Overview and Access of Digital Elevation Models (DEM)

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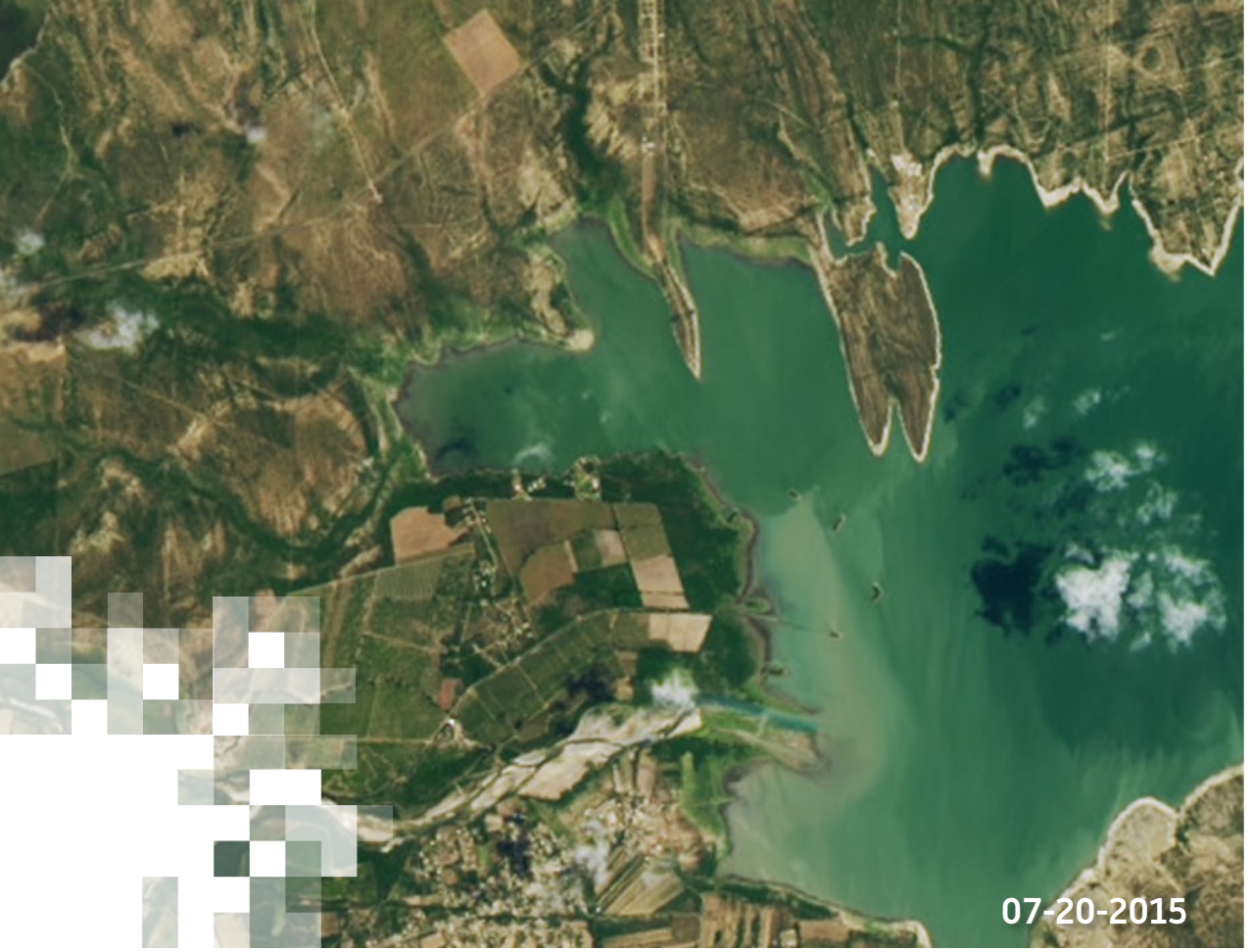
Learning Objectives

By the end of this presentation, you will be able to:

- Compare SRTM, ASTER, and TanDEM-X missions for using Digital Elevation Models (DEM)
- Access DEM for flood management applications



Satellites and Sensors for Digital Elevation Models (DEM)

Shuttle Radar Topography Mission (SRTM)

- C-band (5.6 cm) radar mission
- Payload onboard Space Shuttle Endeavour
- Completed mission in February 2000
- 176 orbits around Earth over 11 days
- Acquired digital terrain elevation data of all land between 60°N – 56°S latitude
  - ~80% of Earth's total land mass

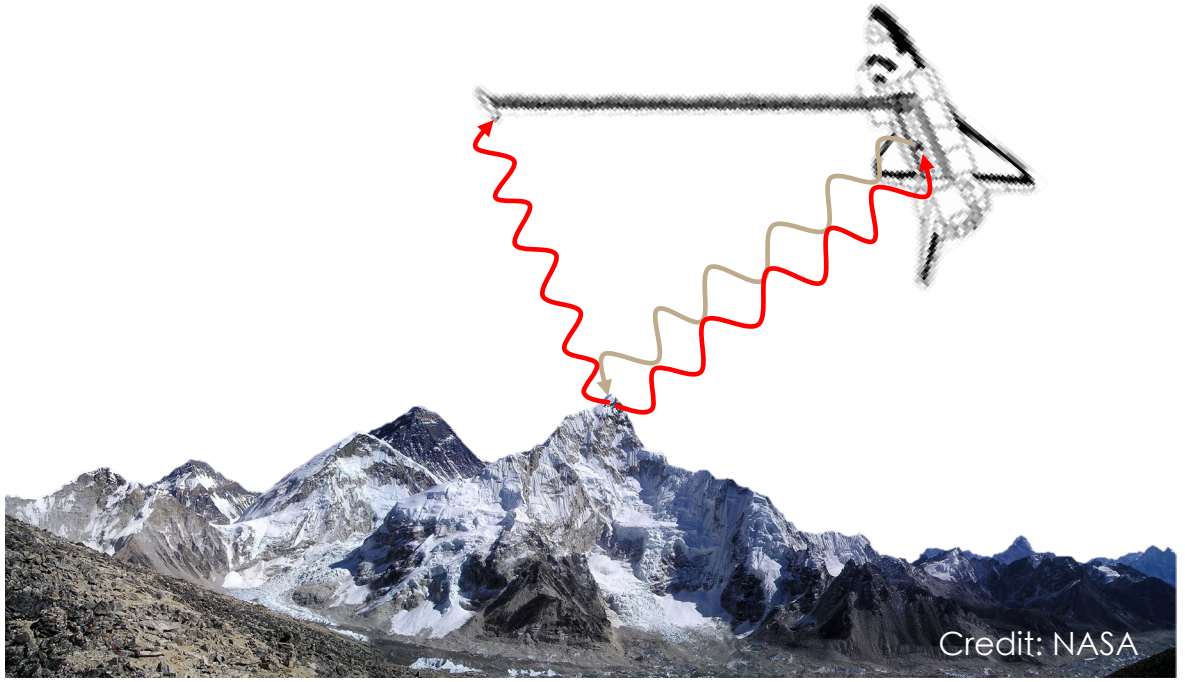
http://www2.jpl.nasa.gov/srtm/mission.htm

Credit: NASA

SRTM Digital Terrain Data

- SRTM used interferometry to gather topographic (elevation) data.
- Interferometry:
  - two radar images of the same area are taken from different views
  - the difference in the two images determines the height of the surface in the digital elevation model (DEM)
- As of 2015, terrain data are available at 1 arc second or 30 m spatial resolution.

http://www2.jpl.nasa.gov/srtm/instr.htm



Transmitted Wave

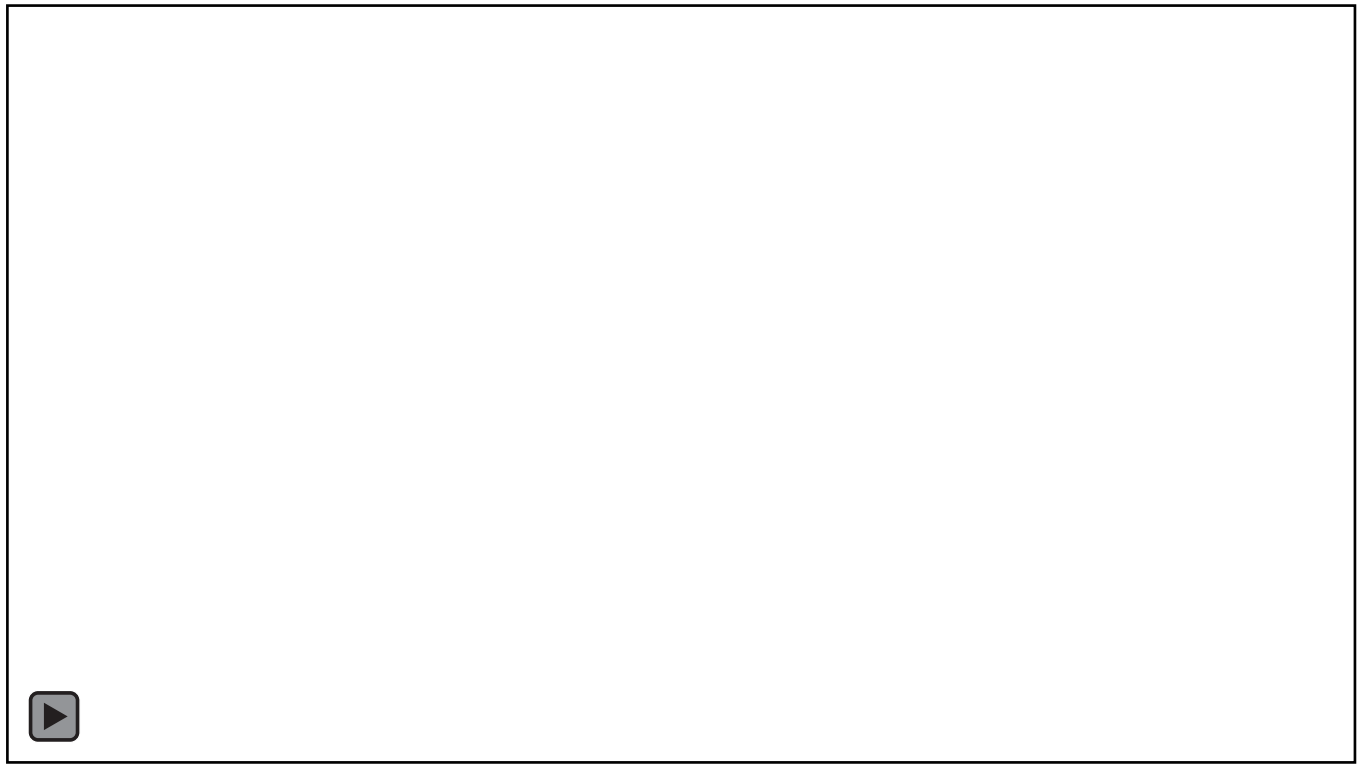
Received Wave

Radar signals being transmitted and received on the SRTM mission (not to scale)

Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

- Instrument onboard Terra satellite
  - Polar orbiting satellite launched Dec 1999.
- Spatial Resolution: 15 m, 30 m, 90 m
  - Global coverage
- Spectral Resolution (14 bands)
    - Bands 1–3: 15 m (VNIR)
    - Bands 4–9: 30 m (SWIR)
    - Bands 10–14: 90 m (TIR)

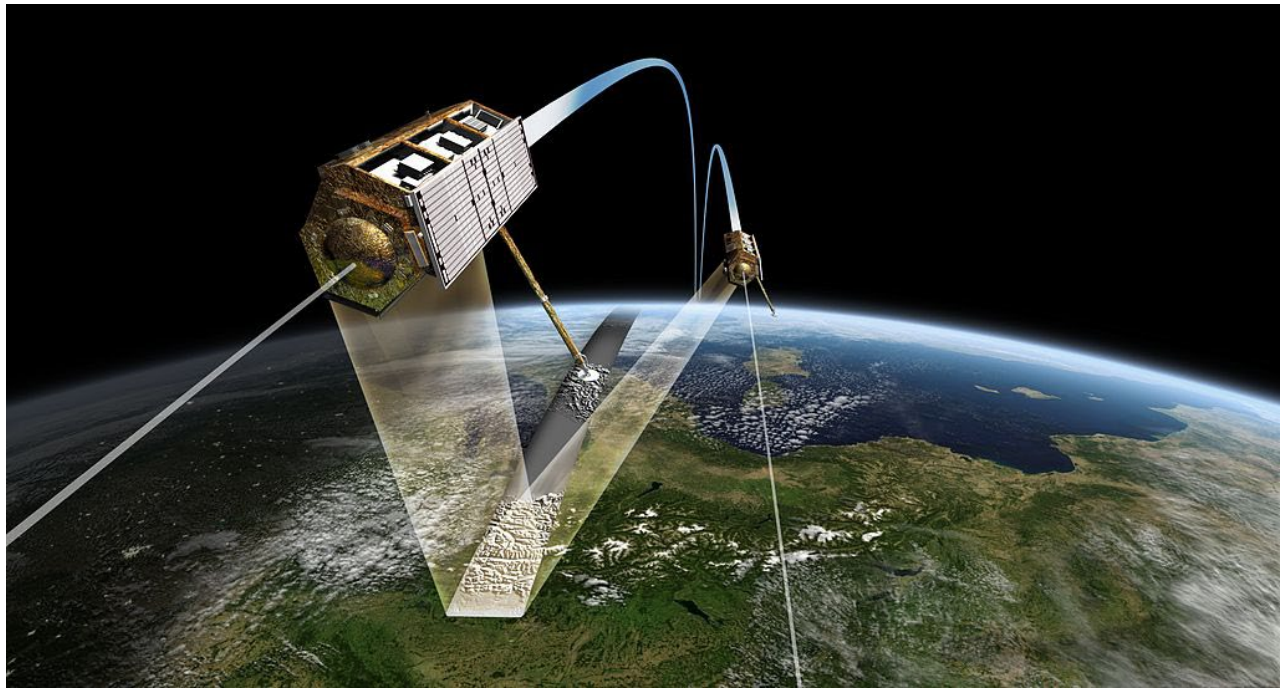
https://asterweb.jpl.nasa.gov/



This flyover of the Hawaiian island of Oahu was made by draping January 13, 2010, image data from the Advanced Spaceborne Thermal Emission Radiometer (ASTER) instrument on NASA's Terra spacecraft over new ASTER Version 2 digital elevation data.
Credit: NASA Science Visualization Studio (SVS)

TerraSAR-X add-on for Digital Elevation Measurement (TanDEM-X)

- Mission flying two identical satellites in a closely controlled formation with distances between 250 & 500 m
- Phased array SAR antenna (X-band wavelength ~3.1 cm, frequency 9.6 GHz
- Digital Surface Model (DSM) that represents the surface of the Earth including buildings, infrastructure and vegetation.
- Spatial resolution: 10 m (Europe), 30 m & 90 m (global)

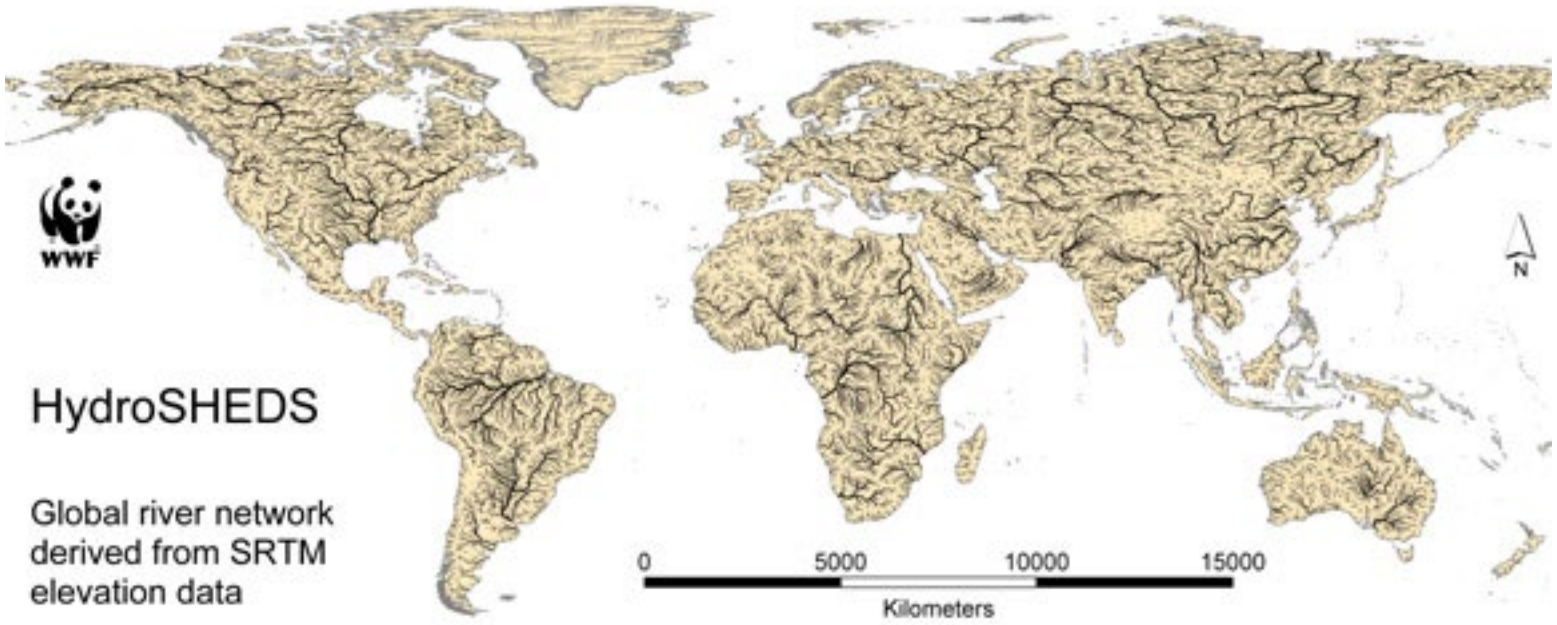


Credit: DLR

https://spacedata.copernicus.eu/en/web/guest/collections/copernicus-digital-elevation-model

DEM Applications

- Useful for mapping hazardous terrain
- Calculate:
  - slope and aspect
  - catchment area
  - forest canopy height
- Models:
  - runoff
  - stream networks
  - landslides



Credit: USGS HydroSHEDS

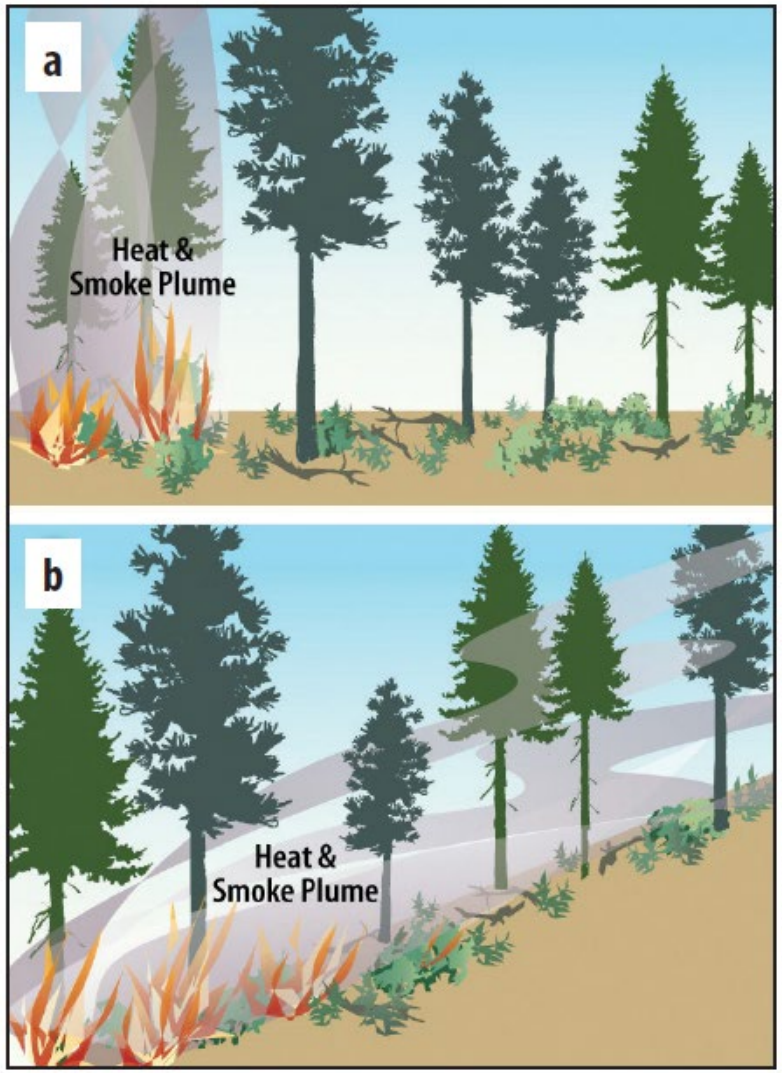
Elevation

- Elevation Impacts:
  - Amount and timing of precipitation
  - Wind exposure
  - Seasonal drying of fuels
  - Lightning strikes
- Examples: Lower elevations tend to dry out faster, thus they experience increased fire spread.

This perspective view, combining a Landsat image with SRTM topography, shows topography. Image Credit: NASA

Slope

- Increased Slope = Faster Fire Spread
- Slope Position: Where does the fire have room to move?
  - Fires that start at the bottom of the slope have greater area to spread.
  - As heat rises in front of the fire, it more effectively preheats and dries upslope fuels, making for more rapid combustion.



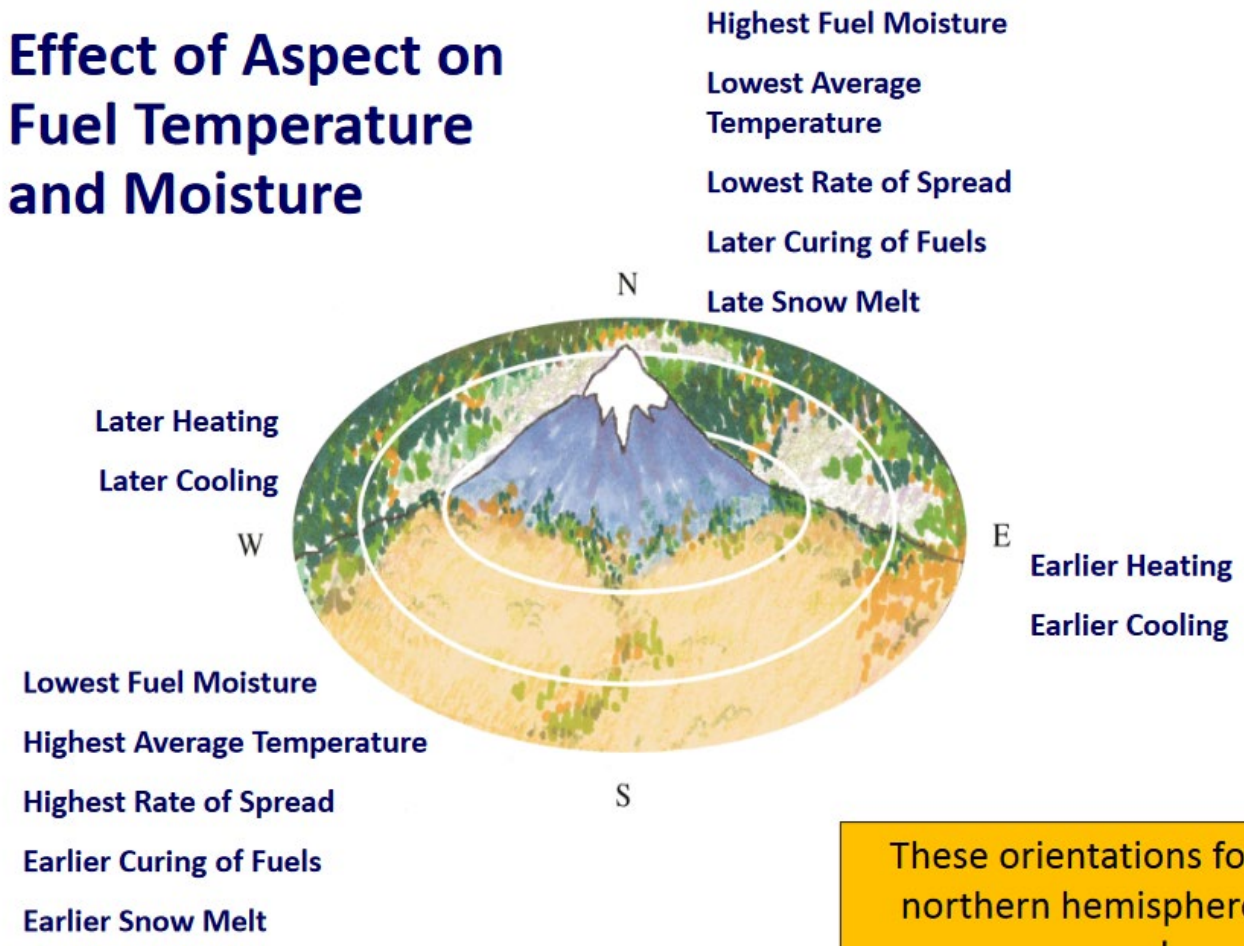
Fires spread more quickly uphill. Image Credit: Fitzgerald, Oregon State University

Stephen Fitzgerald, Oregon State University.

Uphill fire scars. Image Credit: University of Arizona

Aspect

- Direction of the Slope
  - Solar Radiation
    - Example: South-facing slopes have higher solar radiation and drier fuels.
  - Vegetation Type
    - Example: South and West facing slopes have less vegetation.

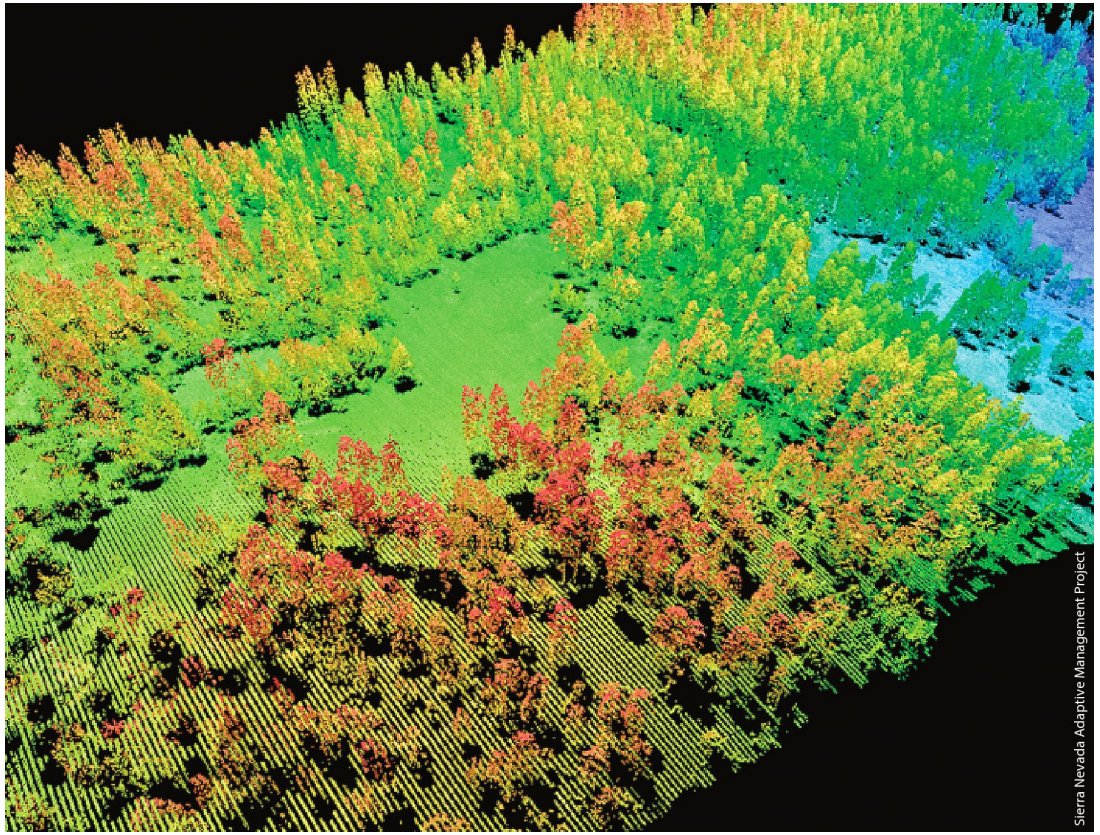


These orientations for the northern hemisphere, of course!

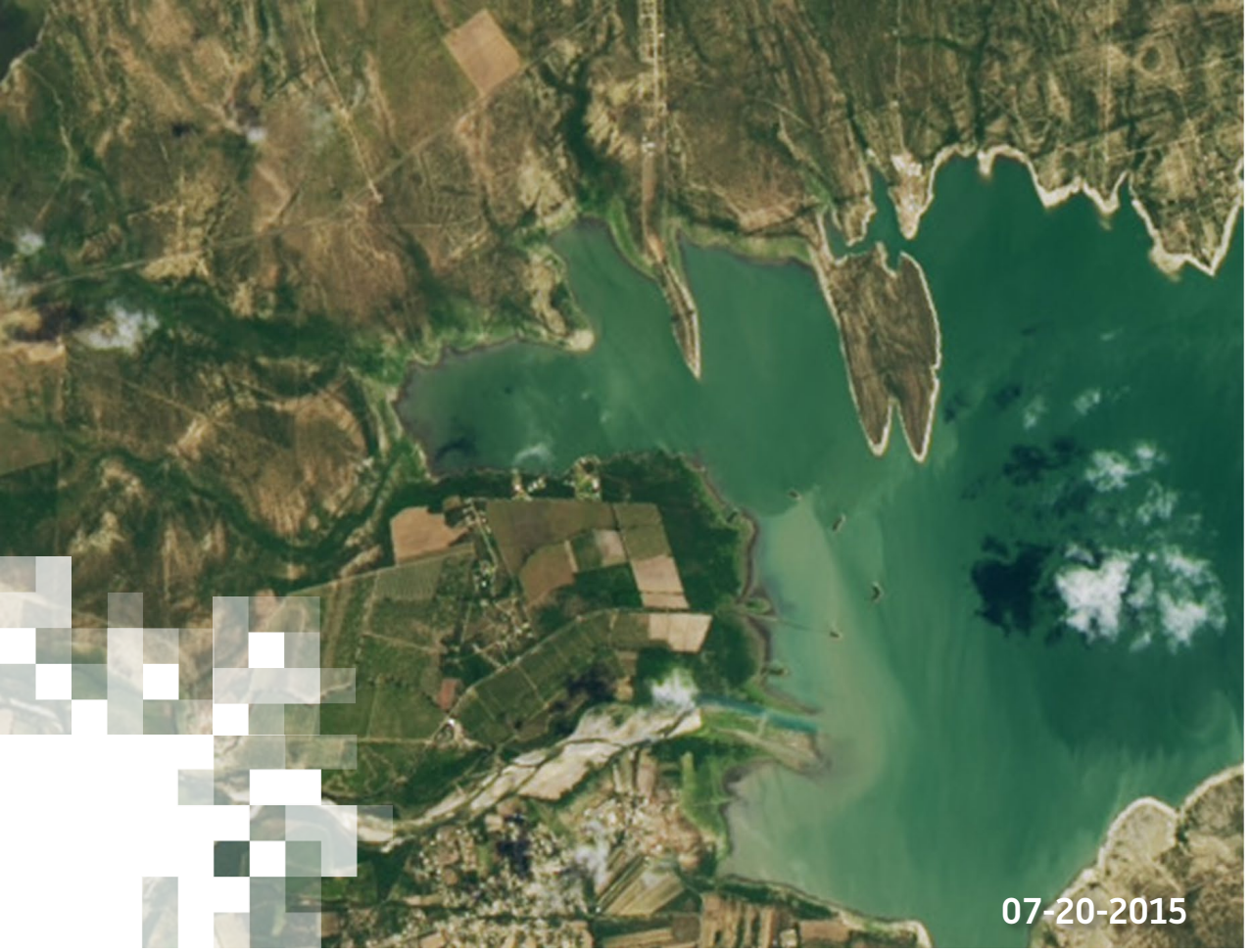
Image Credit: University of Arizona

Canopy Height and Density

- The vertical and horizontal distribution of plant material in a forested ecosystem is a driver of fire spread.
- Canopy structure influences fire dynamics directly as fuel and indirectly through its influence on other variables in the fire environment, like fuel moisture below the canopy.
- Synthetic Aperture Radar (SAR) and Airborne Light Detection and Ranging (LiDAR) data can assess canopy structure over large areas.



Lidar points show trees in the Sierra National Forest, where much of the research on remote sensing has occurred. Image Credit: Keley and Tommaso, 2015



Data Acquisition of Digital Elevation Models (DEM) in GEE JavaScript