



Forest Service  
U.S. DEPARTMENT OF AGRICULTURE

# Spring 2025 CSU Hackathon

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March 28, 2025

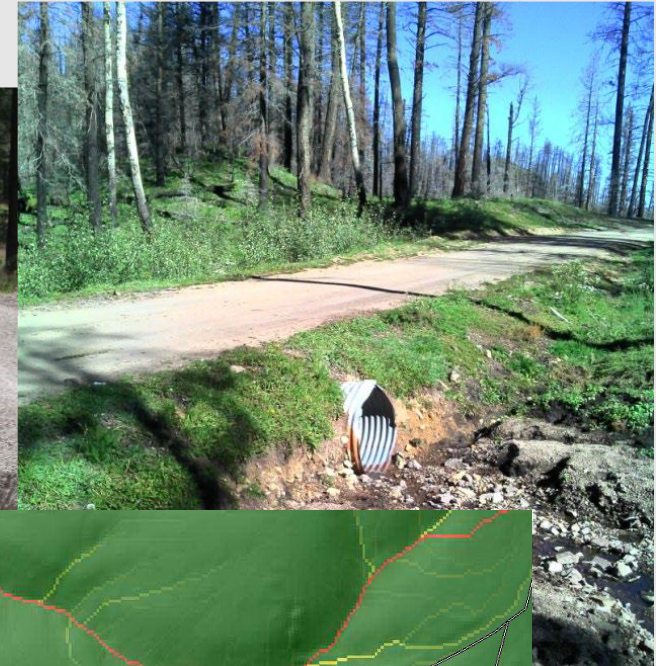
# Prompt 1: Uncharted Challenge

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- Objective
  - Train an AI model to map uncharted roads from lidar imagery. The data package includes high-resolution imagery (digital terrain model and hillshade), and an accurate road network for the same area. This task introduces participants to developing foundational AI models using high-resolution imagery.
- Purpose
  - Road networks on Forest Service and adjacent lands are critical for a variety of purposes ranging from forest management to wildfire suppression to transportation management to recreation.

# Why are FS road data important?

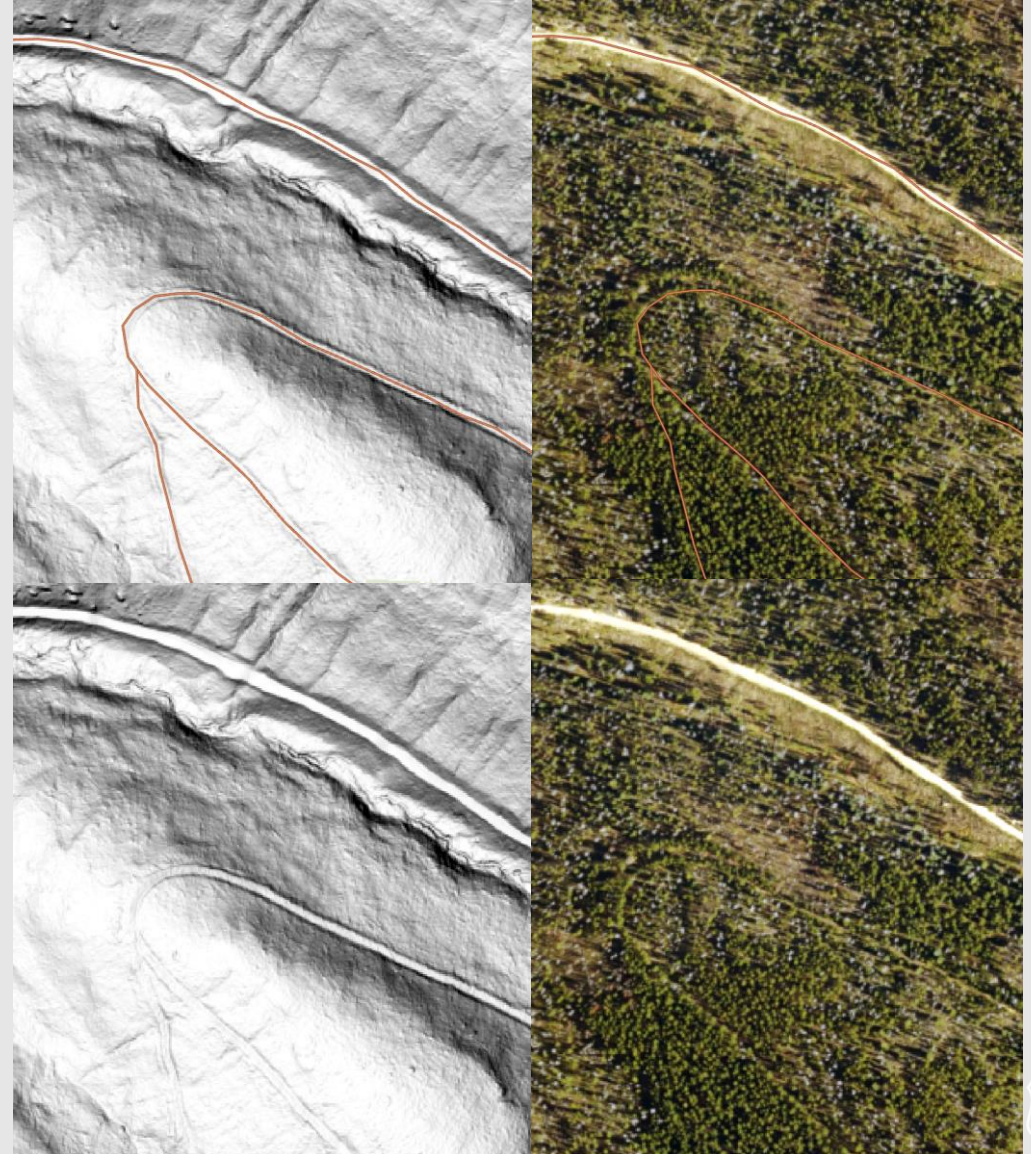
- Basic infrastructure to serve the many objectives of land management
- Good roads data provides benefits to...
  - Wildland fire planning and response
    - Access, fuel breaks, firefighter safety
  - Forest planning
  - Forest management / Silviculture
    - Forest thinning and fuel treatment location and access
  - Recreation
  - Hydrology
  - SAFETY





# Why are existing data lacking?

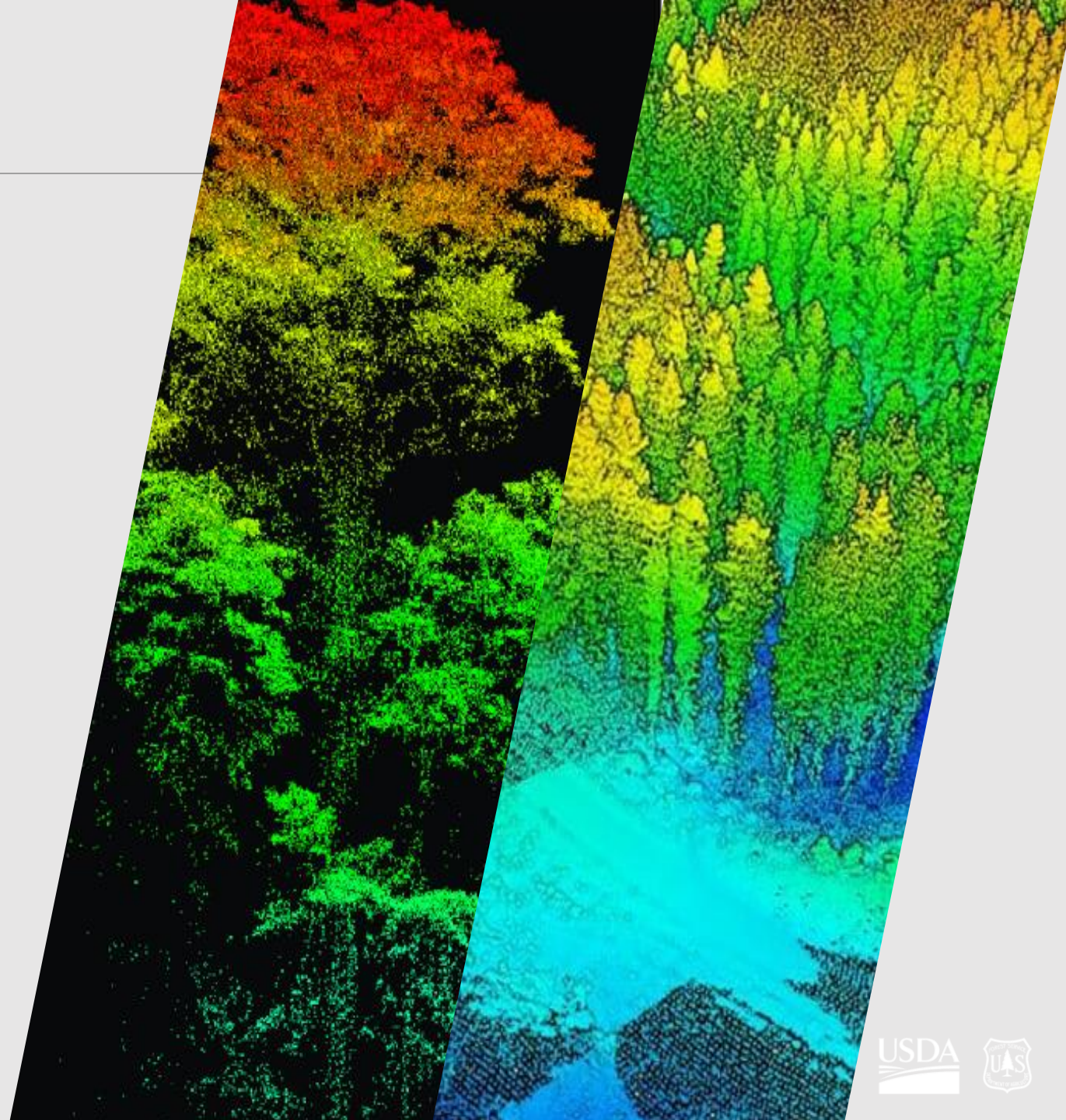
- Deficiencies/Challenges
  - Existing corporate road network data is incomplete and spatially inaccurate by today's standards.
  - Current best practices involve labor intensive on-screen digitizing and costly GPS mapping for updating and creating more accurate and precise road features.
- Automation and remotely sensed data
  - Roads can be obscured in traditional imaging (e.g., rgb) by tree canopies or other vegetation.
  - Roads can appear spectrally similar to other exposed soil, making spectral separation difficult.





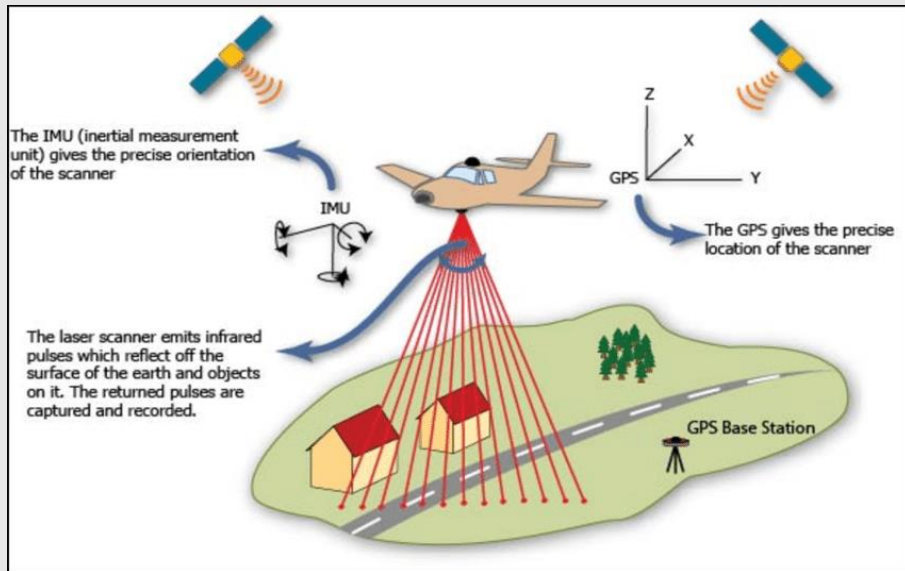
# What is LiDAR?

- Light Detection and Ranging (LiDAR)
- LiDAR is a remote sensing technology that uses laser pulses to measure the distance to objects.
- It is used by the FS to inform resource managers and specialists about existing topography and vegetation conditions of National Forests.
- FS and USGS support the acquisition and application of LiDAR data across the US.





# Lidar Platforms



Airborne Laser Scanning  
(ALS)



Terrestrial Laser Scanning  
(TLS)



Unoccupied Aerial Systems  
(UAS)

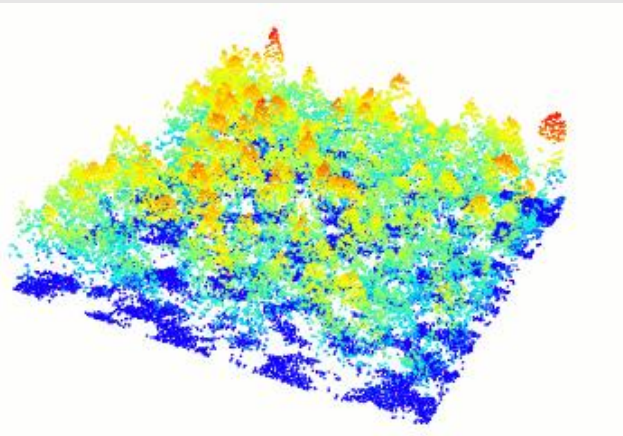
# LiDAR derivatives

## First order derivatives

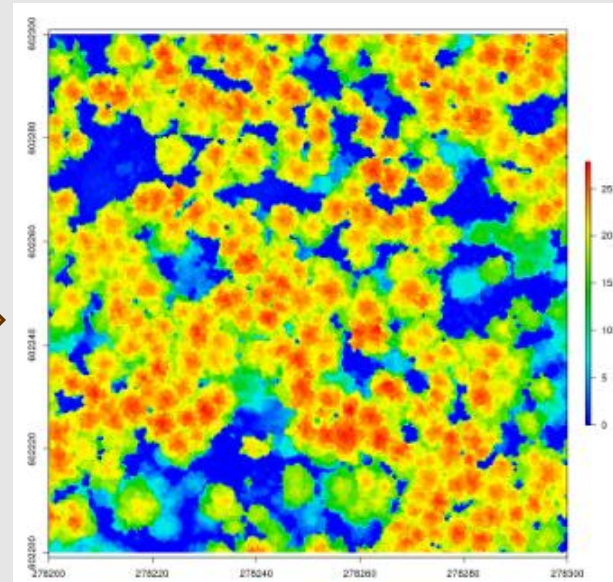
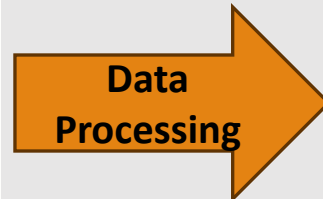
*Simple workflows that require appropriate software and hardware*

## Second order derivatives

*Might require field data  
Collaboration with -ologists  
Statistical modeling*

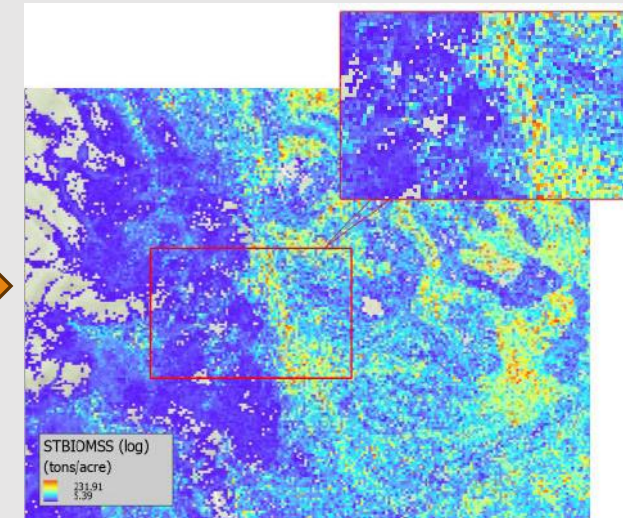
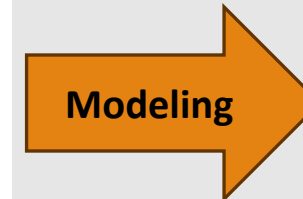


Raw Lidar point clouds



### Digital Elevation Model (DEM)

Digital Surface Model  
Canopy Height and Cover  
Individual Tree Crowns  
Point Cloud Metrics

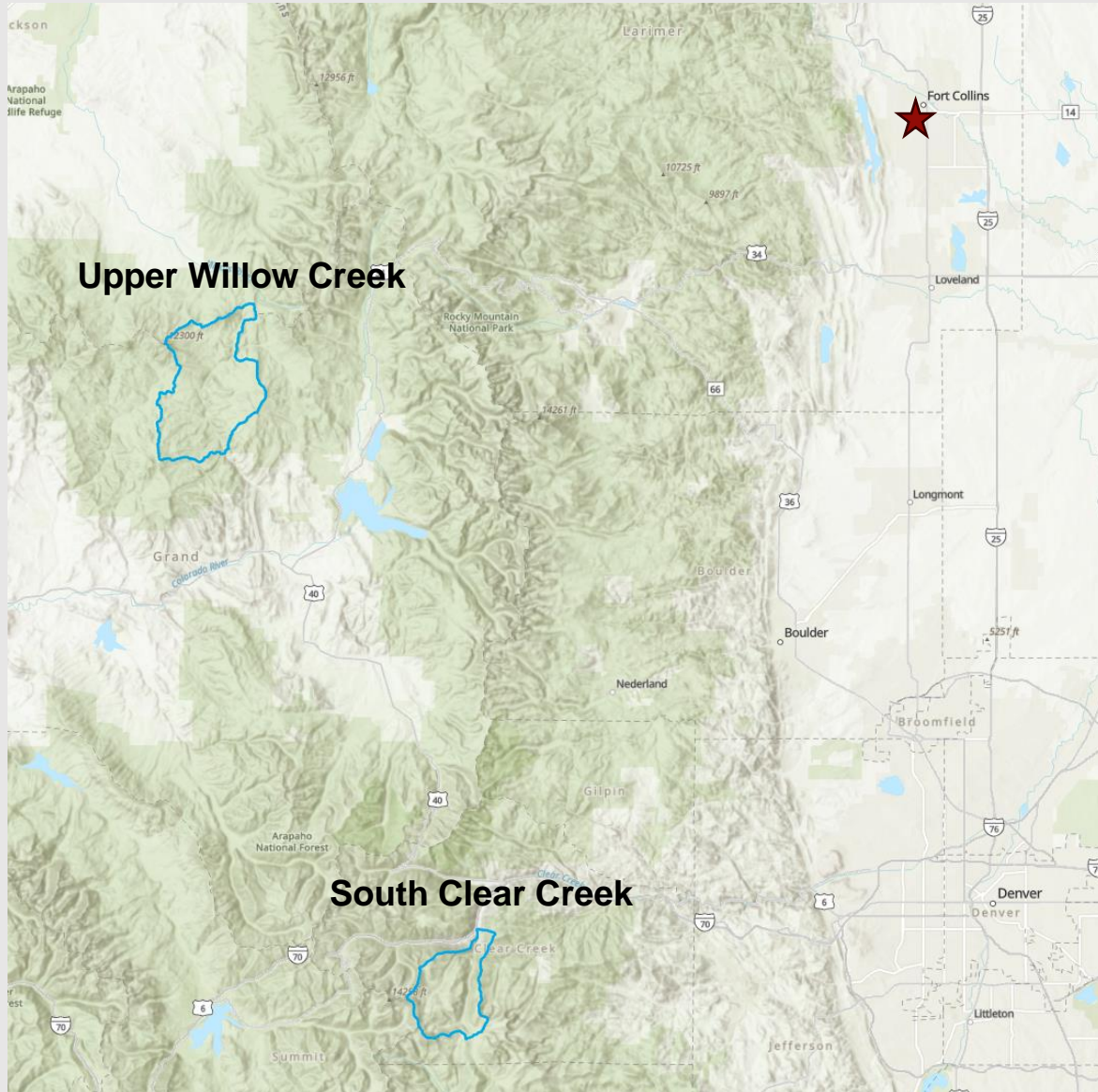


### Roads!!

Biomass, Volume, Fuels  
Change detection  
Wildlife habitat



# The Study Areas



Arapaho & Roosevelt National Forest

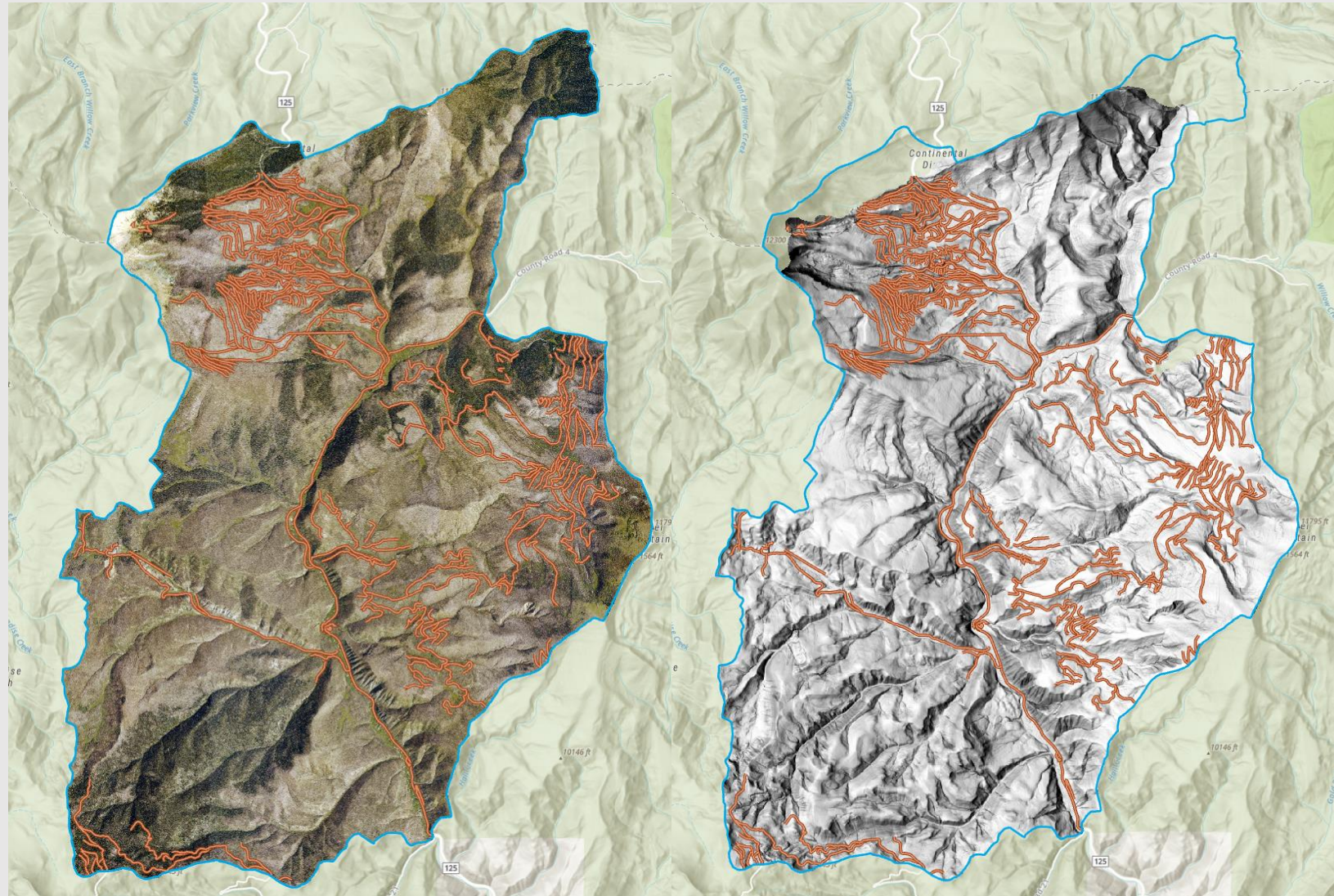
2 HUC-12 Watersheds

LiDAR data from 2020 and 2023



# Upper Willow Creek Watershed

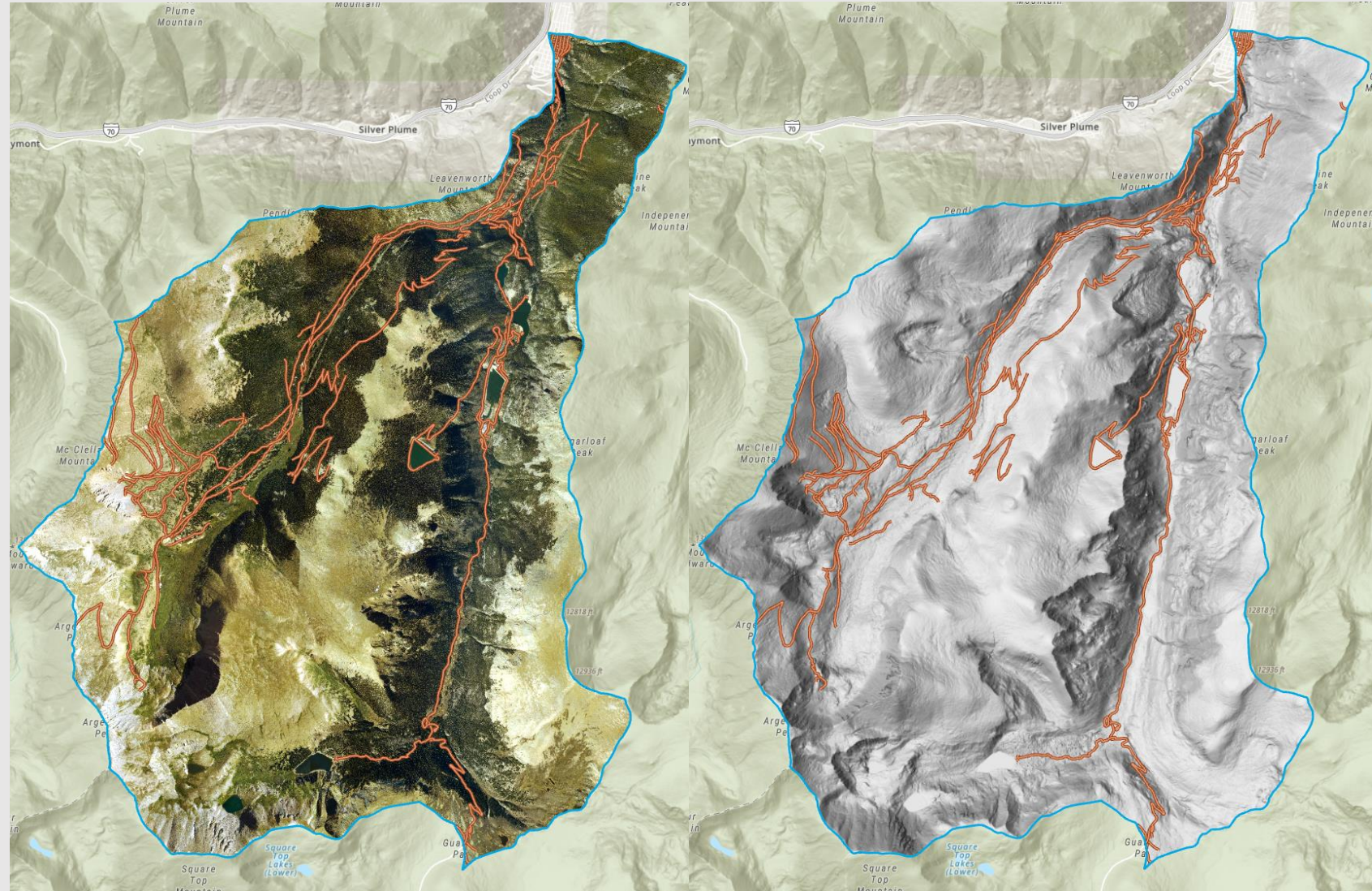
- Lidar from 2023
- Burned during the East Troublesome Fire in 2020
- Past timber removal
- Dataset
  - LiDAR bare earth DEM (GeoTIFF; 1m resolution)
  - DEM Hillshade (GeoTIFF; 1m resolution)
    - $255.0 * ((\cos(\text{Zenith\_rad}) * \cos(\text{Slope\_rad})) + (\sin(\text{Zenith\_rad}) * \sin(\text{Slope\_rad}) * \cos(\text{Azimuth\_rad} - \text{Aspect\_rad})))$
  - 2023 NAIP imagery (GeoTIFF; 1m resolution)
  - Digitized roads (shapefile)
  - Digitized roads mask (GeoTIFF; 1m resolution)
  - Watershed boundary (shapefile)





# South Clear Creek Watershed

- Lidar from 2020
- Past mining activity
- Dataset
  - LiDAR bare earth DEM (GeoTIFF; 1m resolution)
  - DEM Hillshade (GeoTIFF; 1m resolution)
    - $255.0 * ((\cos(\text{Zenith\_rad}) * \cos(\text{Slope\_rad})) + (\sin(\text{Zenith\_rad}) * \sin(\text{Slope\_rad}) * \cos(\text{Azimuth\_rad} - \text{Aspect\_rad})))$
  - 2023 NAIP imagery (GeoTIFF; 1m resolution)
  - Digitized roads (shapefile)
  - Digitized roads mask (GeoTIFF; 1m resolution)
  - Watershed boundary (shapefile)







# Forest Service

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