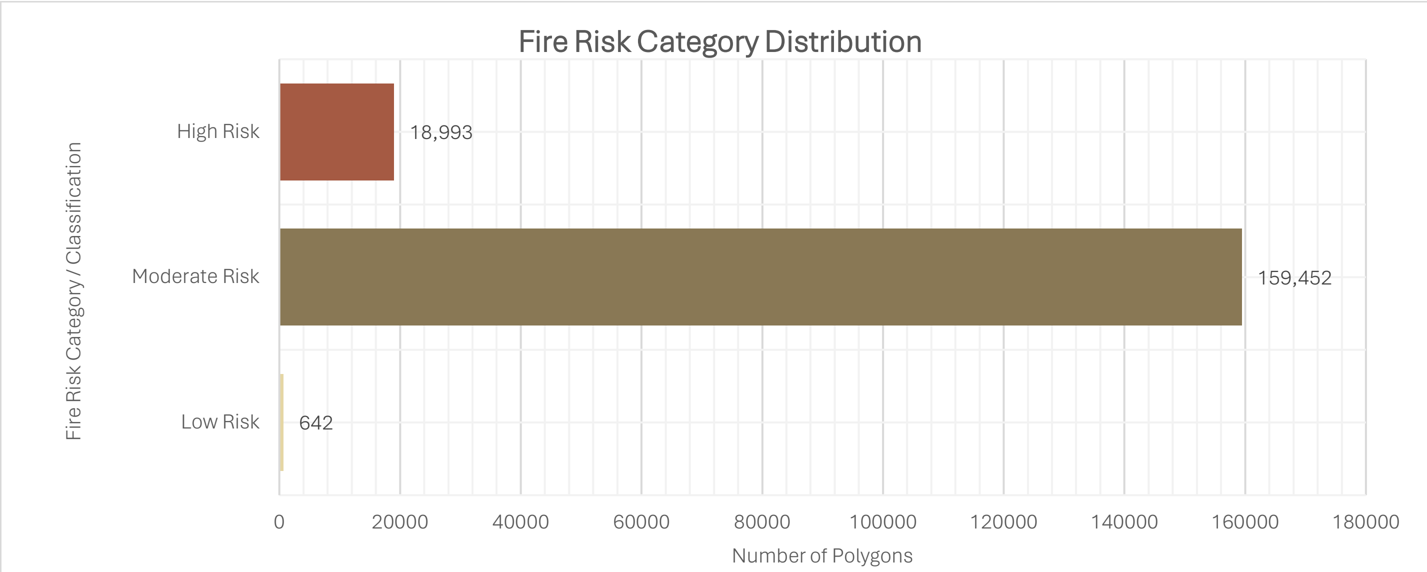


Figure 4: Count of Polygons per FireRisk Category

Visualizing the summary results with a graph helps highlight the distribution across risk levels.



Additional Considerations Regarding the PLVI Dataset

It is worth noting that the Primary Land and Vegetation Inventory (PLVI) dataset primarily covers Alberta's Grassland and Parkland Natural Regions. As such, areas situated within the Foothills or Boreal Forest zones may instead depend on the Alberta Vegetation Inventory (AVI) for equivalent ecological data. This distinction is important when assessing coverage or comparing vegetation trends across broader provincial extents.

Another consideration involves the IMAGE_YR field, which refers to the year of aerial interpretation. This value may differ between regions, introducing variability in how current or outdated some records may be—especially in landscapes that have undergone recent disturbances.

Despite these spatial and temporal limitations, the PLVI remains an essential resource for wildfire risk analysis. Its structured classification of species composition, density, and disturbance history directly supports fire risk modeling. Many fire management strategies—including prescribed burning, vegetation control, and emergency readiness—use similar ecological indicators to identify high-risk areas.

Finally, it is important to acknowledge that the PLVI follows the standards set out in the *Alberta Vegetation Inventory Standards Manual (Version 2.1)* (Alberta Government, 2025), which ensures consistency and credibility in the way vegetation attributes are recorded, interpreted, and applied for resource planning.

Closing Statement

Together, these PLVI attributes provide the ecological and structural foundation for quantifying fire susceptibility across land units in Alberta, supporting standardized and data-driven wildfire risk assessments.

Alberta Provincial 25m Raster

The Alberta Provincial 25 Metre Raster, obtained from Altalis (altalis, Provincial DEM, n.d.), provides high-resolution elevation data that forms the foundation for deriving slope and aspect—two key terrain variables that influence wildfire behavior. The raster represents a digital elevation model (DEM) standardized across the province at 25m resolution, making it suitable for detailed surface analysis. In this project, it was used to calculate the slope steepness and dominant slope direction (aspect) across Alberta, which were later reclassified into categories relevant to fire spread modeling.

Wildfire Perimeters (1931–2024)

This dataset contains the recorded perimeters of major wildfires in Alberta's forested areas, spanning from 1931 through the 2024 fire year (Alberta, n.d.). It plays a critical role in fire incidence analysis, informing decisions related to timber loss, salvage operations, forest inventory updates, and broader forest management planning. The fire perimeters have been mapped using evolving technologies over the decades—ranging from hand sketches and aerial photography to GPS and satellite imagery—and are now consolidated in a geographic information system. While not comprehensive of every historical fire, it reflects significant wildfire events with mapped polygon boundaries, making it valuable for understanding past fire patterns and their spatial impact.

Municipal Boundaries

To spatially associate wildfire risks with human settlements and administrative divisions, the **Municipal Boundaries** dataset from AltaLIS (altalis, Municipal Boundaries, 2025) was added. This shapefile provides full provincial coverage of all municipal jurisdictions in Alberta, including:

- Counties and Municipal Districts (MDs)
- Cities, Towns, and Villages
- Summer Villages and Hamlets
- Special Areas and Improvement Districts

The dataset is updated monthly to reflect Order in Council changes and remains aligned with Alberta’s cadastral framework. This layer is essential for identifying communities at risk and aligning mitigation strategies with municipal planning zones.

Slope

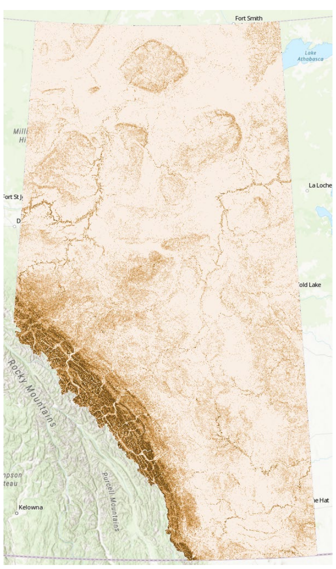
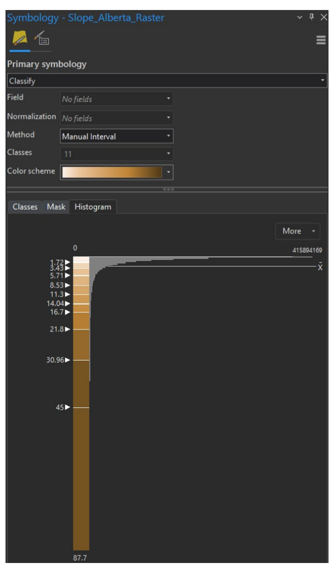
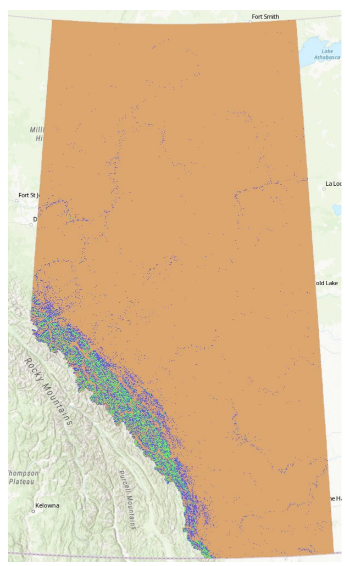
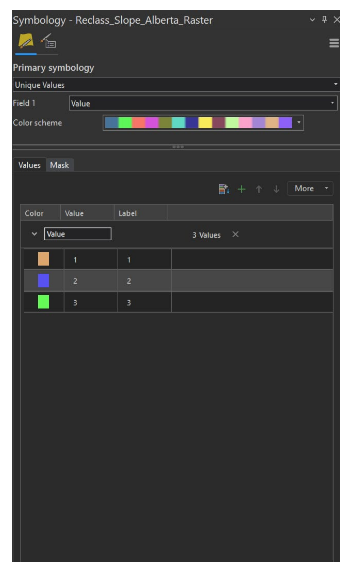
Slope_Alberta_Raster		Reclass_Slope_Alberta_Raster	
			

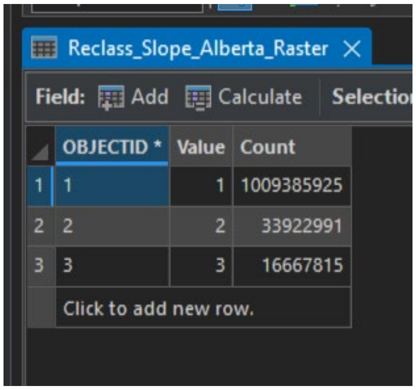
Figure 5: Slope and Reclass Slope for Alberta Terrain

After classifying vegetation-based fire risk, the next logical step was to factor in terrain—specifically **slope**—which plays a critical role in wildfire behavior. Steeper slopes can accelerate fire spread uphill due to preheating of vegetation, while flatter areas tend to burn more slowly.

To calculate slope, I used the **Alberta Provincial 25m Raster** dataset obtained from Altalis (altalis, Provincial DEM, n.d.). From this, a **slope raster** was derived using ArcGIS Pro's **Slope tool**, expressed in degrees. I then reclassified the output into three categories (Butler, Anderson, & Catchpole):

- **1 = Low slope** (0°–15°)
- **2 = Moderate slope** (16°–30°)
- **3 = High slope** (above 30°)

This reclassification helps translate continuous terrain data into meaningful fire risk zones. Areas with steeper slopes (especially above 30°) were given the highest slope-related risk level due to their increased likelihood of rapid fire movement.


Reclass_Slope_Alberta_Raster

Field: Add Calculate Selectio

	OBJECTID *	Value	Count
1	1	1	1009385925
2	2	2	33922991
3	3	3	16667815
	Click to add new row.		

Figure 6: Distribution of Land by Slope Category

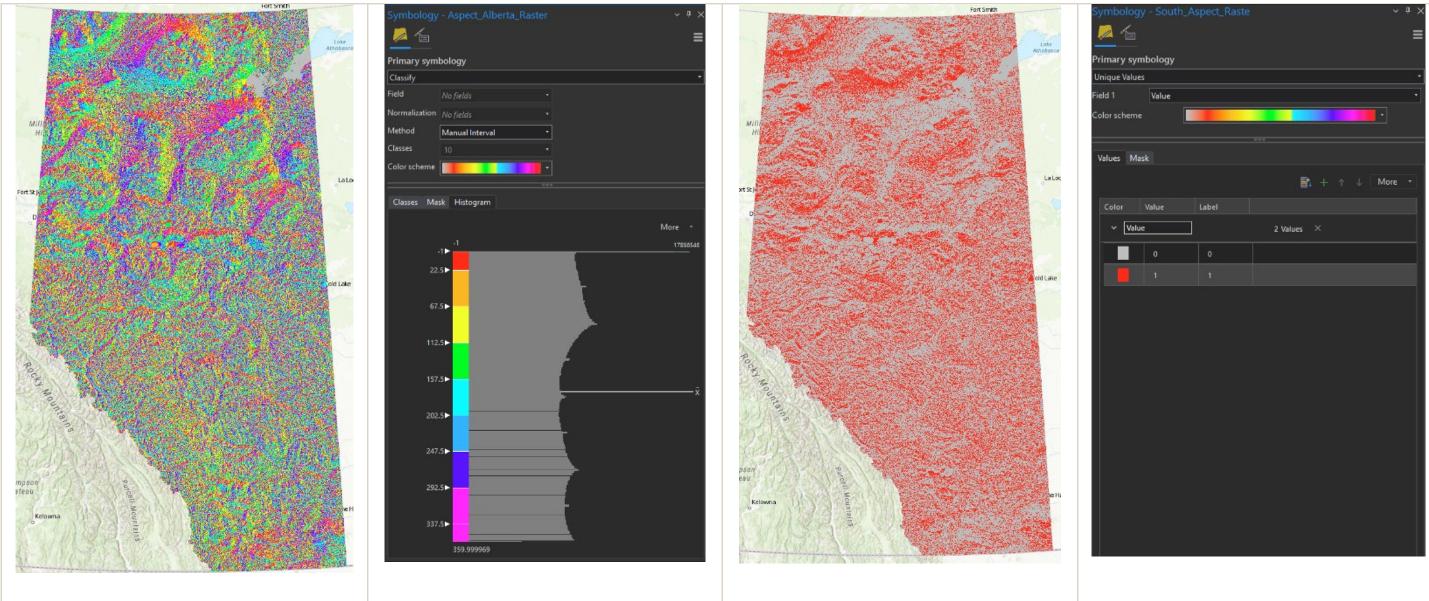
To better understand how slope influences wildfire risk across Alberta, the reclassified slope raster was analyzed to determine the distribution of land by slope category. As shown in the figure above:

- **Low slope (0°–15°)** covers over **1 billion cells**, making it the dominant terrain type.
- **Moderate slope (16°–30°)** appears in around **339 million cells**.
- **High slope (above 30°)** occupies approximately **166 million cells**.

This breakdown reinforces that while most of Alberta is relatively flat, the areas with steeper terrain—though smaller in size—still represent significant wildfire spread risk and were weighted accordingly in the final overlay model.

Aspect and South-Facing Slopes

Aspect_Alberta_Raster		South_Aspect_Raster	



After generating slope, the next terrain factor I focused on was **aspect**—the compass direction that a slope faces. In wildfire modeling, this is critical because it helps identify **south-facing slopes**, which tend to receive more direct sunlight. These areas often dry out faster and are more prone to ignition compared to slopes facing other directions.

Using the **Aspect Tool** in ArcGIS Pro, I derived a raster called **Aspect_Alberta_Raster**, which assigned aspect values from **0° to 360°**, representing compass bearings. Flat areas were assigned a value of **-1** by default (Esri, n.d.).

To isolate risky slopes, I applied a conditional expression in the **Raster Calculator**:

```
Con((Aspect_Alberta_Raster >= 112.5) & (Aspect_Alberta_Raster <= 247.5), 1, 0)
```

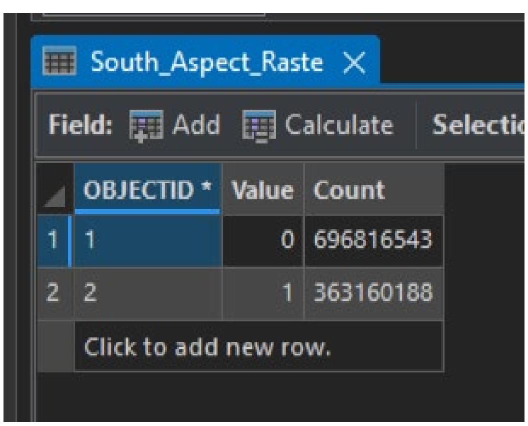
This equation classifies aspects between **112.5° and 247.5°** as **south-facing slopes**, which are known to be more susceptible to wildfire spread due to increased exposure to solar radiation (Esri, n.d.) (Williams, 2022).

The result was the **South_Aspect_Raster**, a binary layer where:

- 1 represents **south-facing slopes**
- 0 represents **all other directions**

This raster was then used as one of the weighted inputs in the final wildfire risk model.

After applying this classification, the distribution of aspect-based wildfire exposure zones is summarized below:



South_Aspect_Raste

Field: Add Calculate Selecti

	OBJECTID *	Value	Count
1	1	0	696816543
2	2	1	363160188
	Click to add new row.		

Figure 7: Distribution of Aspect-Based Wildfire Exposure Zones

These results confirm that a substantial portion of Alberta's terrain exhibits southerly exposure, reinforcing the importance of including **aspect** in the wildfire risk overlay.

Buffering Historical Wildfire Perimeters

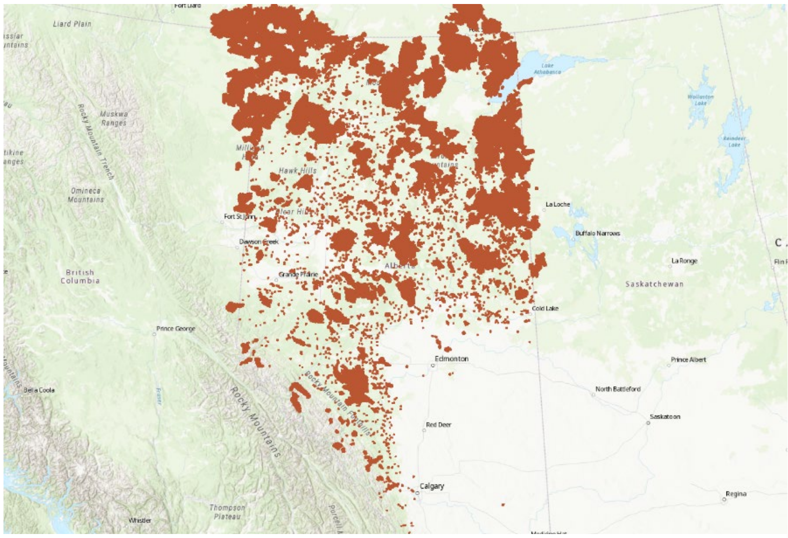


Figure 8: Buffer_Recent_Fires_from_Y2000_Raster

To capture the **influence of past fire events**, I used the dataset WildfirePerimeters1931to2024.shp (Alberta, n.d.), which contains historical wildfire boundaries across Alberta's forested zones.

Since older data may not reflect current landscape conditions, I filtered the perimeters to include **only wildfires that occurred from the year 2000 onward** (FIRE_YEAR >= 2000). This ensures that the analysis reflects **recent fire activity**, which is more relevant to current fuel conditions and fire behavior.

Using the **Buffer tool**, I generated a **2 km buffer zone** around these fire perimeters. This buffer represents areas that are either recovering from previous burns or at higher risk due to historical ignition patterns. The output was saved as Buffer_Recent_Fires_from_Y2000.

To integrate this layer into the final wildfire risk model, I converted the buffered polygon into a **raster format** using the **Polygon to Raster** tool, assigning a constant value of 1. The raster cell size was set to match that of the slope layer to maintain consistency across input rasters. The resulting raster layer was saved as Buffer_Recent_Fires_from_Y2000_Raster.

This raster serves as a **proximity risk layer**, where:

- 1 = within 2 km of a recent wildfire
- NoData = outside the buffer zone

This step ensures that the wildfire risk model considers **historical fire proximity**, which is a common practice in fire behavior modeling and land management planning.

Classifying Vegetation by Fire Susceptibility

To represent fuel types and their flammability potential, I used the **Primary Land and Vegetation Inventory (PLVI)** shapefile (Alberta Government, 2025). This dataset contains detailed ecological attributes such as species composition (LEAD_SP1, LEAD_SP2, LEAD_SP3), conifer cover percentages (CONIF_PCT1–3), and disturbance year (DIST_YR1), which are highly relevant to wildfire susceptibility.

Using the **Field Calculator**, I created a new field called FireRisk. The logic for classification is based on a Python function that considers (see Datasets):

- **Species dominance** (e.g., conifer vs. deciduous)
- **Total conifer cover** (higher = more flammable)
- **Time since disturbance** (recent fires/harvests = lower risk)

Classification Logic Summary:

- **High Risk (3)**: Conifer-dominant stands or ≥60% conifer cover

- **Moderate Risk (2)**: Mixed stands or conifer cover <60%
- **Low Risk (1)**: Deciduous-dominant stands and <25% conifer cover
- Reduced risk for recently disturbed stands (≤10 years)

After calculating FireRisk values, I used the **Polygon to Raster** tool to convert the vegetation shapefile into a raster format (Classified_PrimaryLandAndVegetationInventory). This raster uses the FireRisk field for values and matches the cell size of the AlbertaProvincial25MetreRaster (altalis, Provincial DEM, n.d.) to maintain spatial alignment with other layers.

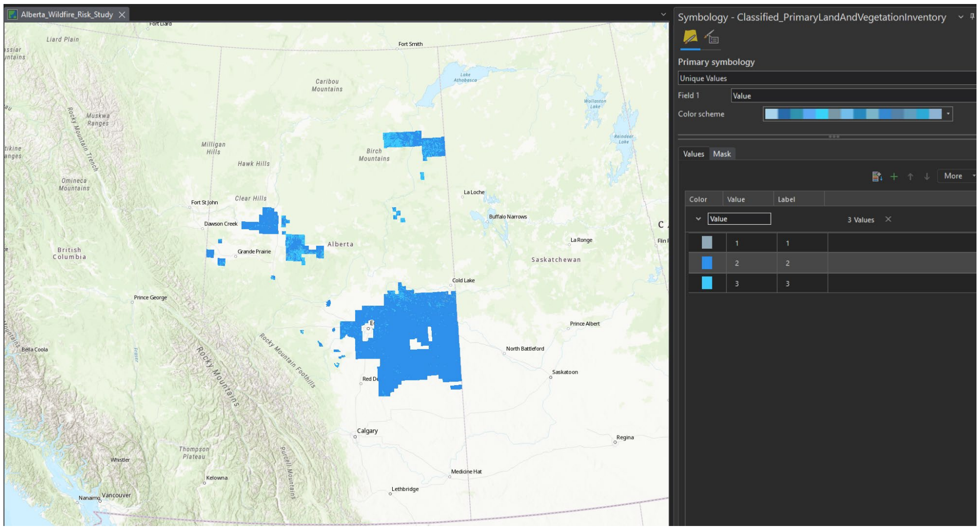
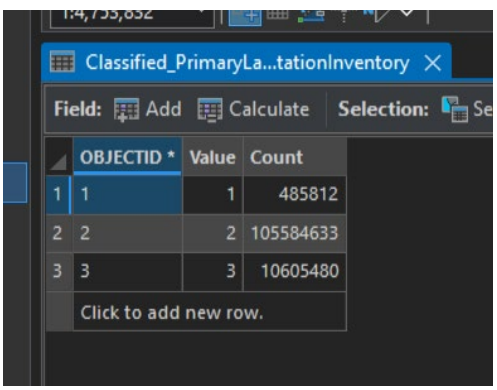


Figure 9: Classified_PrimaryLandAndVegetationInventory

This layer plays a key role in the wildfire risk model by providing **land-based fuel risk levels** derived from actual species composition and ecological conditions, rather than generic land cover categories.


Classified_PrimaryLa...tationInventory

OBJECTID *	Value	Count
1	1	485812
2	2	105584633
3	3	10605480

Figure 10: Fire Risk Level Counts after Converting to Raster

As noted earlier in the Primary Land and Vegetation Inventory (PLVI) section of this report, there is a noticeable difference between the polygon counts generated from the Python FireRisk classification and those from the rasterized output in ArcGIS Pro. This discrepancy is commonly due to differences in spatial resolution and how data is handled during the Polygon to Raster conversion process.

Source	What It Measures	Notes
Python Notebook (FireRisk)	Number of vector polygons classified by script	Each record in the PLVI shapefile (i.e., a stand) is treated as a **single polygon**, regardless of its area
Classified Raster in ArcGIS	Number of **pixels** classified per fire risk level	The raster result counts the **number of cells**, so larger areas contain many more cells—even if they came from one polygon

Table 4: Why the Values Differ Between Python Notebook and ArcGIS Pro

Both results are correct, but for the purposes of this project, the raster output in ArcGIS Pro is used for all subsequent spatial analysis and visualization. This ensures consistency across map algebra operations and allows us to integrate the vegetation risk layer directly into the final weighted overlay model.

Weighted Overlay Analysis

After classifying each biophysical and proximity layer—**Slope**, **Aspect**, **Vegetation**, and **Recent Fire Buffers**—the next step is to combine these into a single fire risk surface using **Weighted Overlay Analysis**. This method allows us to assign a relative influence (weight) to each factor, reflecting how much it contributes to wildfire susceptibility.

In this project, I assigned the following weights based on literature and relevance:

Raster Layer	Description	Value / Scale	Influence (%)
Classified Vegetation	Fuel type risk from PLVI species	1 = Low, 2 = Moderate, 3 = High	30%
Reclassified Slope	Steepness influencing fire spread	1 = Low, 2 = Moderate, 3 = High	30%
South Aspect Raster	South-facing slopes = higher sun exposure	0 = Other, 9 = South-facing	20%
Buffer from Recent Fires	Within 2 km of fires since 2000	0 = Far, 1 = Near	20%

Table 5: Weighted Overlay Inputs

Why These Percentages?

The **influence percentages** reflect how strongly each factor contributes to wildfire behavior:

- **Vegetation (30%)**: Vegetation type is the primary fuel source. Coniferous-dominant stands are highly flammable due to resin content, canopy structure, and deadfall. This makes vegetation one of the most important fire risk indicators.
- **Slope (30%)**: Fires spread faster uphill. Slopes greater than 30° significantly increase flame speed and intensity, especially with wind. Terrain is therefore equally critical in modeling risk.
- **South Aspect (20%)**: South-facing slopes receive more solar radiation, drying vegetation faster and increasing flammability. While important, it's treated as a secondary biophysical modifier.
- **Fire Proximity (20%)**: Areas near recent wildfires are likely to have regrowth or remaining fuels, but may also have already burned recently, making this a less stable variable. It contributes moderately to overall risk.

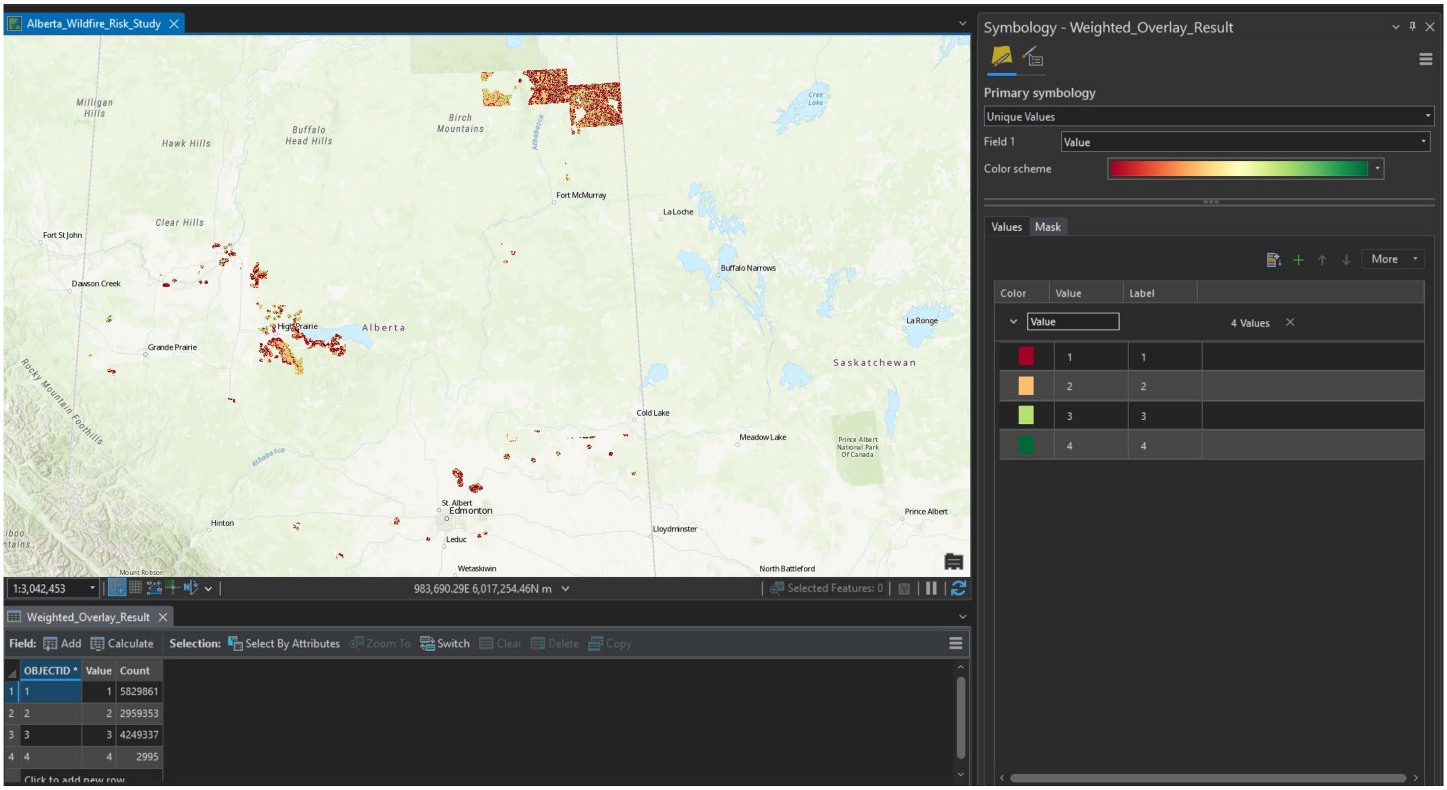


Figure 11: Weighted Overlay Analysis Result

Map Interpretation – Weighted Overlay Result

Classification Summary (Symbology Panel)

The final raster has been classified into **4 fire risk categories**, shown with a **color gradient from red to green**:

Value	Label	Color	Interpretation
1	1	Red	**Highest fire risk areas** — likely steep, south-facing, conifer-dense, and near recent wildfires
2	2	Orange	**Moderate–High risk** — may have partial overlap with critical factors
3	3	Light Green	**Moderate risk** — neutral terrain or vegetation
4	4	Green	**Lowest fire risk** — flat, north-facing, low-flammability vegetation

Table 6: Classification Summary for the Weighted Overlay Analysis Result

Area Coverage (Table Panel)

Based on the **pixel count** (not geographic area yet), here's the distribution:

Risk Class	Value	Pixel Count
Highest Risk	1	5,829,661
Moderate–High Risk	2	2,959,353
Moderate Risk	3	4,249,337
Low Risk	4	2,995

Table 7: Area Coverage Distribution of the Weighted Overlay Analysis Result

Observation

Most of the mapped area falls under **High to Moderate risk (Classes 1–3)**, while very little is assigned the lowest risk (Class 4). This aligns with the assumption that areas with steep, dry slopes and coniferous vegetation dominate certain zones.

Geographic Context (Map Area)

The **clusters of high-risk zones** (in red/orange) are in:

- The **northwestern boreal zones**
- The **area near High Prairie**
- Patches **south of Fort McMurray** and **around Grande Prairie**

Intersecting Rural Boundaries with Highest Fire Risk Zones

To spatially identify which rural municipalities fall within areas of extreme wildfire susceptibility, a targeted overlay was conducted using the final weighted risk output. From the Weighted_Overlay_Result raster, only the highest risk class (value = 1) was extracted and converted into vector format. This allowed for a clean intersection with the RURAL boundary layer.

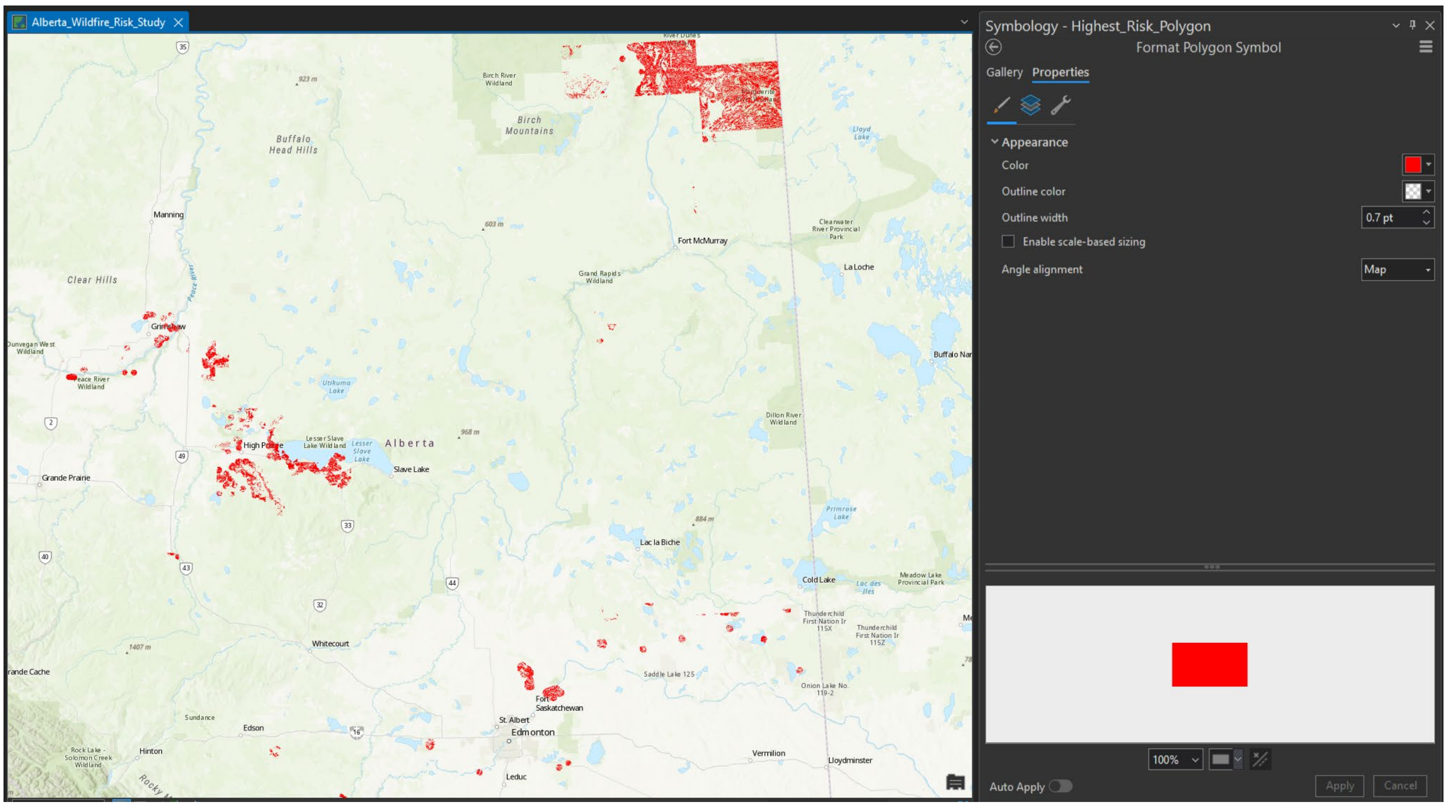


Figure 12: Areas with Highest Risk of Wildfires

The resulting dataset, Highest_Risk_RURAL, highlights portions of rural jurisdictions that overlap with the most critical wildfire risk zones. This intersection preserves key municipal attributes (such as GEONAME and GEOCODE) to support further analysis, reporting, or emergency planning at the local level.

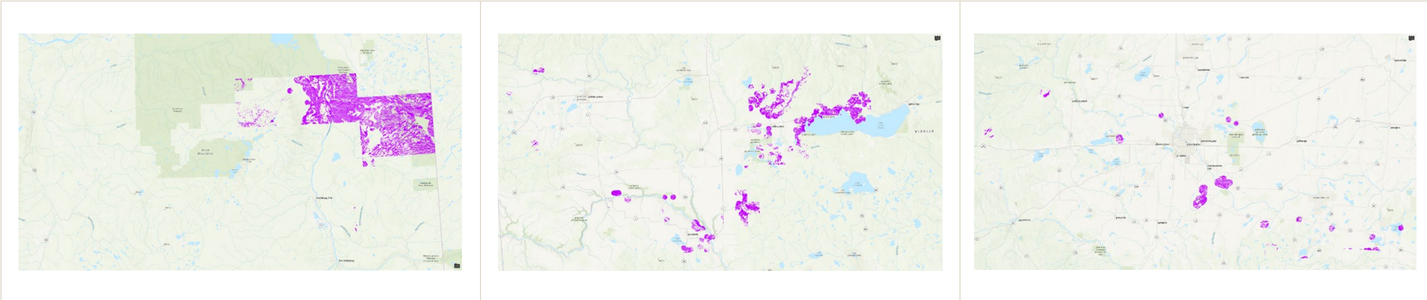


Figure 13: Intersection of Highest Risk Areas with Rural Boundaries

This step ensures that risk mitigation strategies can be geographically targeted to the most vulnerable rural areas.

Converting High-Risk Polygons to Points for Graphical Summary

To support visual analysis and summary statistics, the intersected polygons representing rural areas at the highest wildfire risk were converted to points. This conversion places a centroid within each polygon, allowing for efficient spatial representation and simplified data extraction.

Using the **Feature to Point** tool in ArcGIS Pro:

- **Input Features:** Highest_Risk_RURAL
- **Inside Option:** Checked to ensure the point falls within the original polygon boundary
- **Output:** Highest_Risk_RURAL_Points

Once converted, the points table was used to generate summary graphs—such as counts by rural municipality—providing a clearer understanding of which areas are most affected. These visuals aid in communicating priority zones for fire mitigation and planning efforts.

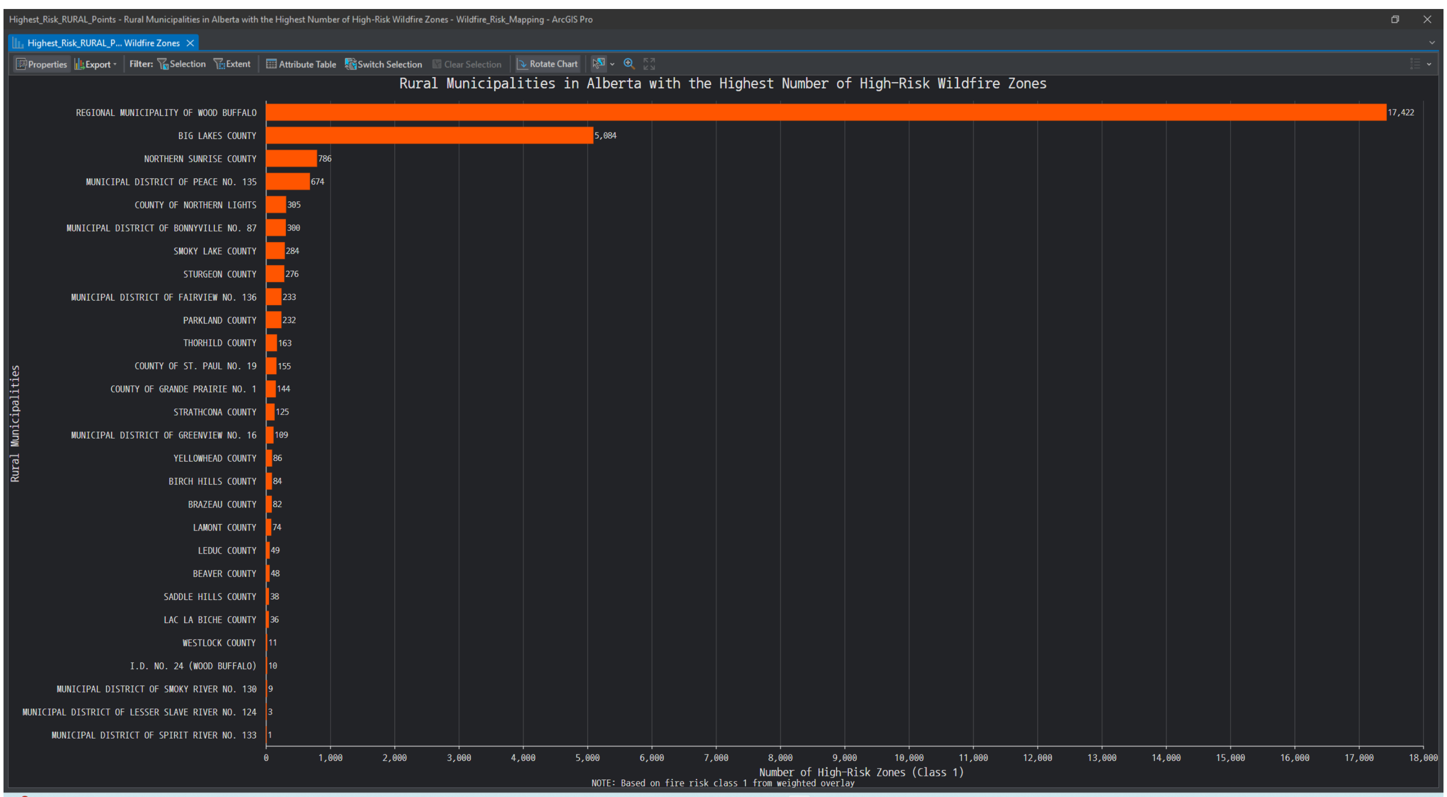


Figure 14: High-Risk Wildfire Zones by Rural Municipality

The chart highlights rural municipalities in Alberta that intersect with wildfire risk **Class 1** — the highest danger level derived from the Weighted Overlay analysis. Among all, the **Regional Municipality of Wood Buffalo** shows a significantly elevated number of high-risk zones, followed by **Big Lakes County** and **Northern Sunrise County**. These regions collectively account for the largest clusters of priority concern, which may warrant further attention in emergency response planning, resource allocation, or fire prevention strategies. The count is based on centroid-converted polygons, offering a visual breakdown of how many distinct high-risk locations fall within each rural boundary.

Conclusion and Recommendations

This wildfire risk mapping study successfully combined topographic, vegetation, and historical fire data to model and visualize areas in Alberta most vulnerable to wildfire hazards. By integrating slope, aspect, vegetation type, and proximity to past fires using a weighted overlay analysis, we were able to generate a reliable risk surface and identify high-risk municipalities with spatial precision.

The results show that several rural regions — notably the **Regional Municipality of Wood Buffalo**, **Big Lakes County**, and **Northern Sunrise County** — contain substantial clusters of high-risk zones. These outputs provide a valuable spatial reference for wildfire preparedness, emergency planning, and ecological risk assessment.

Recommendations:

- **Prioritize Mitigation in High-Risk Areas**: Municipalities with dense clusters of risk Class 1 areas should consider preemptive mitigation, such as vegetation thinning, fire breaks, and community preparedness plans.
- **Use Results in Operational Planning**: Emergency responders and land managers may use this data to inform evacuation routes, resource staging, and public awareness campaigns.
- **Update Regularly with New Data**: Repeat this analysis with updated PLVI, fire perimeter, and LiDAR-based elevation data to maintain relevance over time.
- **Integrate with Municipal and Provincial Models**: This GIS-based approach can complement larger-scale fire behavior or land-use models in Alberta.

By adopting a structured, data-driven approach, this project ensures reproducibility and adaptability — ready for future updates, different study regions, or integration with climate-related projections.

Next Steps

To build on the results of this wildfire risk mapping study, the following steps are recommended for future development and extended application:

- Integrate Real-Time Fire Monitoring
  Incorporate satellite-based fire detection systems (e.g., MODIS, VIIRS) for live fire spread awareness in relation to identified risk zones (EarthData, n.d.).
- Refine Vegetation Modeling with AVI in Boreal Regions
  Since PLVI is limited to Grassland and Parkland regions, extend classification logic to **Alberta Vegetation Inventory (AVI)** data to cover Boreal and Foothills zones more accurately.
- Add Anthropogenic Risk Layers
  Consider proximity to infrastructure (roads, pipelines, communities) to enhance vulnerability assessment alongside biophysical risk.
- Validate Model Against Historical Incidents
  Cross-reference high-risk areas with past wildfire incidents to evaluate prediction accuracy and refine overlay weightings.

- Develop Web-Based Map Interface
  Convert results into an interactive dashboard or ArcGIS Online app for easier access by planners, responders, and decision-makers.

- Document the Workflow for Replication
  Package the geoprocessing steps and Python scripts into a structured toolbox for reuse across other jurisdictions or by future students.

Appendix A: What Are MODIS and VIIRS?

MODIS (Moderate Resolution Imaging Spectroradiometer) and VIIRS (Visible Infrared Imaging Radiometer Suite) are Earth-observing sensors mounted on NASA satellites (EarthData, n.d.). These instruments are widely used in wildfire monitoring due to their ability to:

- Detect thermal anomalies — such as active wildfires — using infrared sensors.
- Provide near-real-time fire location updates, multiple times per day.
- Support global fire mapping, including burned area extent and active fire front detection.

These satellite tools are commonly integrated into platforms like NASA FIRMS (Fire Information for Resource Management System) and Canadian Wildland Fire Information Systems, helping analysts monitor fire spread and compare it with local fire risk zones like the ones we mapped in this study.

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