

Fire and Agriculture in California

Identifying Most Flammable Crop Land and Counties

BACKGROUND

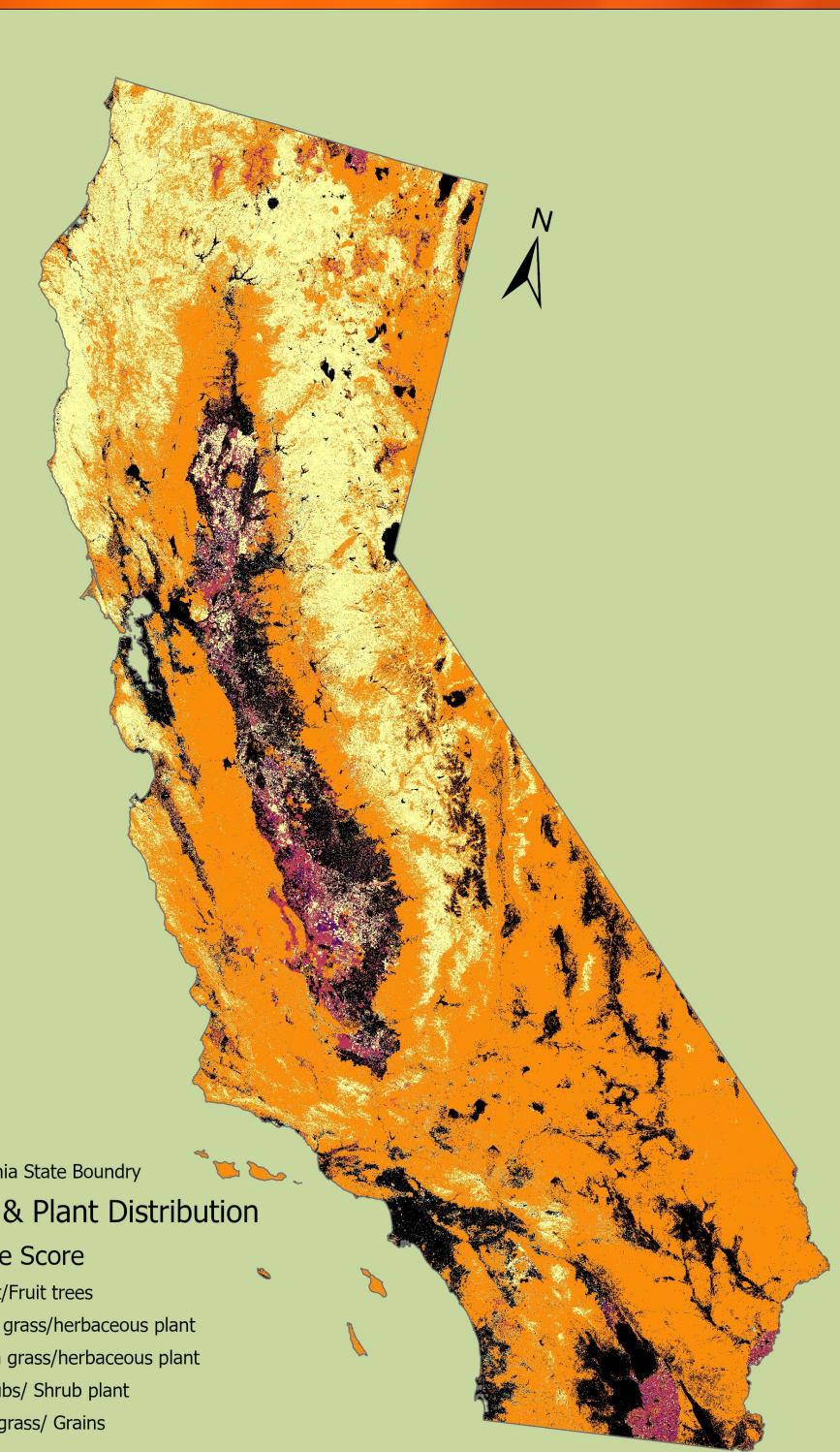
More than a quarter of California's landmass is used for agriculture. While fire and climate change have concurrent and severe negative impacts on the agriculture field. However, agricultural burning actually helps farmers remove crop residues left and control pests.

So it is vital to understand the spatial relationship between the land fire and the agricultural land in California. First, it could help to better understand the concurrent condition of agricultural land and how it relates to the land fire. Second, it can be used to predict and identify the vulnerability of agricultural land and counties in California from the land fire.

METHODOLOGY

Raster data layers were obtained from both Cropland Data Layer (CDL) and the Fire Behavior Fuel Model 13 (FBFM13) for the entire California state. Reclassify the CDL by giving each crop class a reasonable fire score (Map 3). Reclassify the FBFM13 layer by giving each model a measurable fire score instead of a classification index (Map 4). Combine two processed layers with 50-50 weight and get the weighted fire score for the whole state (Map 5). Attribute query on the original CDL to select only the agricultural land and classify the crops into 5 groups based on their growing habits (Map 1). Convert the agricultural land raster into a polygon layer. With the newly agricultural polygon layer as the feature mask and weighted fire score for the whole state (Map 5) as the input raster layer, perform Extraction by mask. This gives the fire score for the agricultural land only (Map 2).

Zonal statistic by table with California county as a target layer and the agricultural land only fire score (Map 2) as a value raster to get the total agricultural fire score for each county. Join this newly formed table back to the county layer using county names as the key to get the exact information and results for the agricultural land fire risk analysis (Table 3).



Map 3:
California Crop and
Plant Distribution
classified with Fire
Score

Crops, plants, forests and all kinds of topography are included in this map. The fire score are based on Anderson's paper (Anderson 1981), and the example of corresponding crops are shown together in the table (Table 1.b).

Crops & Plants

California Air Resource Board. 2022; Available from: <https://www.arb.ca.gov/our-work/programs/agricultural-burning>.

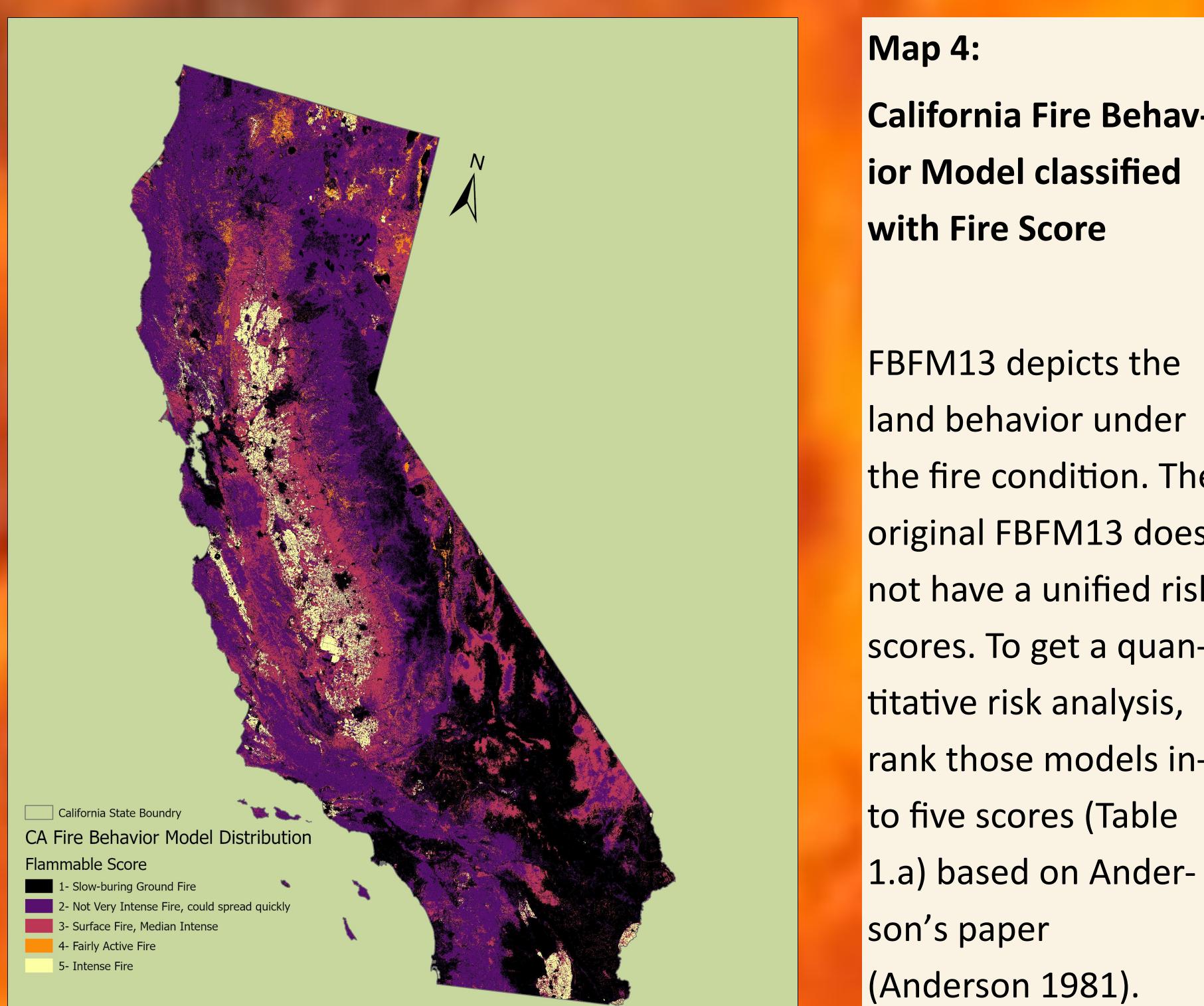
Tohra, Ahmad Sidiq, and Herry Triani. "A spatial model of forest and land fire vulnerability level in the Dairi District, North Sumatra, Indonesia." *Biodiversity Journal of Biological Diversity* 22.8 (2021).

Nguyen, T.T.; Tran, T.D.; Linh, T.V.K.; Le, T.S.; Pham, T.T.; Ho, D.P. Building Models for Agricultural Land Fire Prediction Using Remote Sensed Environmental Data: A Case Study in Dien Bien Province, Vietnam (2003 – 2016). *Preprints* 2020, **2020070535**; doi: 10.20944/preprints202007.0535.v1.

Korontzi, Stefania, Jessica McCarty, and Christopher Justice. "Monitoring agricultural burning in the mississippi River Valley Region from the moderate resolution imaging spectroradiometer (MODIS)." *Journal of the Air & Waste Management Association* 58.9 (2008): 1235-1239.

FBFM 13	Typical Fuel Complex	Rate of Spread (chains/hour)	Flame Length (feet)	Fire Score
Table 1.a				
1	short grass	78	4	4
2	timber (grass and under-story)	35	6	3
3	tall grass	104	12	5
4	chaparral (tall shrub)	75	19	4
5	(young) brush	18	4	2
6	(old) dormant brush, hardwood slash	32	6	3
7	southern rough	20	5	2
8	closed timber litter	1.6	1.0	1
9	hardwood litter	7.5	2.6	2
10	timber (litter and under-story)	7.9	4.8	2
11	light logging slash	6.0	3.5	2
12	medium logging slash	13.0	8.0	2
13	heavy logging slash	13.5	10.5	2

What's on the land?	Crop example	Fire score
Tall grass	Grain: Wheat, Corn	5
Shrubland	Blue Berry	4
High grass / herbaceous plant	Strawberry, Celery	3
Low grass / herbaceous plant	Tomato	2
Fruit / fruit trees	Apples Trees	1



Map 4:
California Fire Behavior
Fuel Model classified
with Fire Score

FBFM13 depicts the land behavior under the fire condition. The original FBFM13 does not have a unified risk scores. To get a quantitative risk analysis, rank those models into five scores (Table 1.a) based on Anderson's paper (Anderson 1981).

Fire Behavior Fuel Model

UNEP. Ten impacts of the Australian bushfires. 2020 [cited 3 July 2020]; Available from: <https://www.unenvironment.org/news-and-stories/story/ten-impacts-australian-bushfires>.

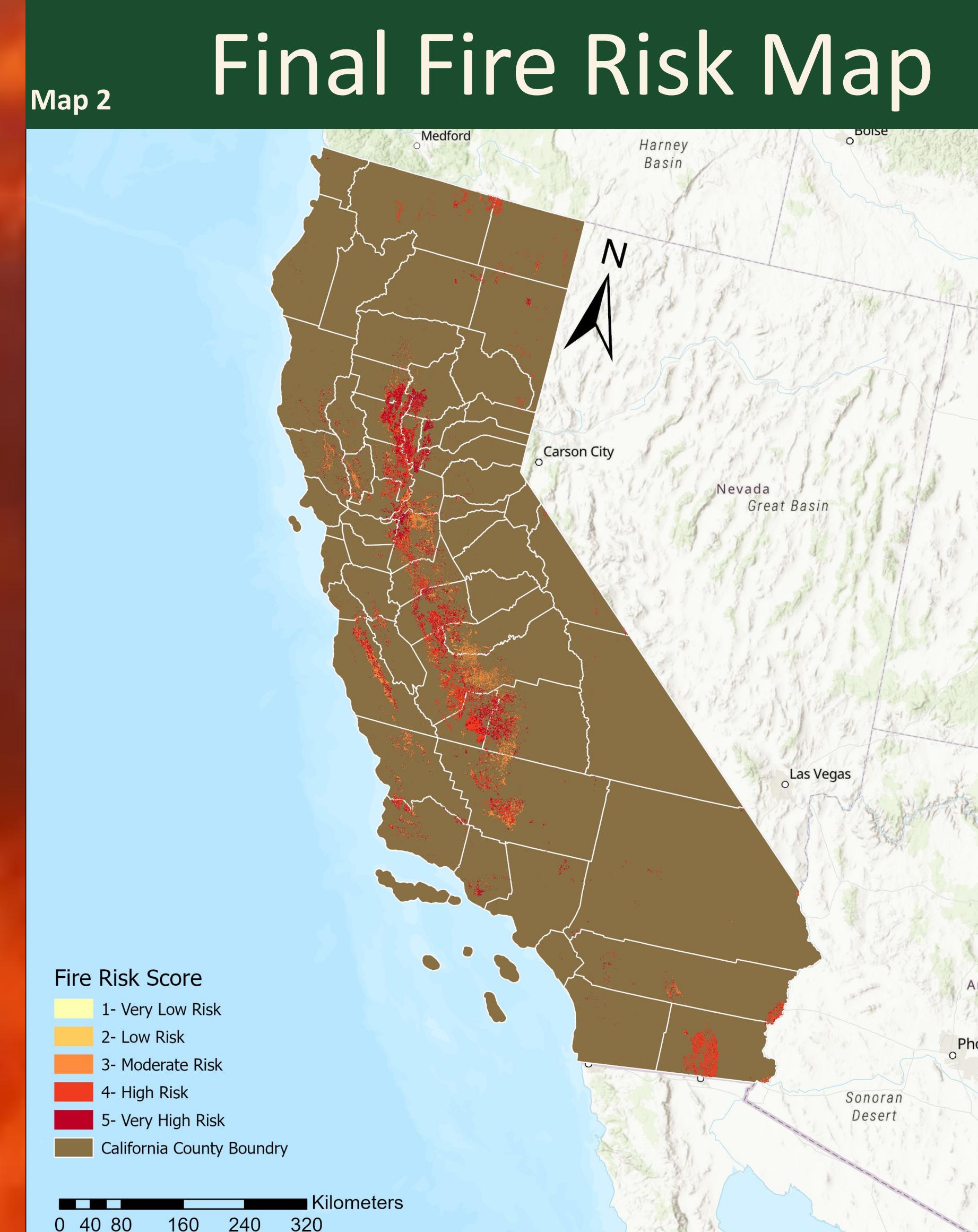
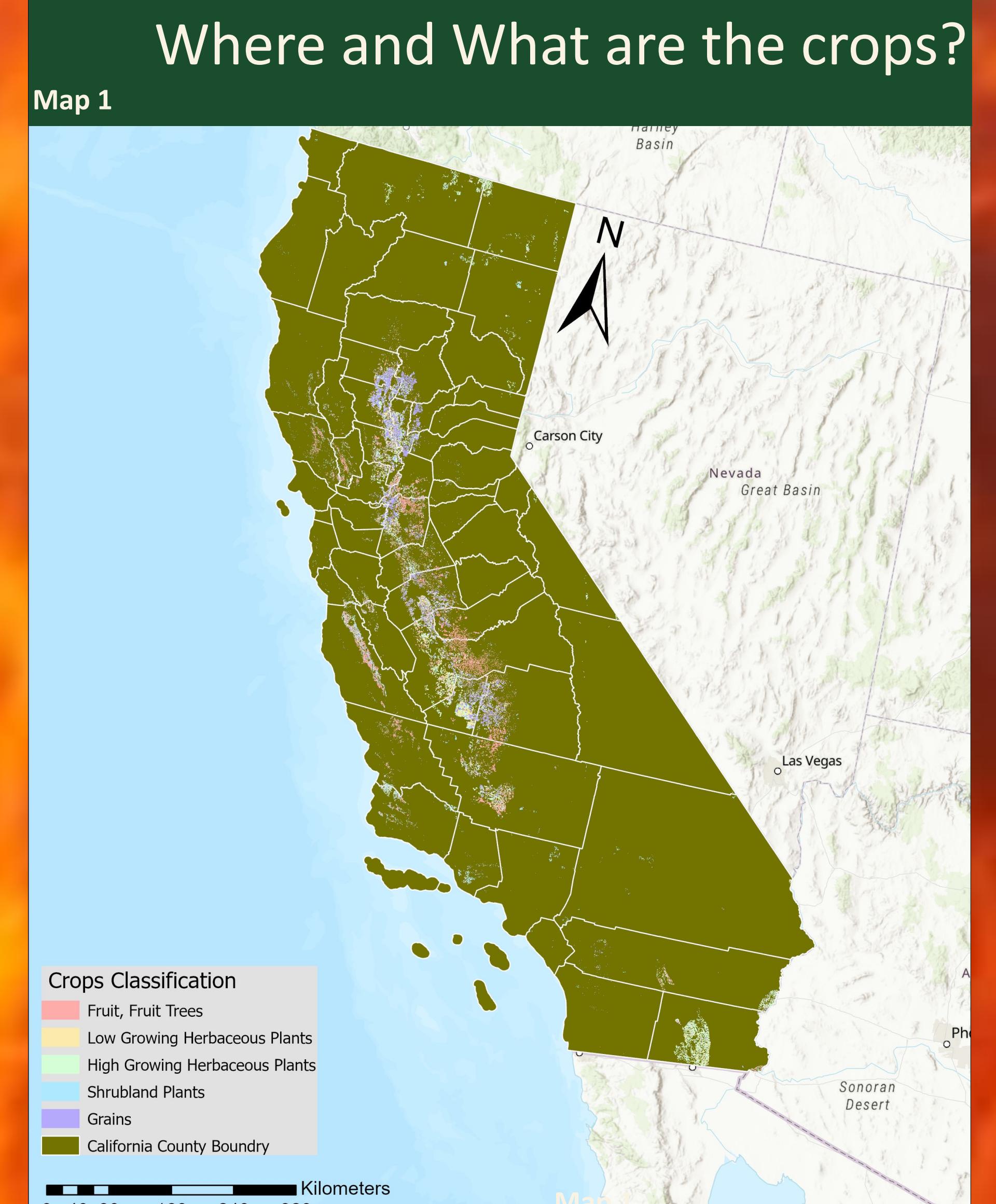
University of California, Davis. The Measure of California Agriculture. The University of California Agricultural Issues Center. 2009; Available from: <https://aic.ucdavis.edu/wp-content/uploads/2019/01/moca9.pdf>.

Anderson, Hal E. *Aids to determining fuel models for estimating fire behavior*. Vol. 122. US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, 1981.

https://www.farmprogress.com/sites/farmprogress.com/files/styles/article_featured_standard/public/WFP-ARS-fire.jpg?itok=x6KLHjA

<https://www.arb.ca.gov/our-work/programs/agricultural-burning>

Reference



FIRE SCORE RANKING	COUNTY NAME	Fresno county has the highest agricultural fire risk, and the northern part of central California crop land has very high fire risk. The majority of crop land has moderate to very high fire score.
1	FRESNO	
2	MERCED	
3	IMPERIAL	This risk analysis is restricted by the overlapping between FBFM13 and the crops. FBFM13 is not developed specifically for agricultural land. So applying FBFM13 to the crops will have certain errors in choosing the optimum model for some crops.
4	KINGS	
5	KERN	
6	SAN JOAQUIN	
7	TULARE	
8	COLUSA	Future analysis could explore more into the agricultural fire risk based on this research by using a more agricultural-centric fire behavior fuel model, which uses growing crops as the main fuel groups in building the fire models.
9	YOLO	
10	MONTEREY	

Table 2:
Top 10 "Agriculturally Flammable" Counties



Weighted Fire Risk

- USDA National Agricultural Statistics Service

- 2021 California Cropland Data Layer | NASS/USDA

- LANDFIRE (LF), Landscape Fire and Resource Management Planning Tools, a shared program between the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior, providing landscape scale geospatial products to support cross-boundary planning, management, and operations.

LF2020 [LF 2.2.0] version of the data.

Data Source

Results & Discussion

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UEP 232 INTRO TO GIS

July 5, 2022 Summer Semester

Coordinate System:

NAD 1983 Contiguous USA Albers

Projection: Albers (Meters)