WILDFIRE RISK MANAGEMENT AND ASSESSMENT USING REMOTE SENSING IN B.C.

GEOG453 – Fall 2022

KL

Kiana Lim

AS

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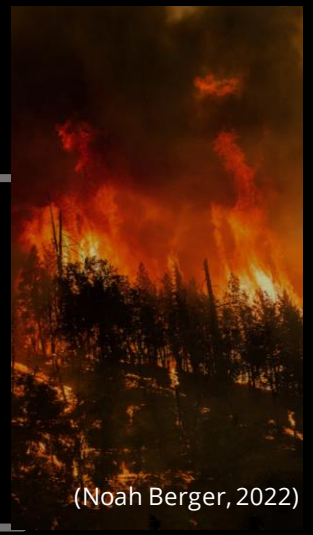
SFU

Outline

Overview of the topics to be discussed.

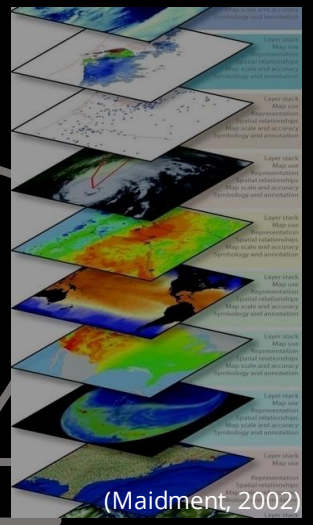
1



(Noah Berger, 2022)

INTRODUCTION

2



(Maidment, 2002)

METHODS

3

(Winvic, n.d.)

RESULTS & DISCUSSION

4

(Ashley, 2014)

SUMMARY

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INTRODUCTION

- Forests are important landscapes that provide several benefits.
- Fire cycles are a natural process. However, climate change and human-caused factors have disturbed them.

- Forest fires have:
  - Grown intense in duration.
  - Increased in recovery cost.
  - Occurred more frequently

- Fires have impacted:
  - Ecosystems
  - Communities
  - Health and safety
  - Economy

- **Our project** monitored select BC fires to understand fire behaviours and forecast areas that are potentially at risk of forest fires.

Next ▸ Methods

(Noah Berger, 2020)

METHODS

Goal: To quantify recent forest fire burn severity and observe trends in certain fire risk variables.

Remote sensing data and methods will be utilized to map fire-afflicted forests and assess a subset of variables for fire risk in the selected fire study areas.

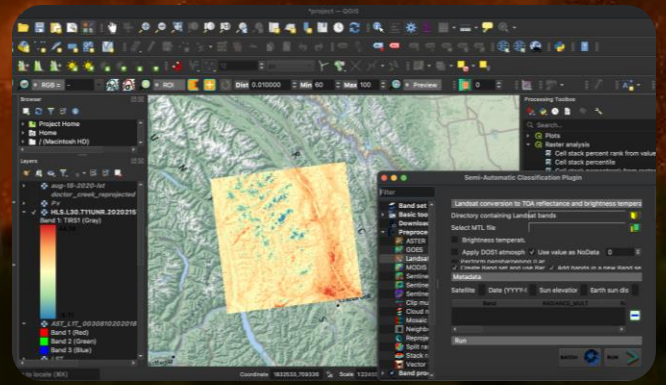
Overview


(RedLeafs, n.d.)

STUDY AREA


(ESA, 2017)

DATA COLLECTION



DATA ANALYSIS

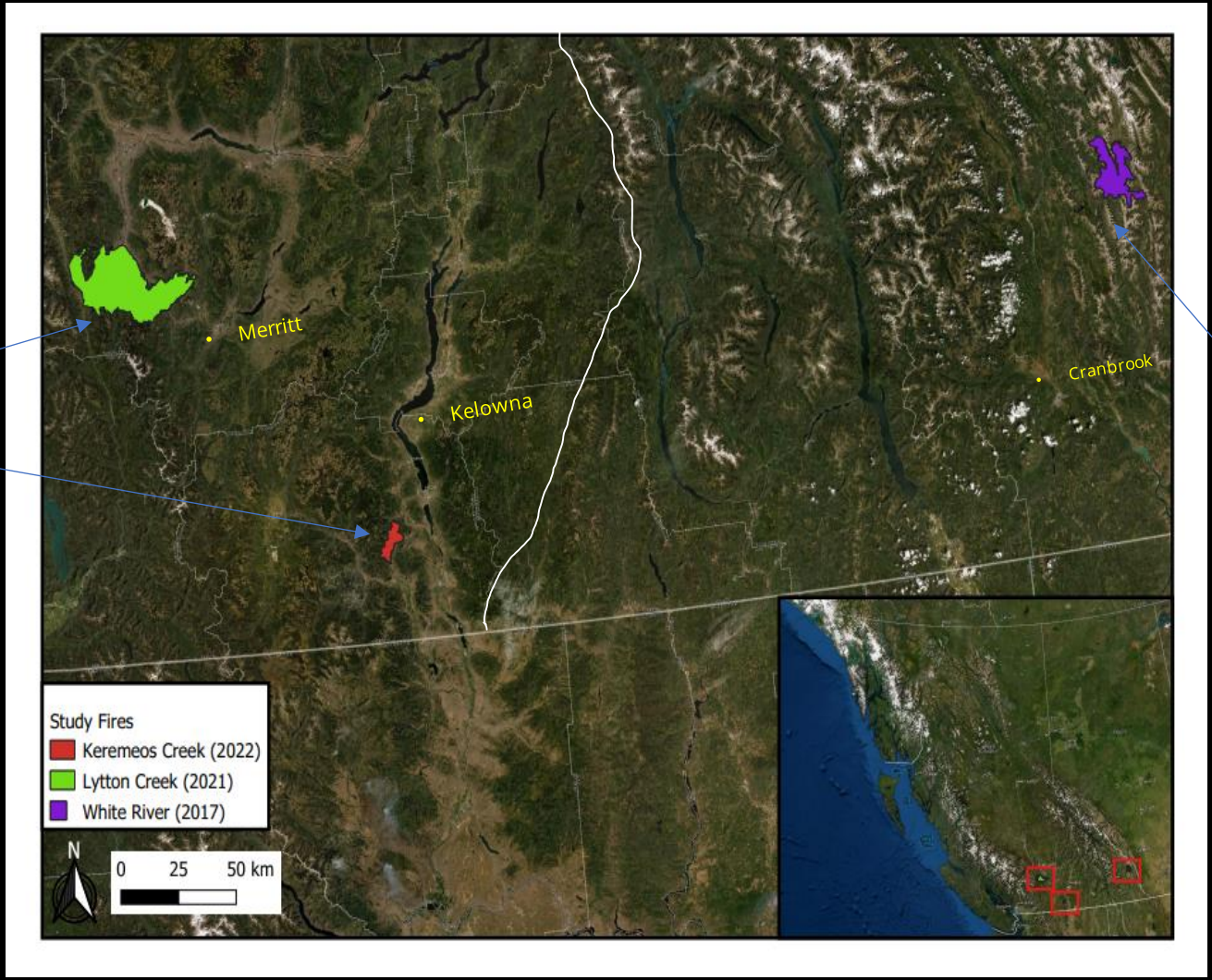
STUDY AREA MAP

Kamloops Region

- Lytton Creek (2021)
- Keremeos Creek (2022)

Features:

- Varying terrain/topography
- Semi-arid desert (study area)
- Varied vegetation



(Created in QGIS using ESRI satellite imagery)

Southeast BC Region

- White River (2017)

Features:

- Mountainous topography
- Climate varies (wet to dry)
- Tree species of commercial value

(BC Wildfire Service, n.d.)

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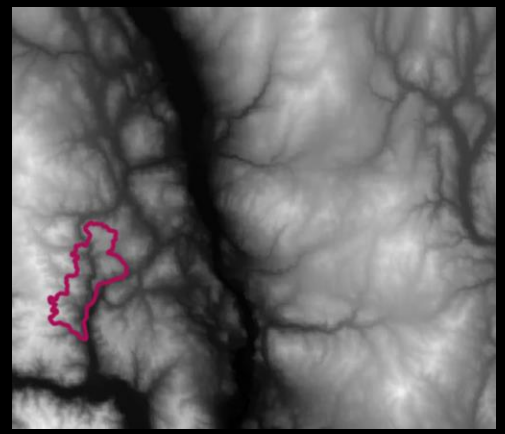
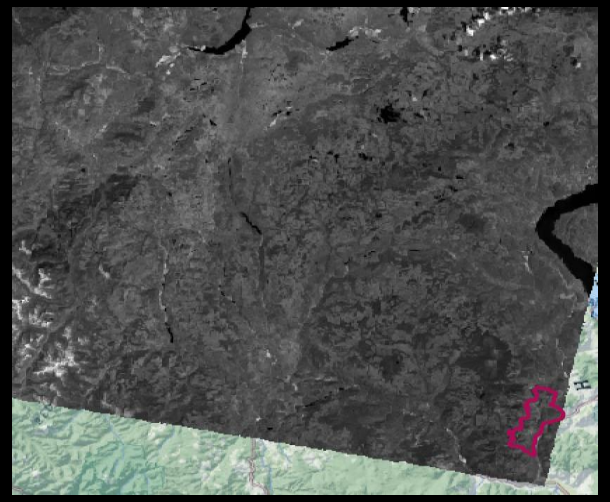
DATA COLLECTION

Satellites	Relevant Specifications
Landsat 8/9	• 30 m resolution • B4 (Red), B5 (NIR), B10 (TIR) • 16-day revisit time*
Sentinel 2	• 10 m resolution • B8 (NIR), B11 (SWIR1), B12 (SWIR2) • 2-to-3-day revisit time (mid-latitudes)
ASTER DEM	• 30 m resolution (1 arc-second) • Temporal extent: 2000 to 2013

ASTER DEM

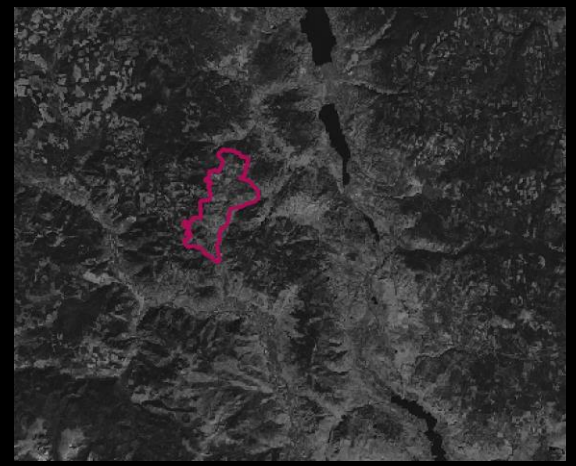




Landsat 8 NIR Image (B5)

Landsat 8 Thermal Image (B10)

Sentinel 2 NIR Image (B8)



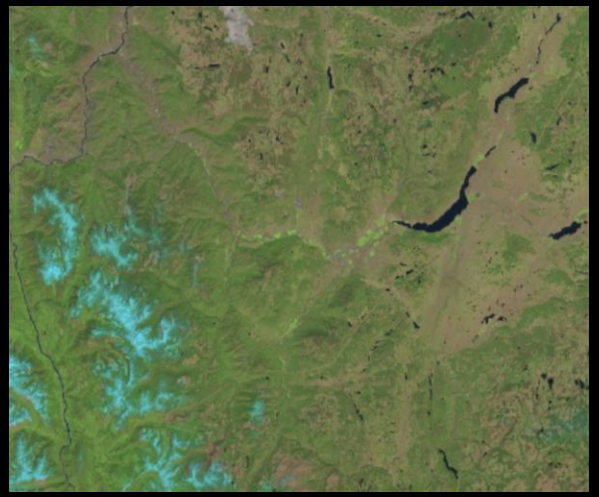
Sentinel 2 SWIR2 Image (B12)

Next

Time period of data collected

DATA COLLECTION

Example images: Sentinel 2; Lytton Creek Fire; True Color Composites



May 22nd, 2021

June 21st, 2021

June 29th, 2021

September 7th, 2021

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ANALYSIS PT. 1: Assessing Fire Risk Variables

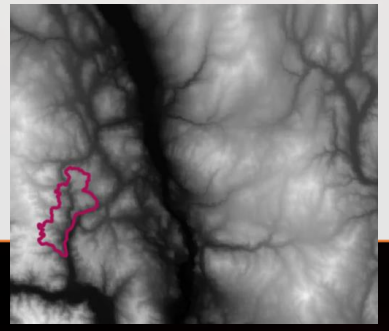
Land Surface Temperature

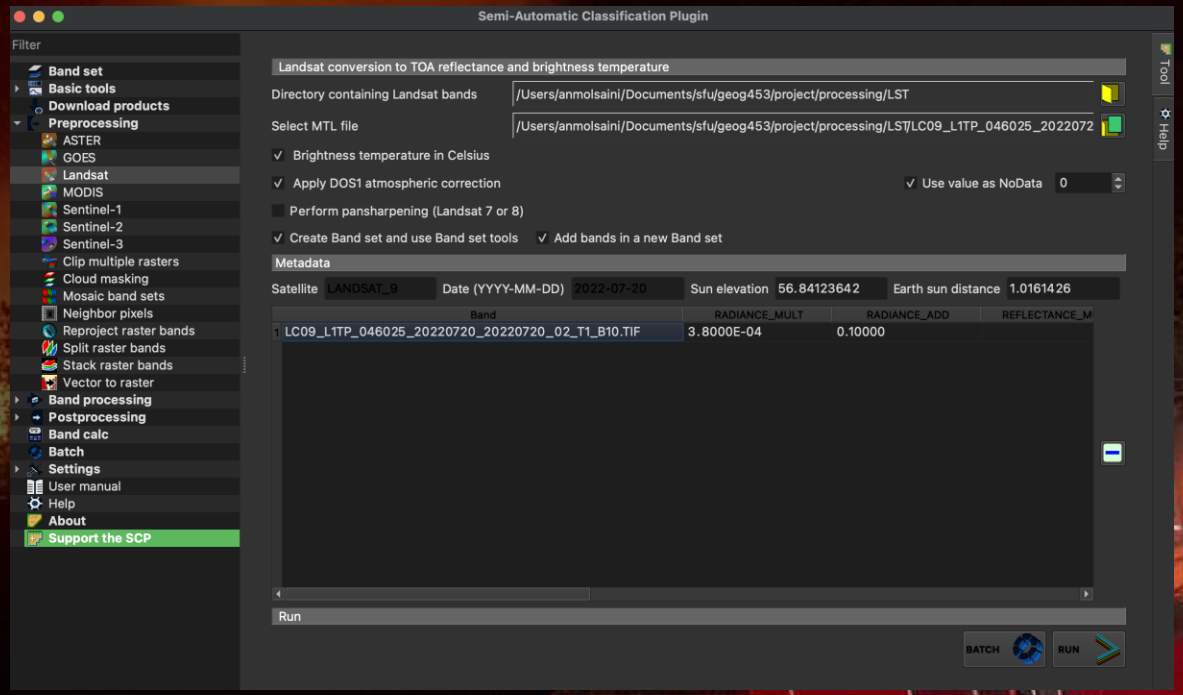
- Landsat 8 / 9

1. Perform atmospheric correction using the Semi-Automatic Classification Plugin (SCP)
2. Convert thermal band to brightness temperature in Celsius.

Digital Elevation Model

- ASTER
- Overlay over the LST maps produced to see if sloping and temperature are related





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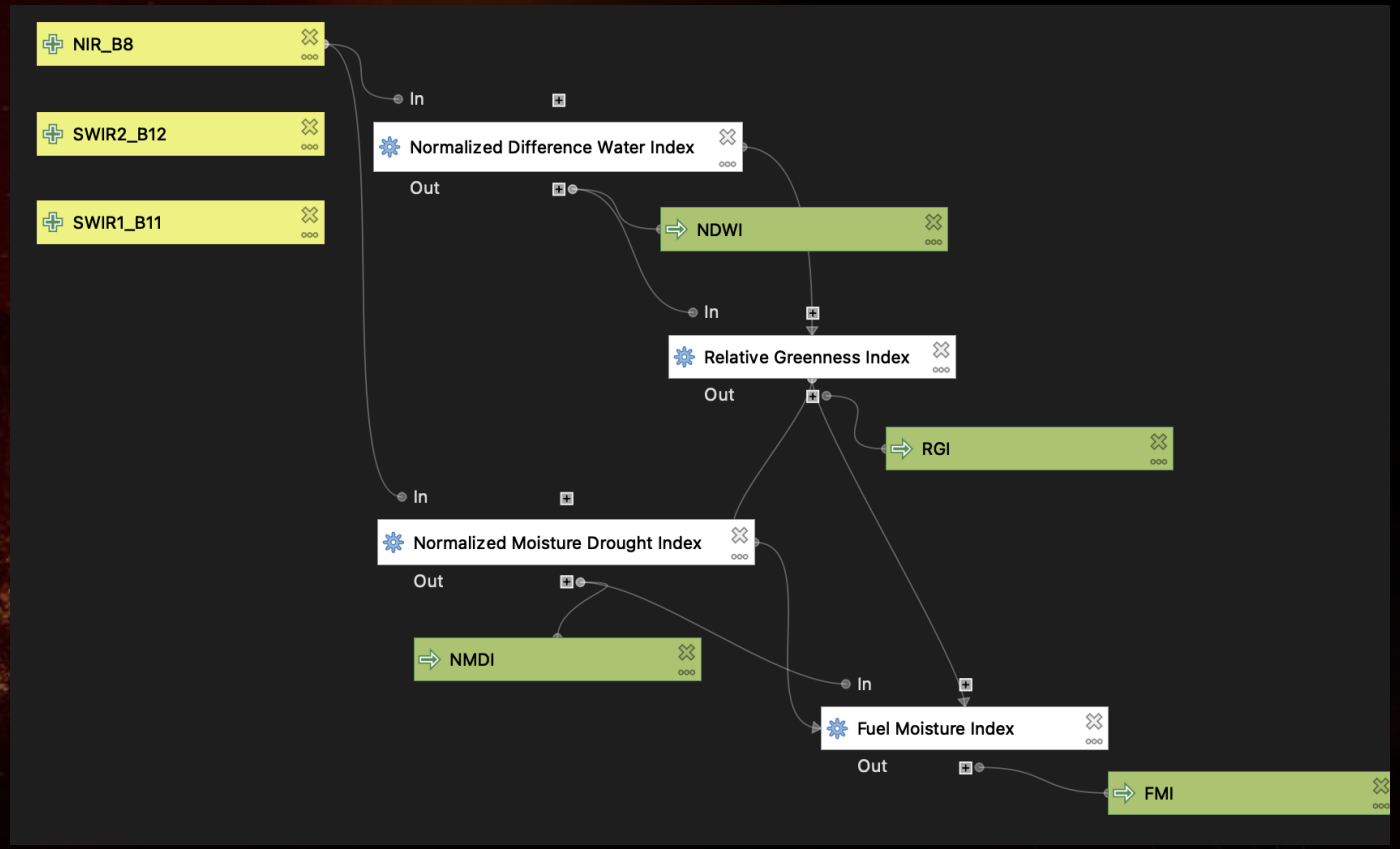
ANALYSIS PT. 1: Assessing Fire Risk Variables cont'd.

Fuel Moisture Index

- Sentinel 2

1. Calculate Normalized Difference Water Index (NDWI).
2. Calculate Normalized Moisture Drought Index (NMDI).
3. Get Relative Greenness Index (RGI) by normalizing NDWI.
4. Compute FMI from NMDI and RGI.



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ANALYSIS PT. 2: Post-Fire Detection

Preprocess by clipping to each of the fire boundaries and normalizing the raster values to a 0-1 scale.

Use Sentinel bands to calculate the pre-fire and post-fire Normalized Burn Ratio indices.

Compute the difference between the two NBRs. (dNBR)

Sort the pixels of the dNBR into classification bins based on BC's fire rating system to produce Burn Severity Classification maps.

Back to Overview

Outline

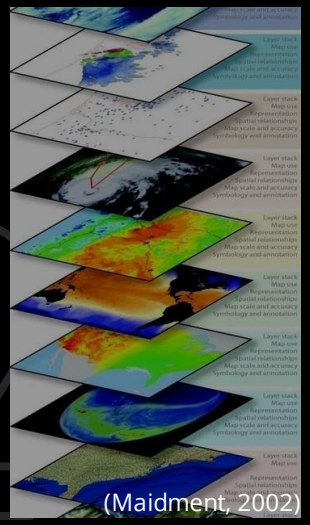
Fire Risk Monitoring and Assessment

1

(Noah Berger, 2022)

INTRODUCTION TO FIRE RISK ANALYSIS

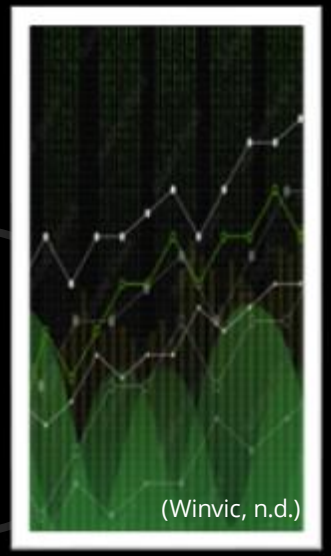
2



(Maidment, 2002)

METHODS

3



(Winvic, n.d.)

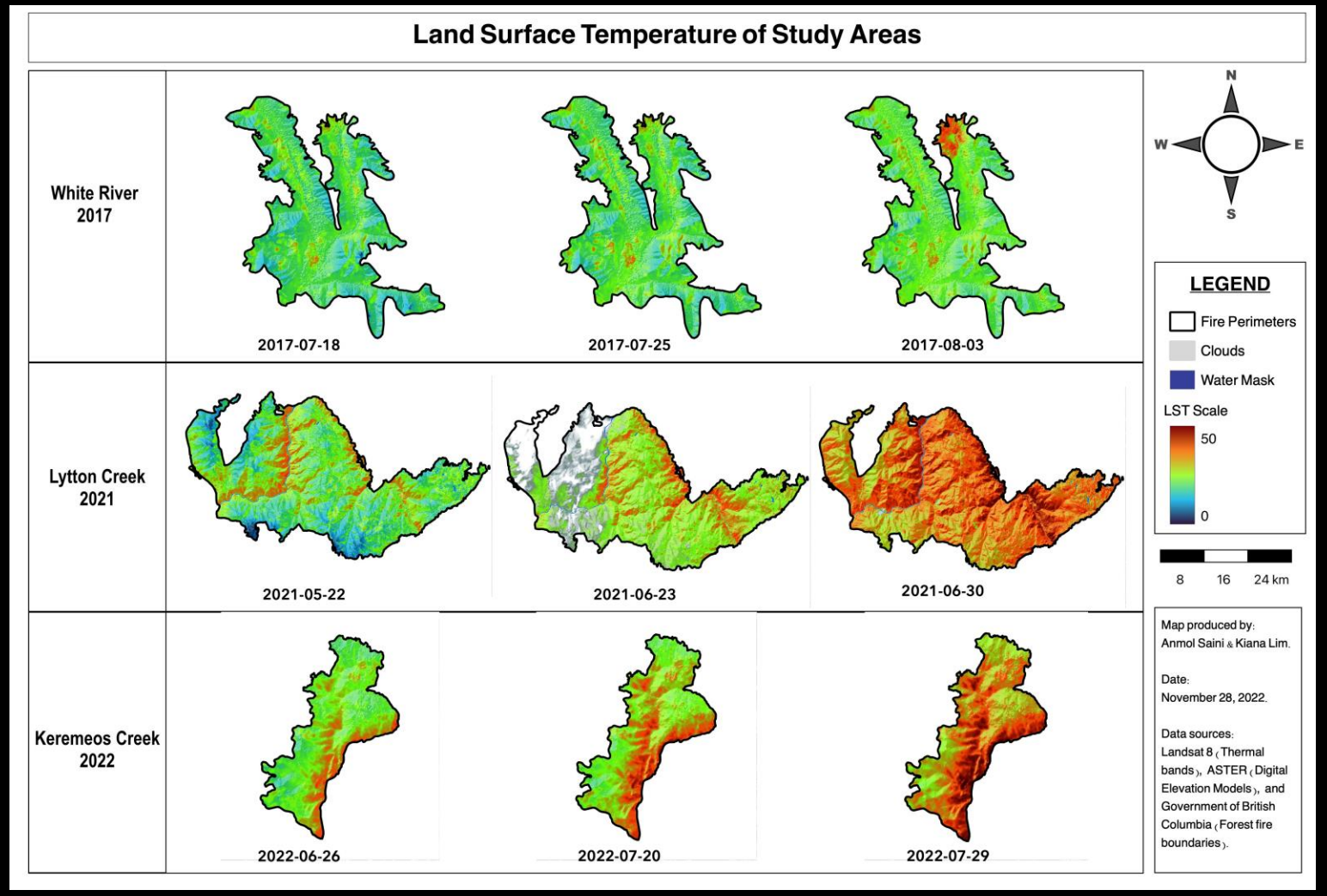
RESULTS & DISCUSSION

4

(Ashley, 2014)

SUMMARY

RESULTS – LST/Slope



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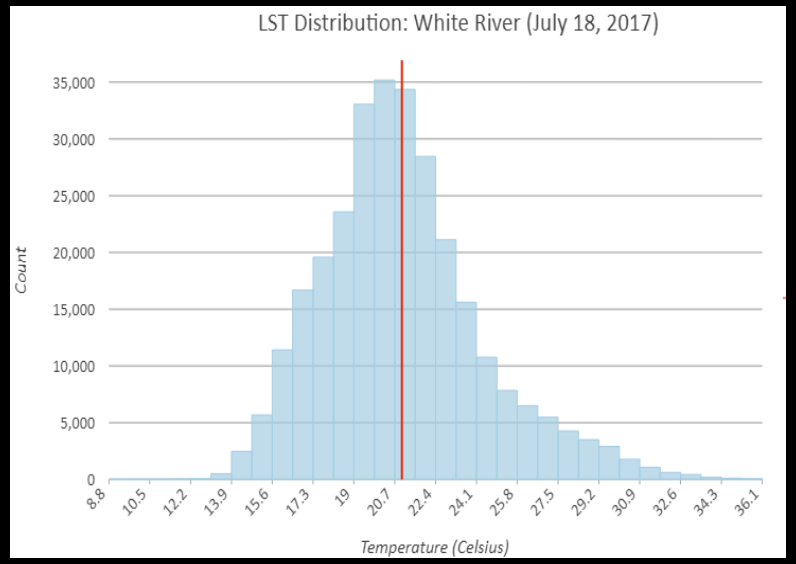
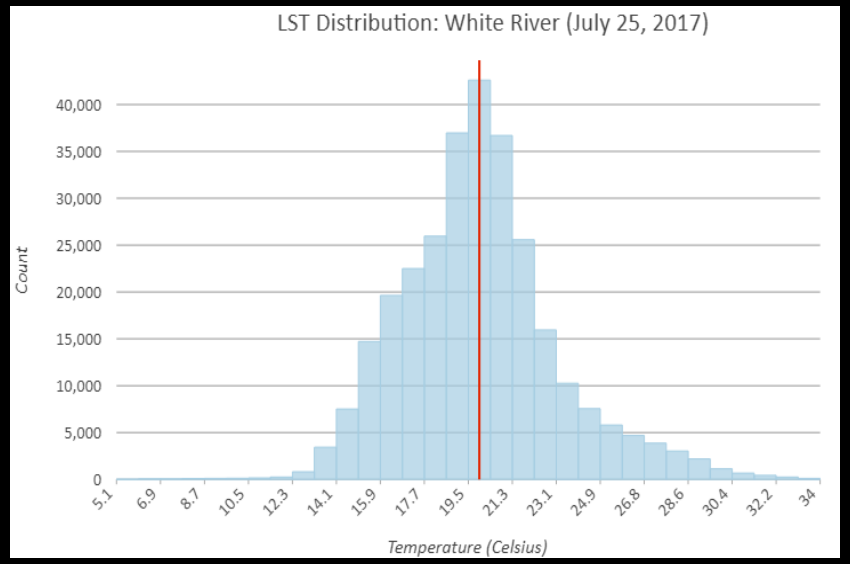
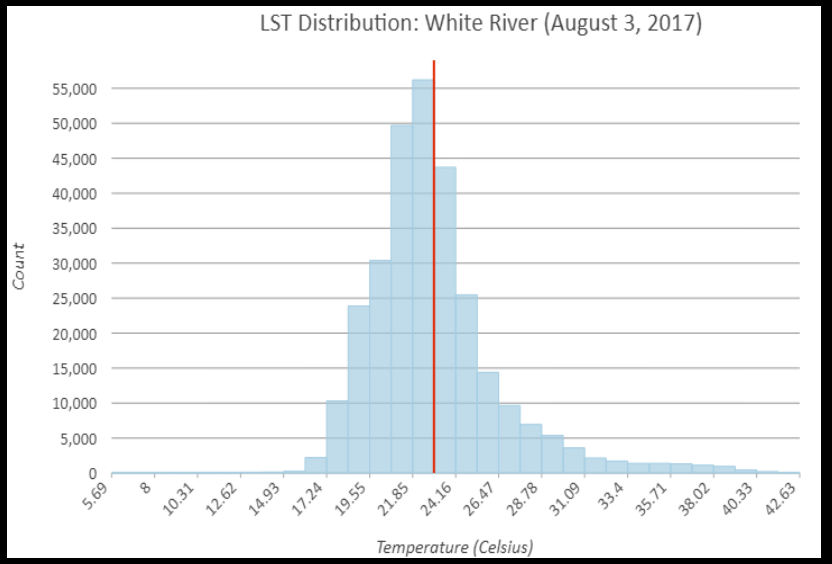
RESULTS – LST/Slope (cont.)



Mean Temperature: 21.02℃



Mean Temperature: 19.97℃

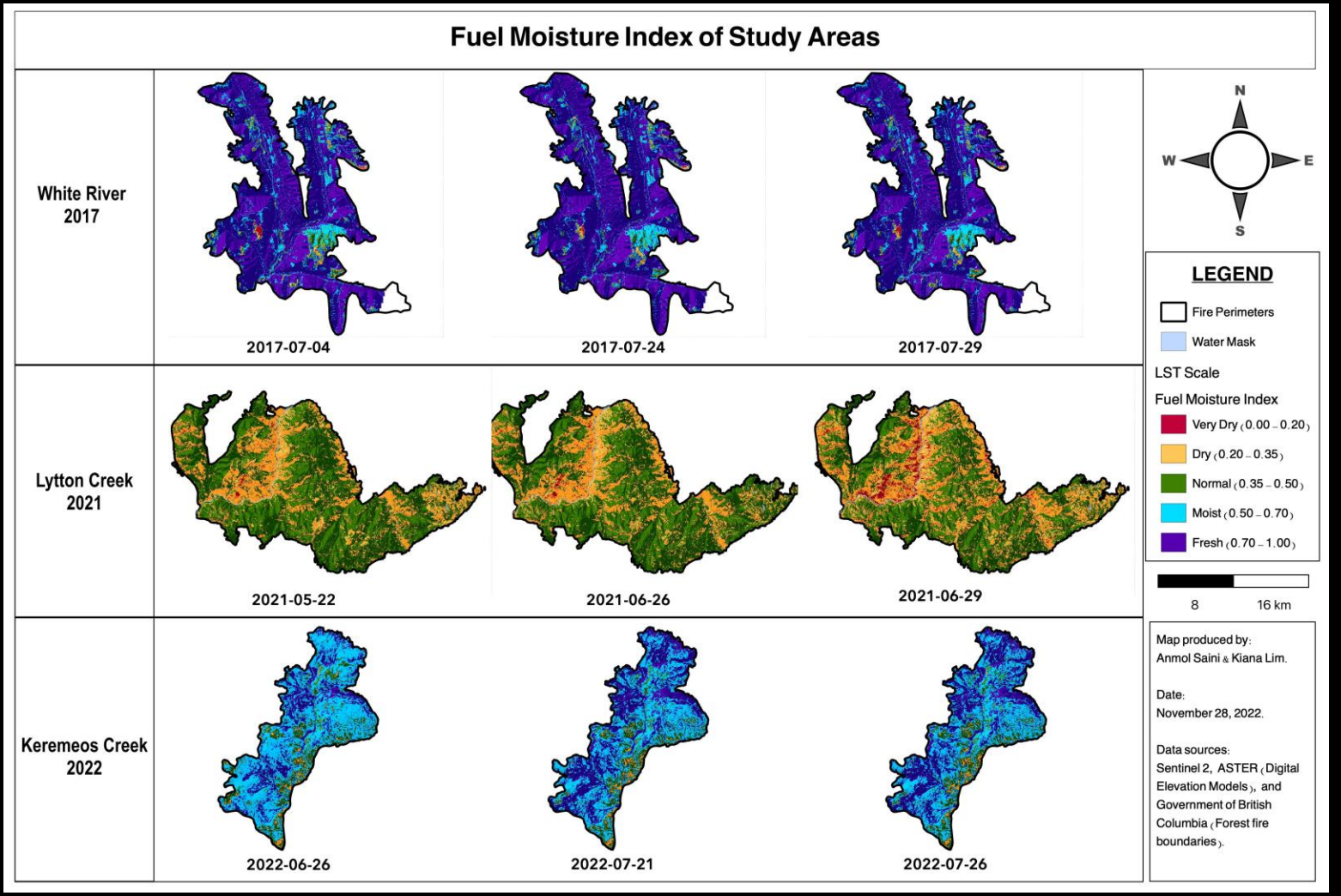


Mean Temperature: 23.00℃

- Generated histograms for 3x pre-fire dates, per study fire
- Slight increasing trend in days leading up to all three study fires

Next

RESULTS - Fuel Moisture



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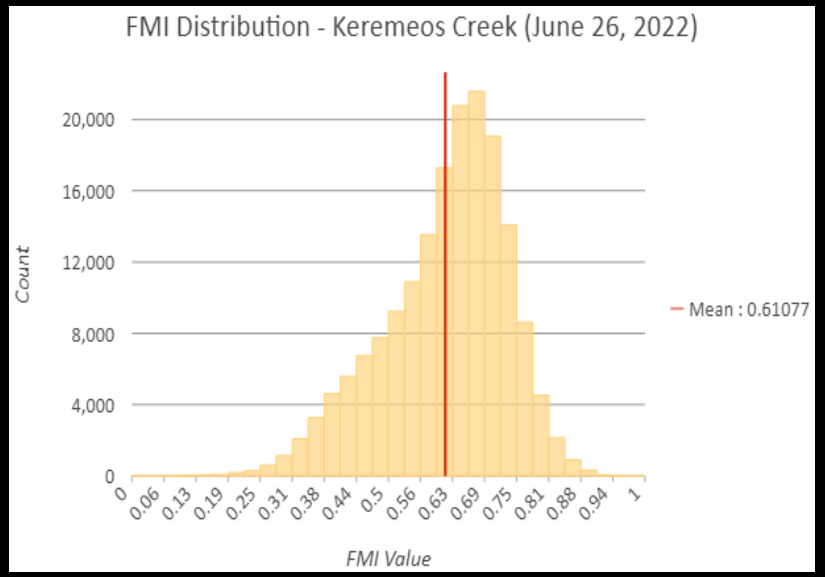
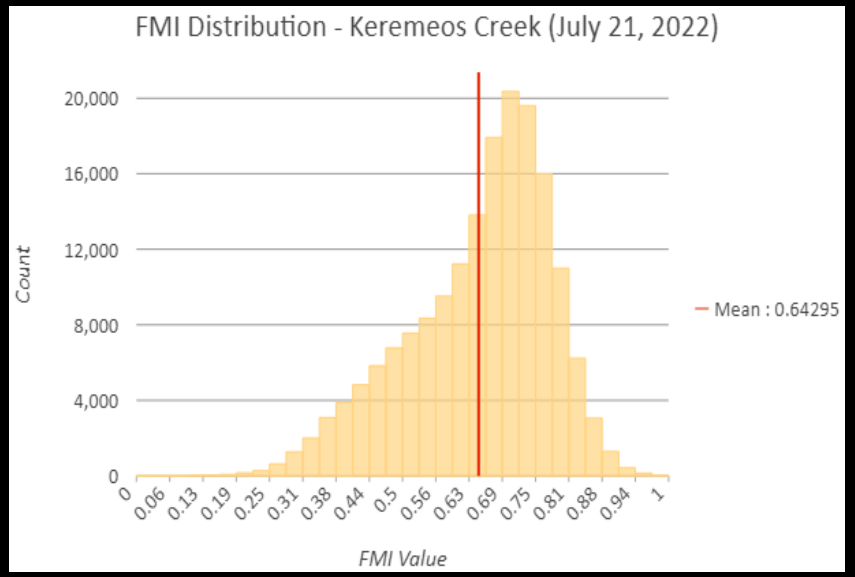
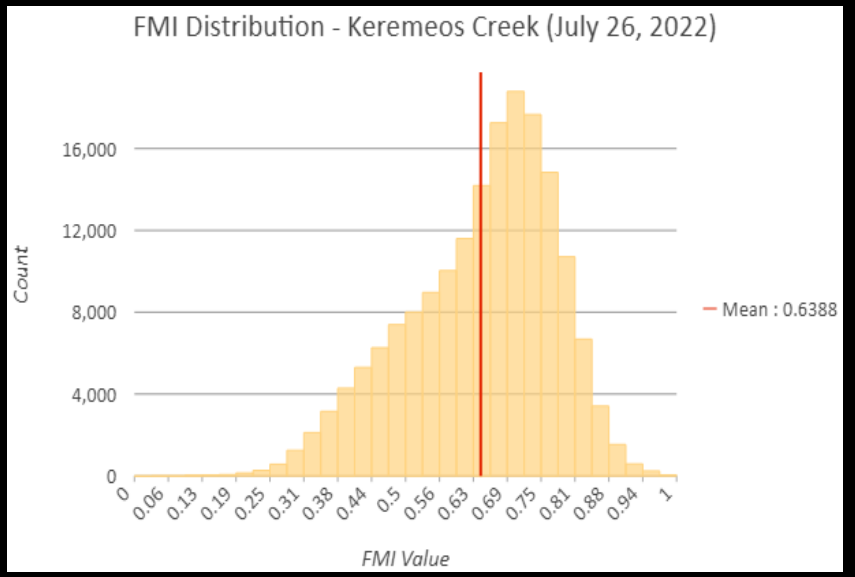
RESULTS - Fuel Moisture







- Generated histograms for 3x pre-fire dates, per study fire
- Slight decreasing trend in days leading up to all 3 fires – most significant in Lytton (2021)

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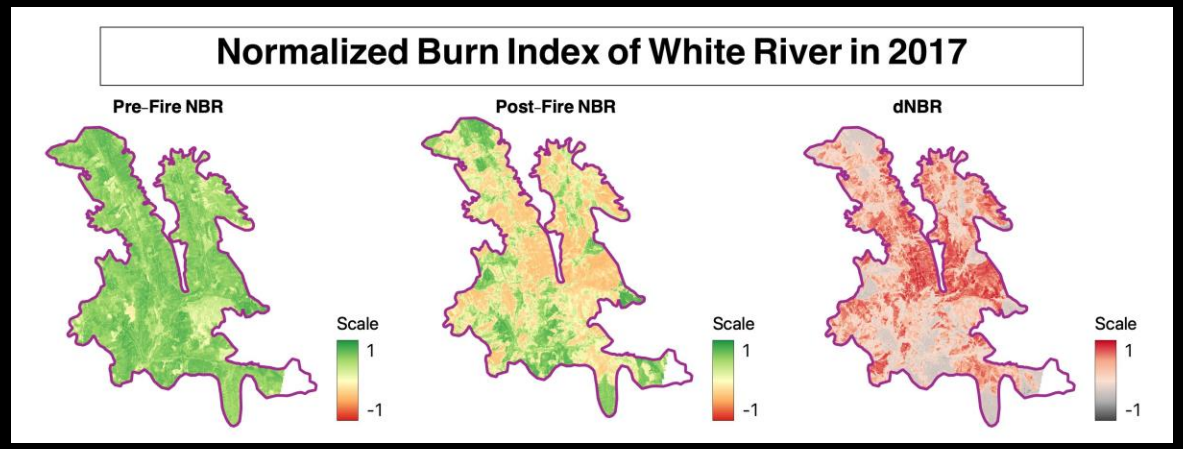
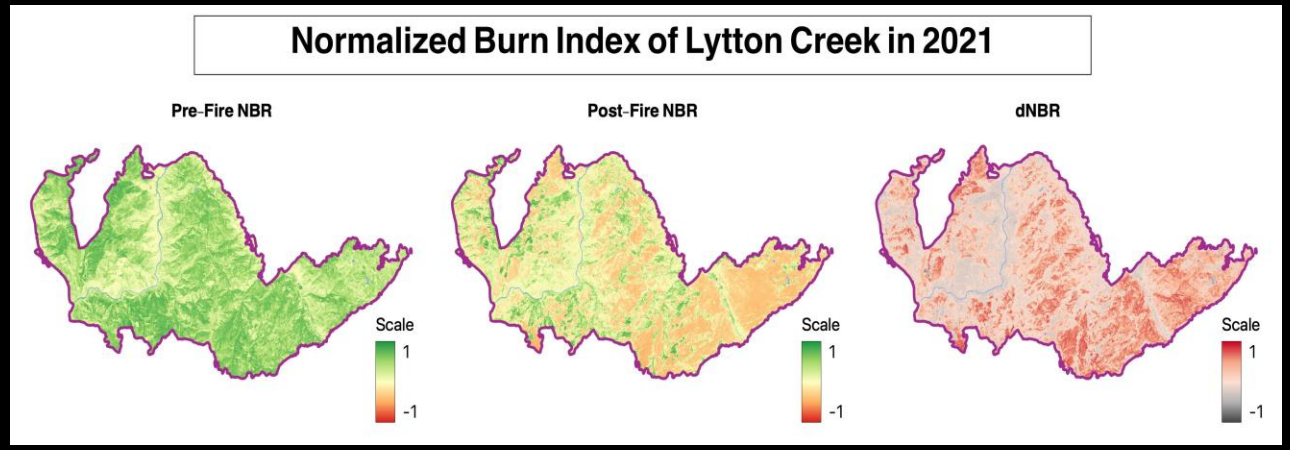
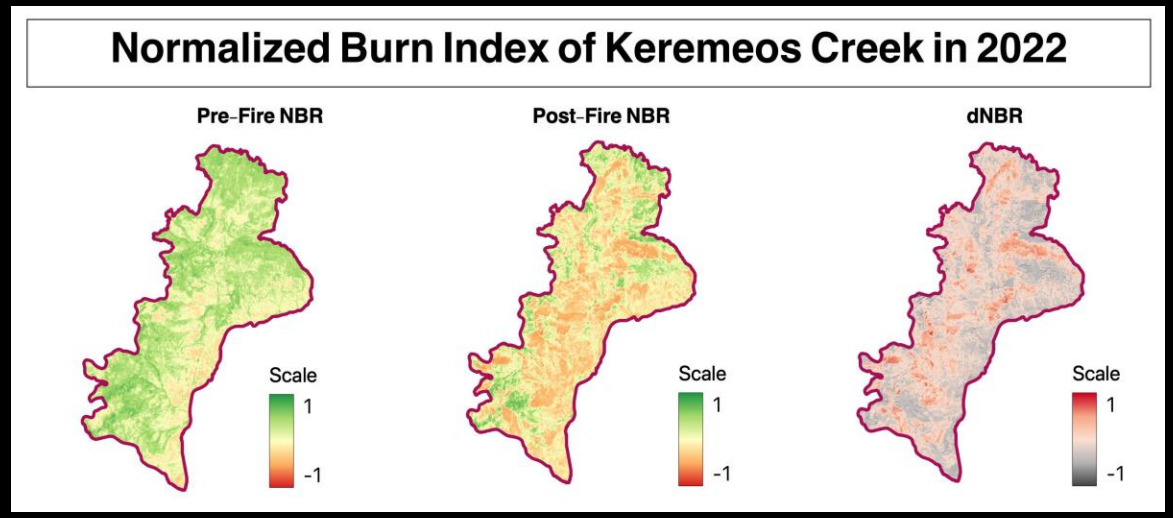
RESULTS – NBR







- The rasters used for each of the pre-fire NBR were taken from Sentinel-2, right before or on the start date of the fire for precision.
- The post-fire images used are cloud-free and after the fires have been completely extinguished.
- The dNBR values are scaled to the range of 0-1 and pixels are separated into classification bins based on BC's Fire Danger rating values.

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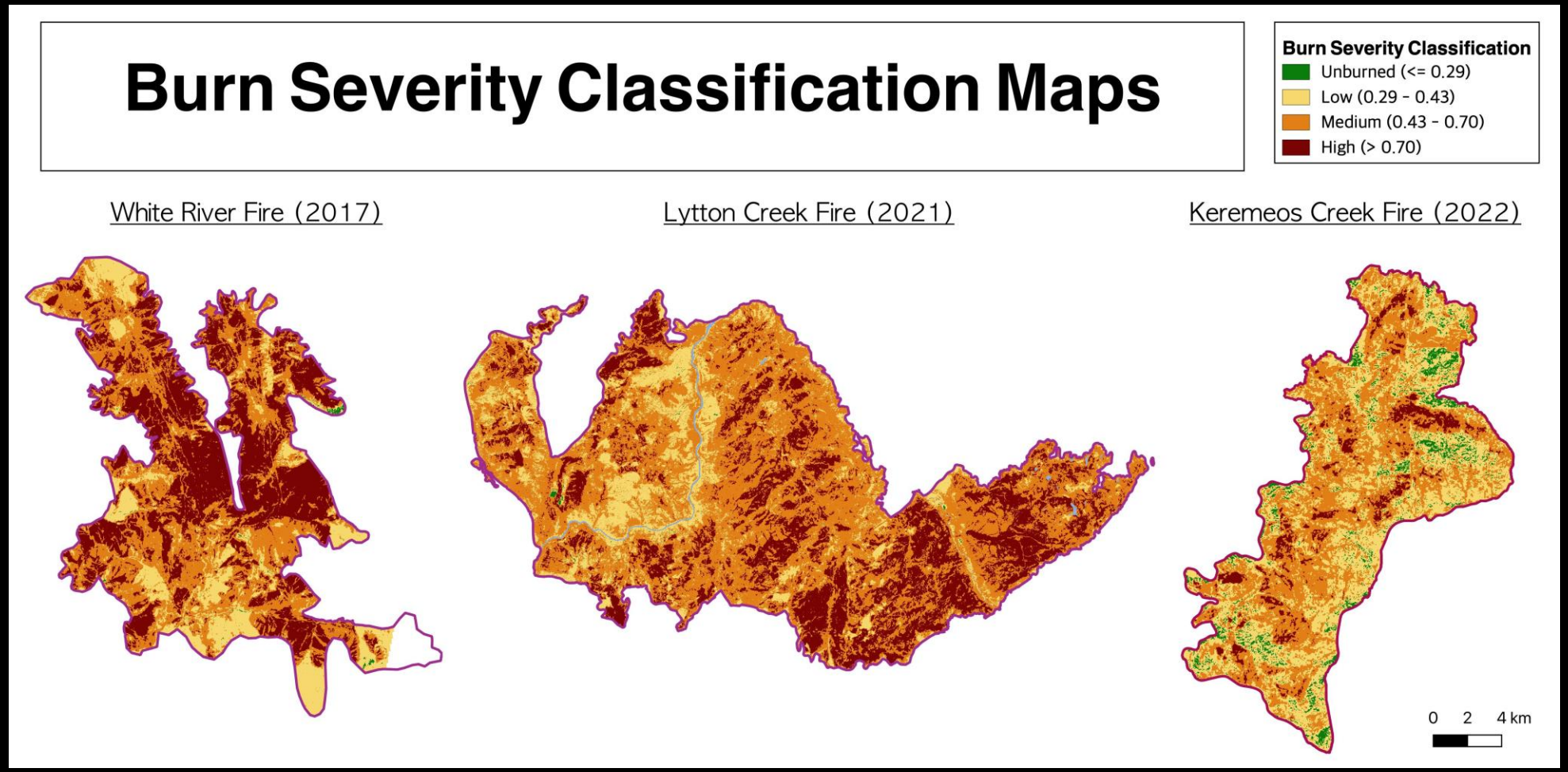
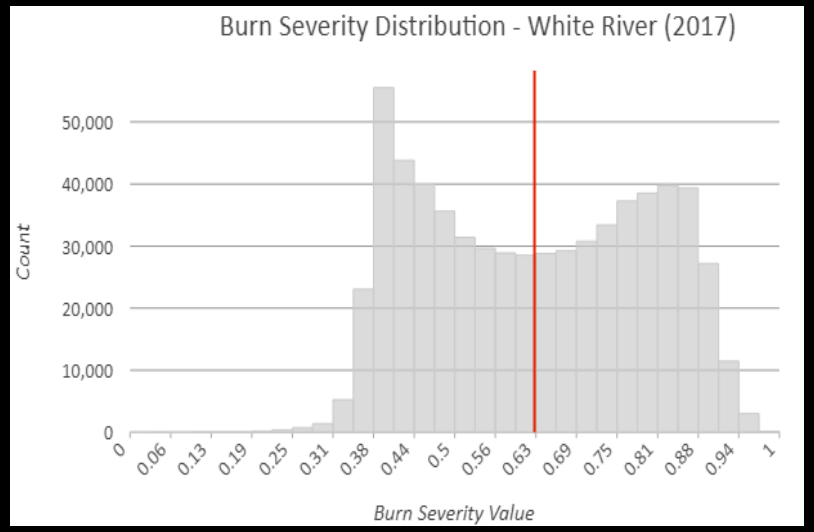
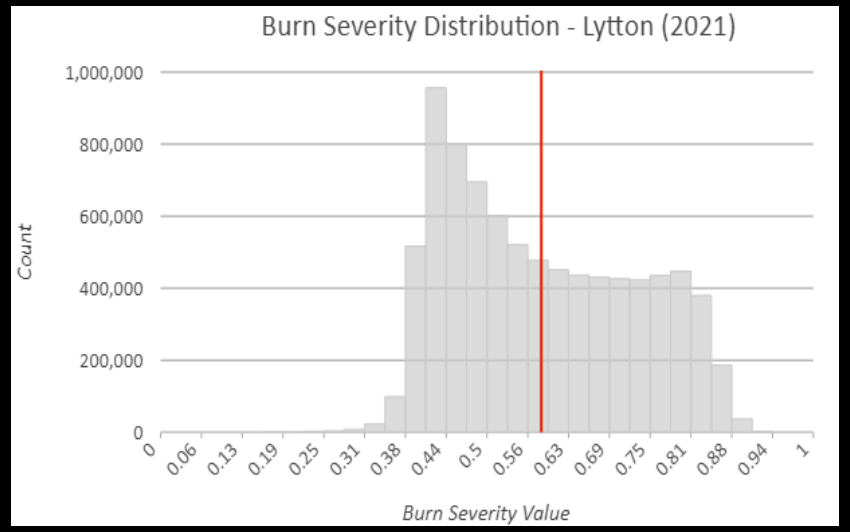
RESULTS – Burn Severity



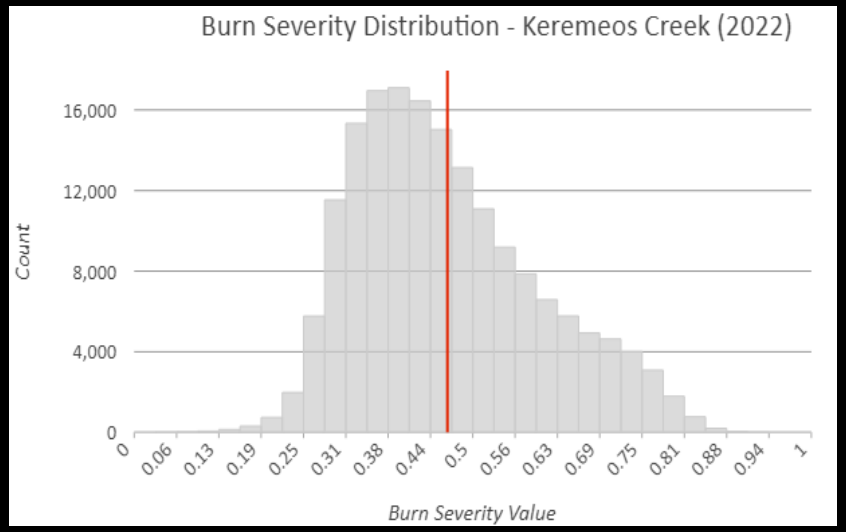
RESULTS – Burn Severity



Mean Burn Severity: 0.62



Mean Burn Severity: 0.58



Mean Burn Severity: 0.46

- Generated histograms for each study fire
- White River had relatively strongest burn severity

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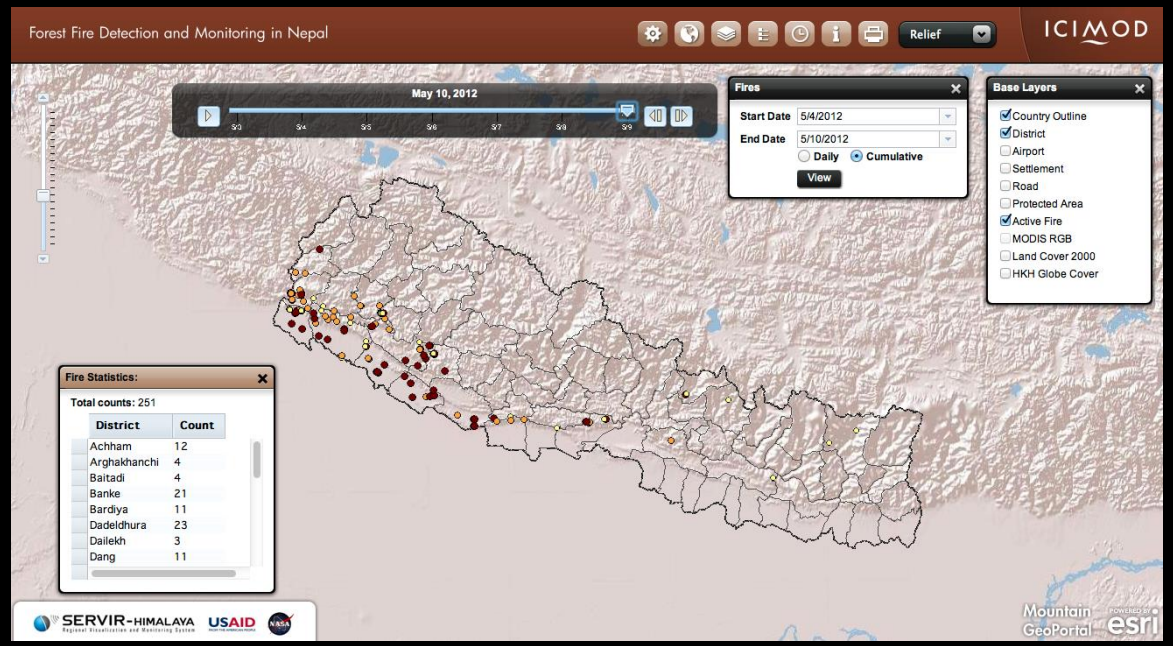
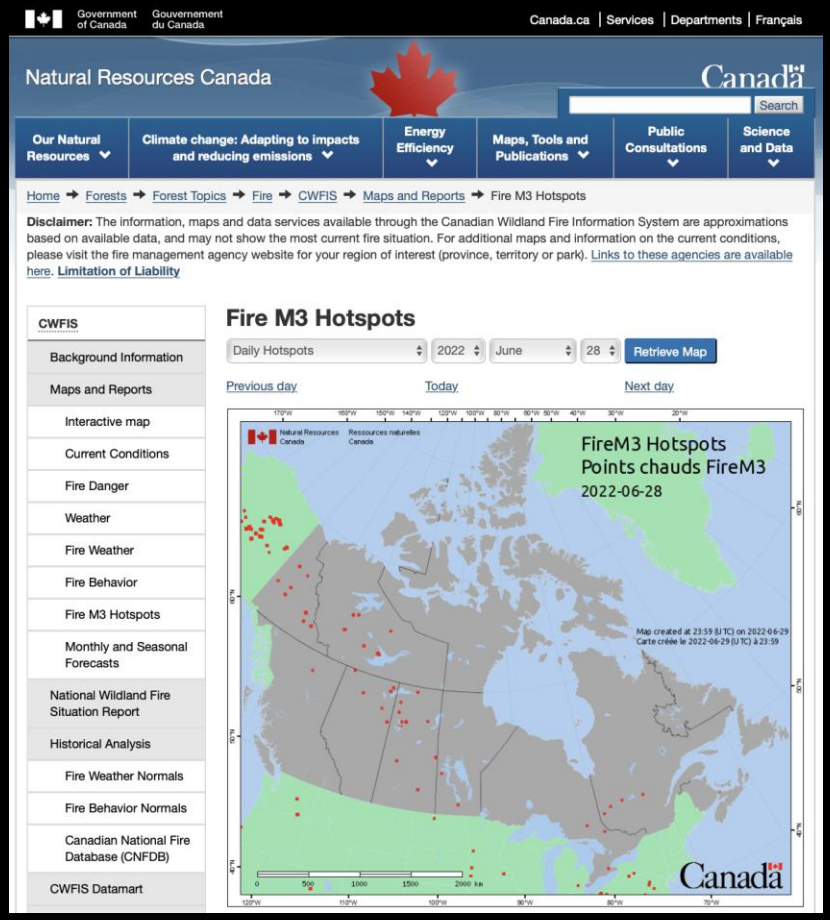
DISCUSSION

Many Forest Fire Monitoring Systems already exist.

- But most of these only monitor active forest fires.
- No system predicts fires in areas before ignition.



Example 1. Fire detection and Monitoring System for Nepal.



Example 2. Canadian Wildland Fire Information System providing Daily Fire M3 Hotspots.

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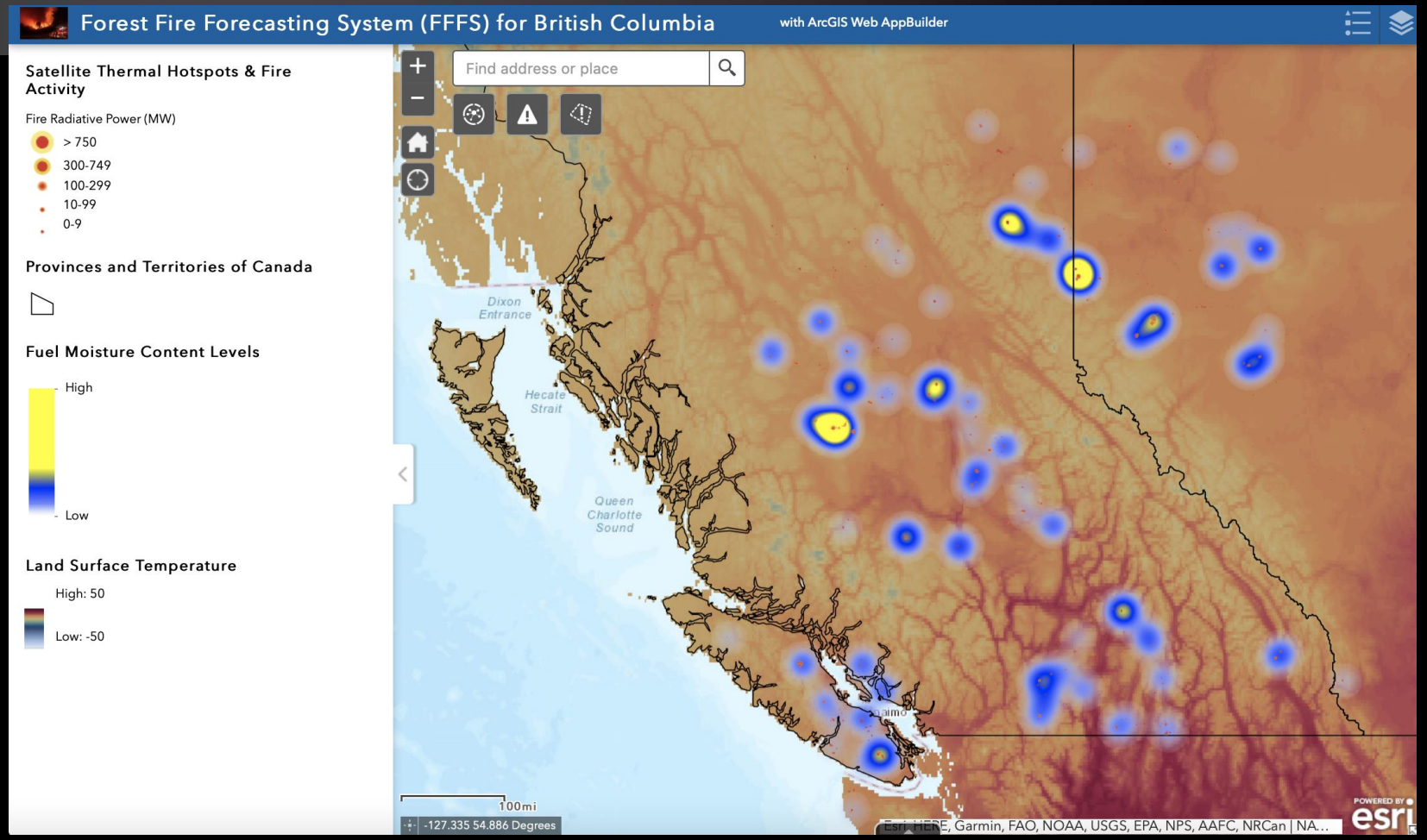
AS

DISCUSSION

We propose the creation of a digital and publicly available system that provides forest fire forecasts based on the Fire Risk Variables.

Here is a sample prototype to depict the potential system.



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DISCUSSION

BRITISH COLUMBIA

Wildfire Season Summary

After two years of below-average fire activity, the BC Wildfire Service faced a tremendously challenging wildfire season in 2021. Those challenges included:

(BC Wildfire Service, n.d.)

Literature gaps filled:

- Spatial – Covers BC
- Temporal – Fires within the last 5 years
- Satellites used – Sentinel 2 & Landsat 8

Identified limitations:

- Small sample size – weak trends, unable to prove correlations
- Data collection constraints
- No weighted variables

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Outline

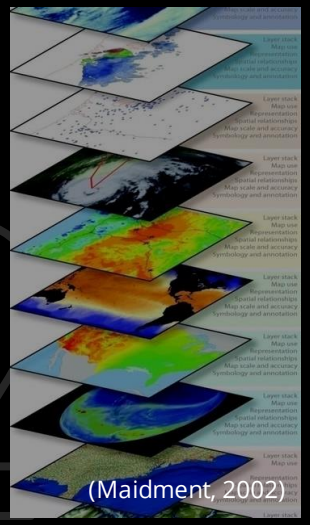
Fire Risk Monitoring and Assessment

1

(Noah Berger, 2022)

INTRODUCTION TO FIRE RISK ANALYSIS

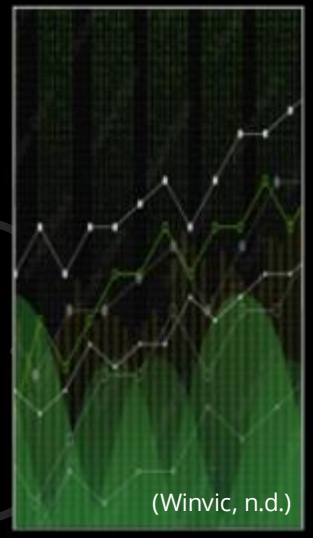
2



(Maidment, 2002)

METHODS

3



(Winvic, n.d.)

RESULTS & DISCUSSION

4

(Ashley, 2014)

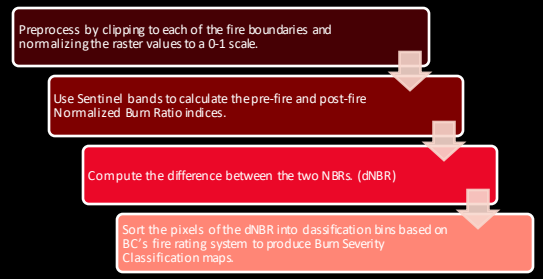
SUMMARY

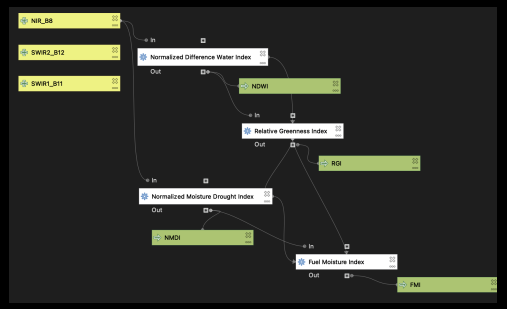
SUMMARY

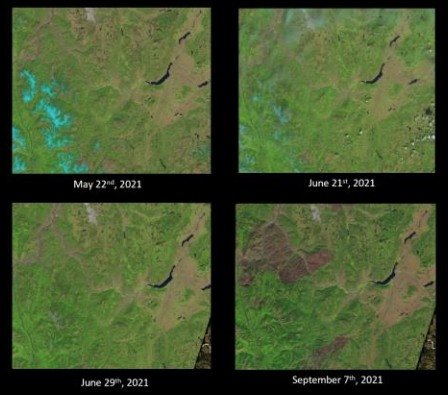
- Introduction: Forest significance and wildfire impacts

- Project goal: To monitor selected BC fires to understand fire behaviours and forecast areas that are potentially at risk of forest fires

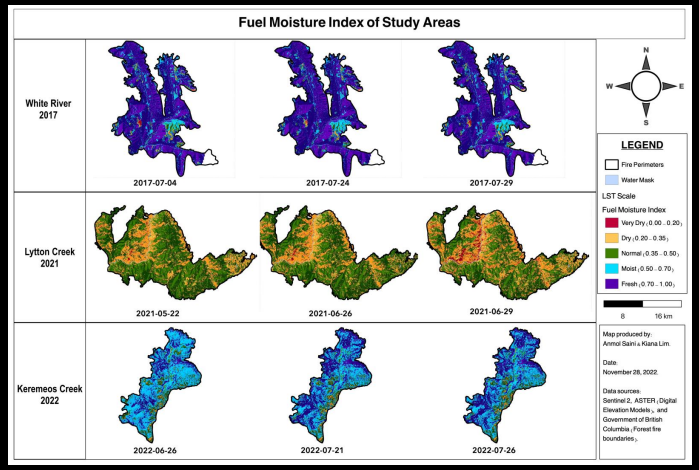
- Methods:
  - Study area;
  - Data collection;
  - Data processing to calculate burn extent/severity; and examine LST, slope, and moisture







- Results: NBR/Severity Maps; Index Maps; Multi-year graphs; Simple workflow for fire monitoring and forecasting



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Navarro, G., Caballero, I., Parra, P.-C., Vazquez, A., & Caldeira, R. (2017). Fig. 5. Spectral index maps for the Normalized Burn Ratio (NBR) of the Madeira Island for: a) pre-fire b) post-fire and c) NBR difference (dNBR). In G. Silva (Ed.), *Semantic Scholar*. https://www.semanticscholar.org/paper/Evaluation-of-forest-fire-on-Madeira-Island-using-Navarro-Caballero/8de7aa867a393132332c40a6d92b183f73b1cc83/figure/7

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THANKS

Any Questions?