



Ethiopia Ecological Forecasting

Mapping Four Decades of Fire History
for Targeted Conservation in the
South-Central Highlands of Ethiopia



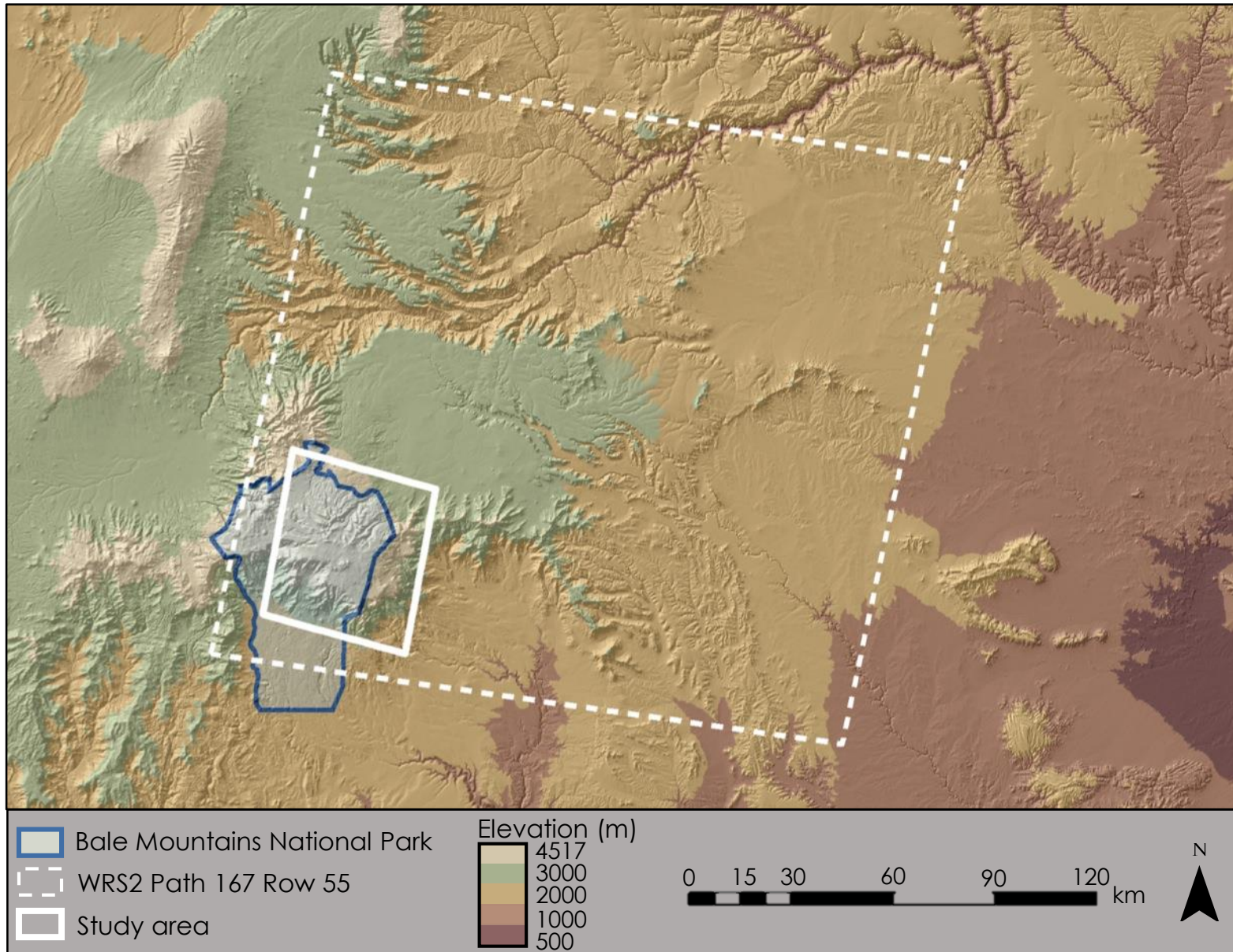
Stephen Chignell (Project Lead)

Kelly Hopping

Chandra Fowler

Darin Schulte

Bale-Arsi Massif, Ethiopia





Community Concerns

- **Positive** effects of intentional burning on social-ecological system functioning
- **Negative** effects of increased fires on wildlife habitat and soil erosion
- **Negative** consequences of forced burning cessation



- **Efficacy** of past and future conservation efforts
- **Limited** capacity and data availability

Objectives

- **Quantify** fire extent and distribution on the Bale-Arsi massif over a 42-year time period
- **Provide** land managers with the most current and complete record of fires in the region

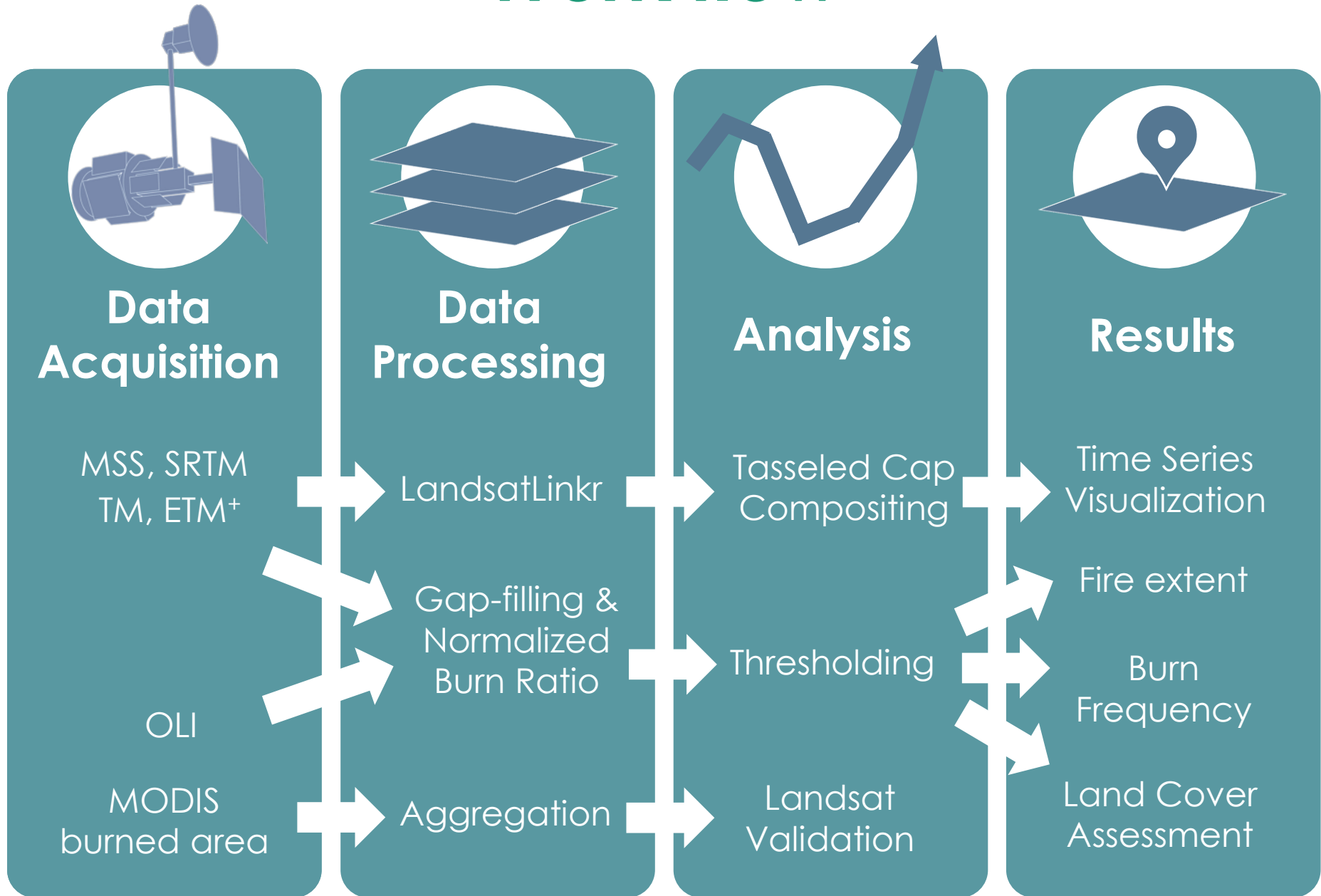


- **Compare** patterns of burning to observed land changes
- **Demonstrate** a reproducible methodology

Methodology



Work flow



Earth Observations

**Terra/Aqua
MODIS**

**Shuttle Radar
Topography Mission
(SRTM)**

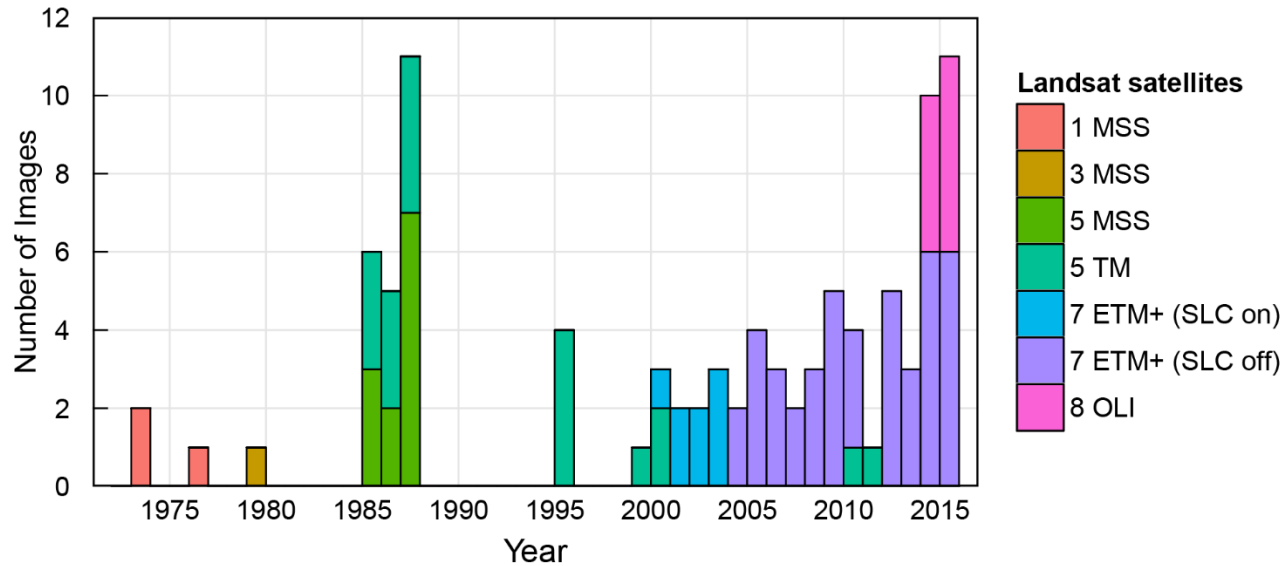
**Landsat 1, 3
Multispectral Scanner
(MSS)**

**Landsat 5
Thematic Mapper
(TM)**

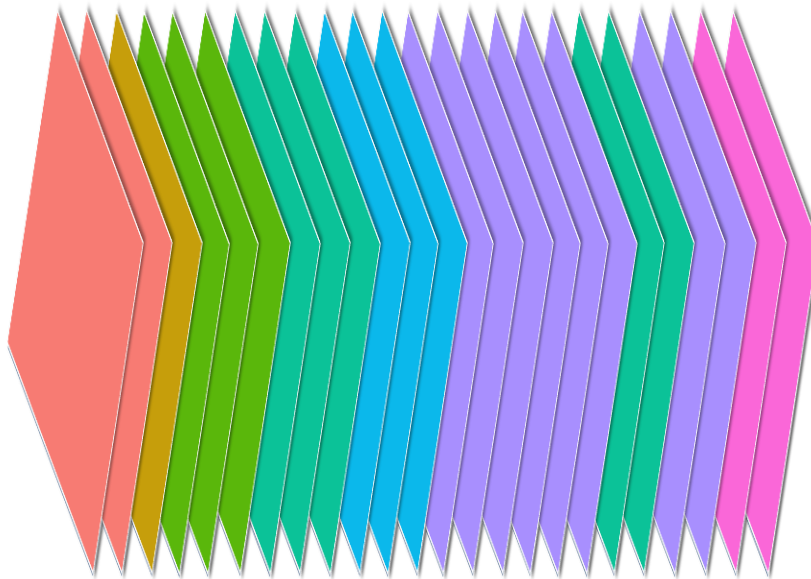
**Landsat 7
Enhanced Thematic
Mapper (ETM+)**

**Landsat 8
Operational Land
Imager (OLI)**

Data Acquisition & Pre-processing



LandsatLinkr



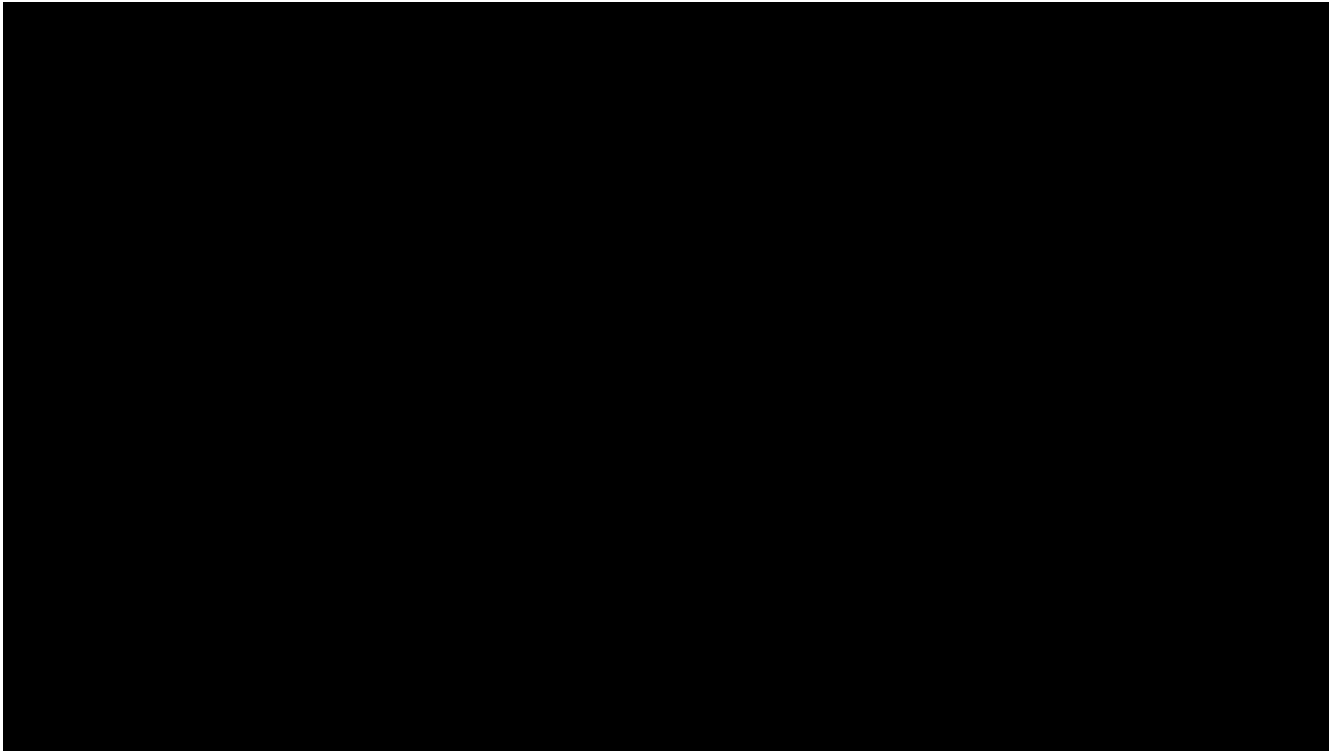
Atmospheric
correction

Cloud mask

Georegistration

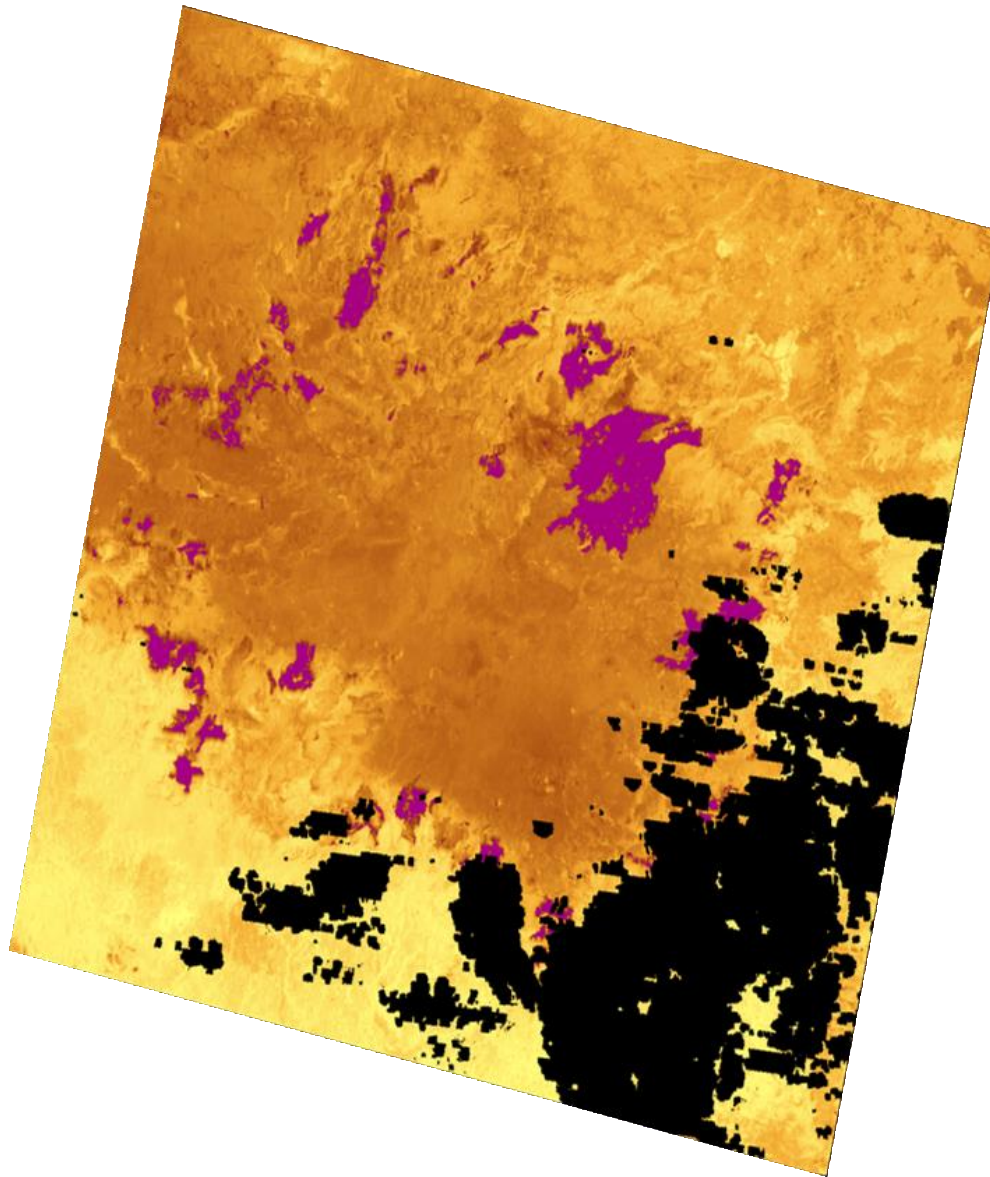
Spectral calibration

Tasseled cap visualization (1973-2015)

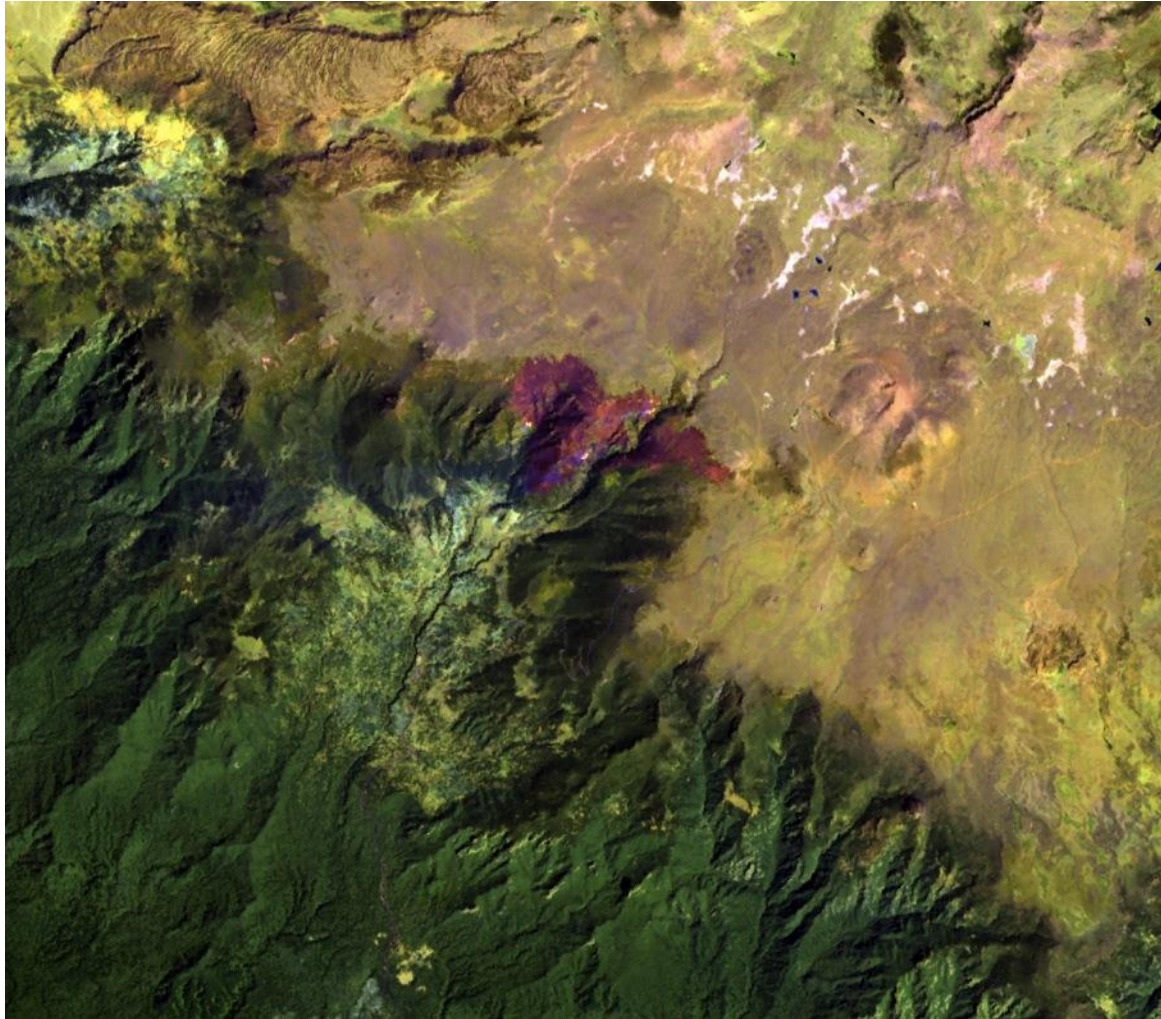


Brightness + Greenness + Wetness

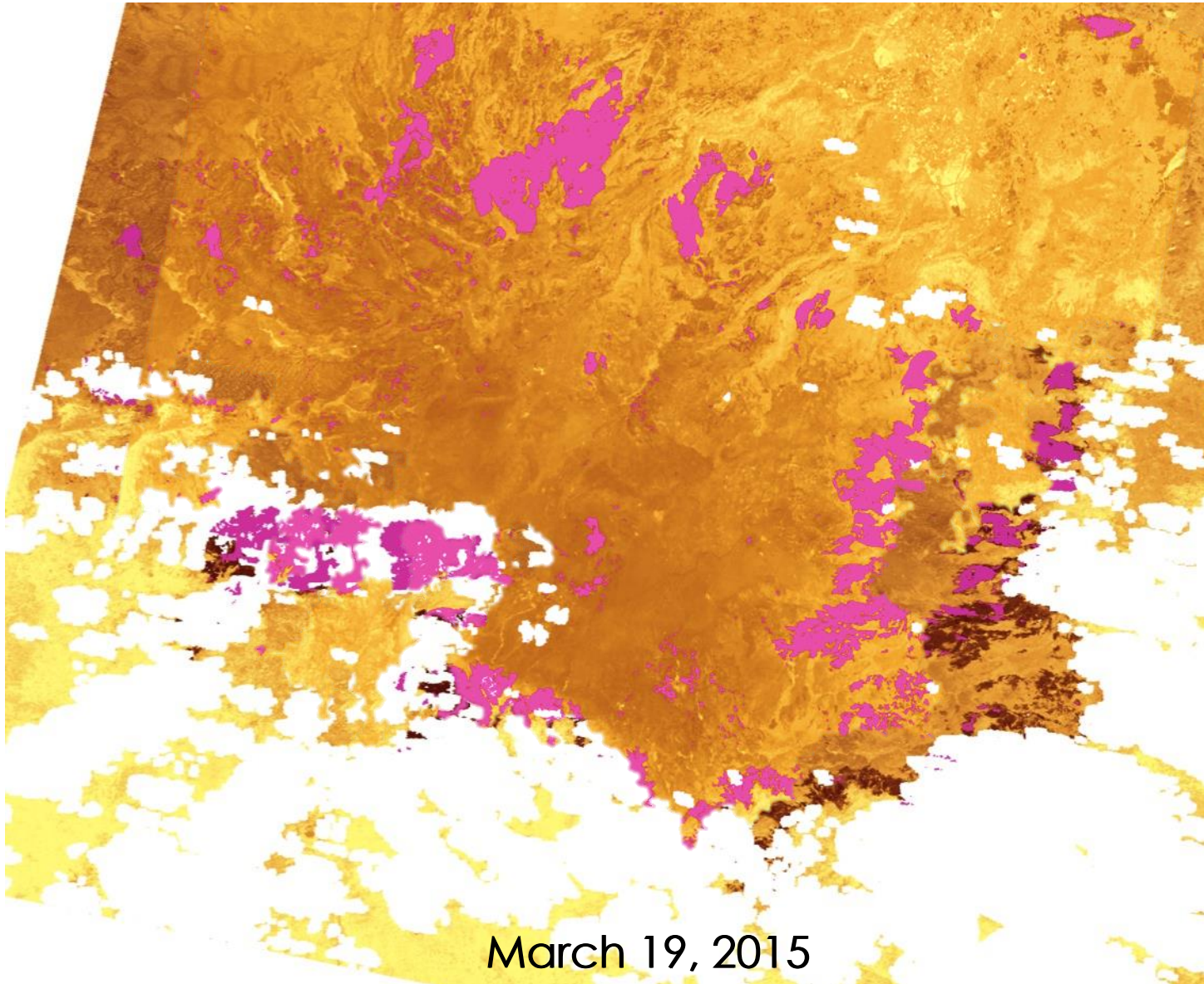
Burned area mapping (1995-2015)



Gap-filling burned areas



Detecting burned areas with clouds



Post-processing

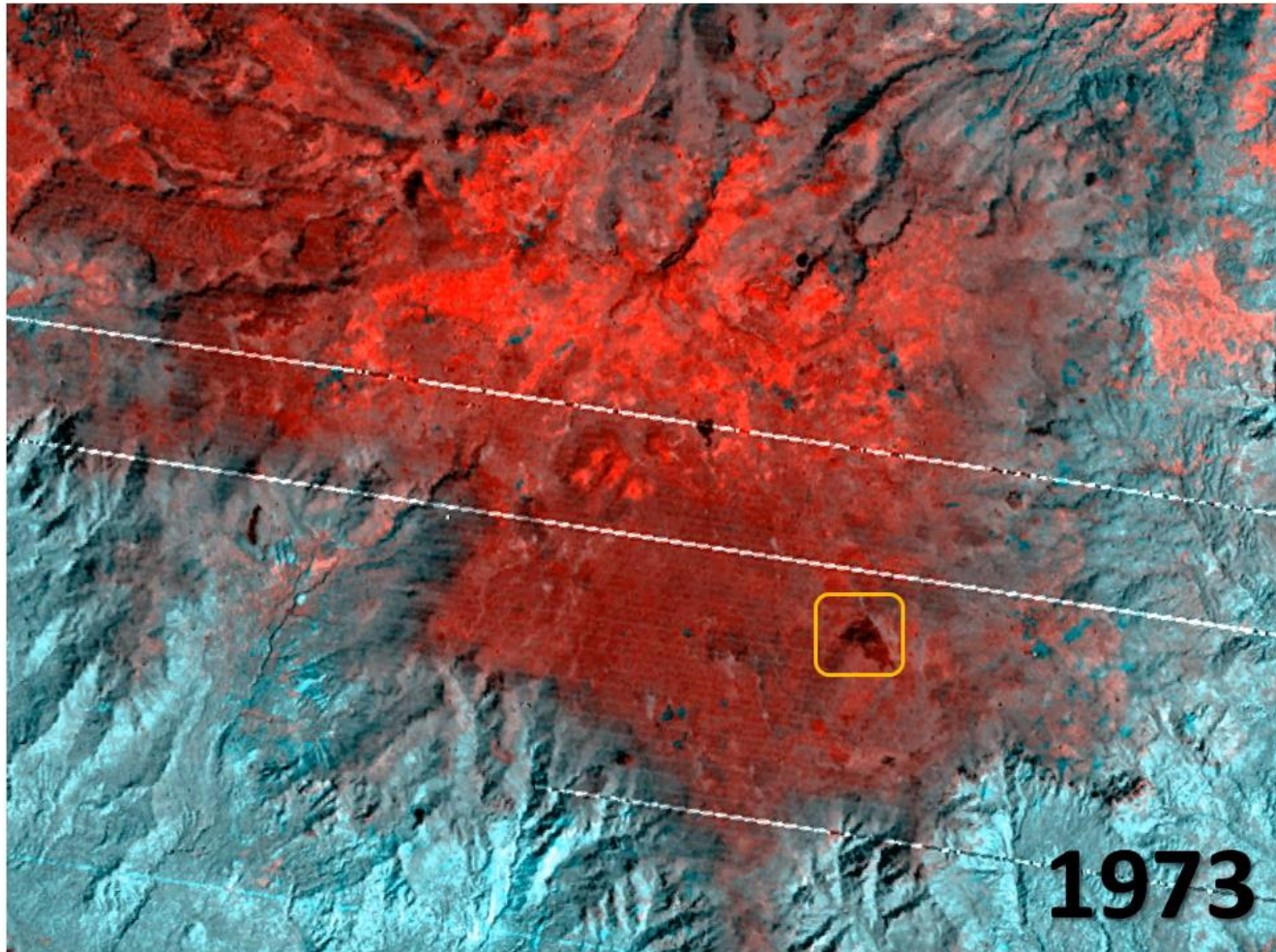
- **Aggregate** burned areas within each year
- **Clip** to areas higher than 3000 m
- **Sieve** out burned areas < 1 hectare (11 pixels) to eliminate noise
- **Remove** erroneous burned areas detected on Tulu Deemtu



Results



Time series visualization



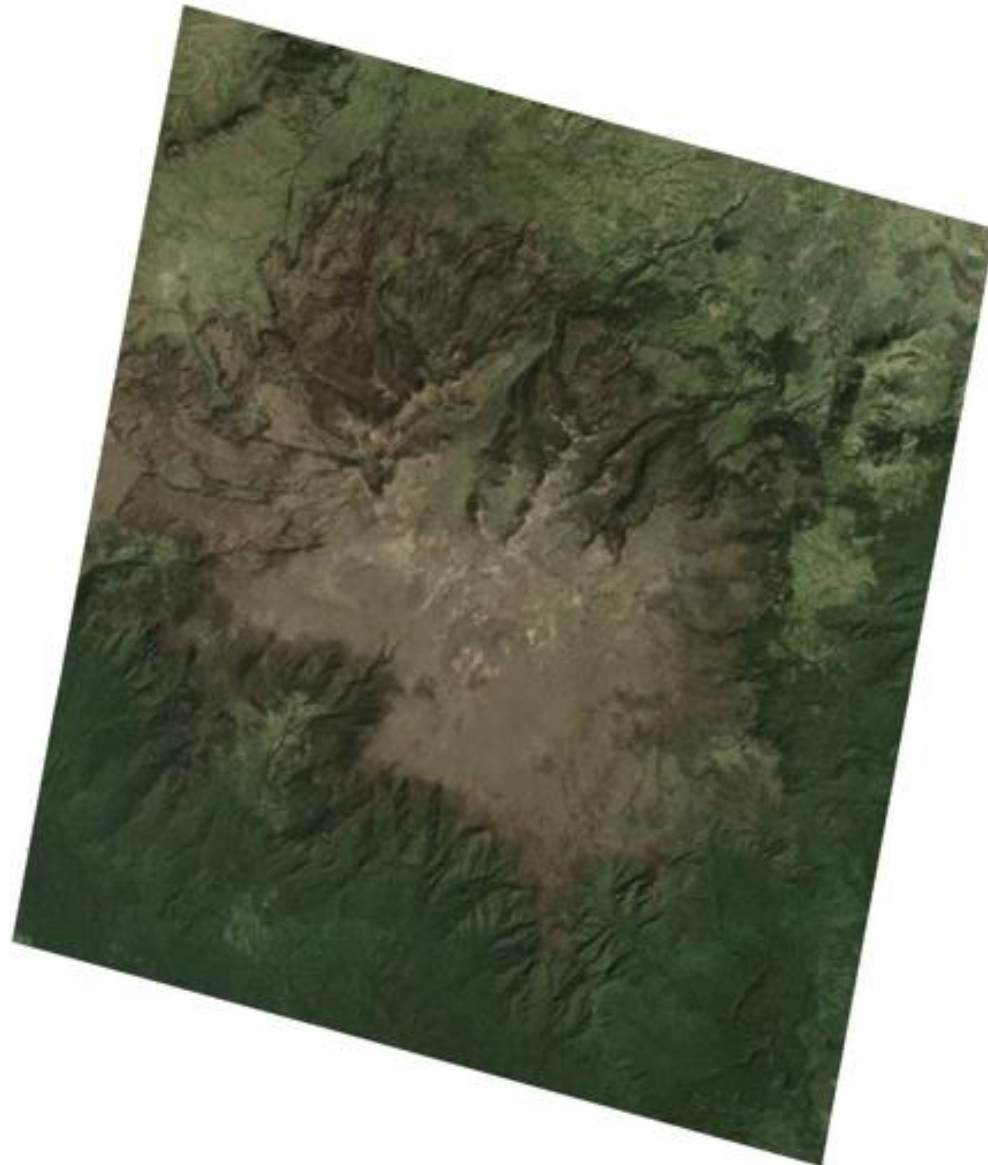
Landsat & MODIS spatial extents

-  Landsat NBR
-  MODIS MCD45A1
-  MODIS MCD64A1
burned area
covered by clouds
(86 km²)

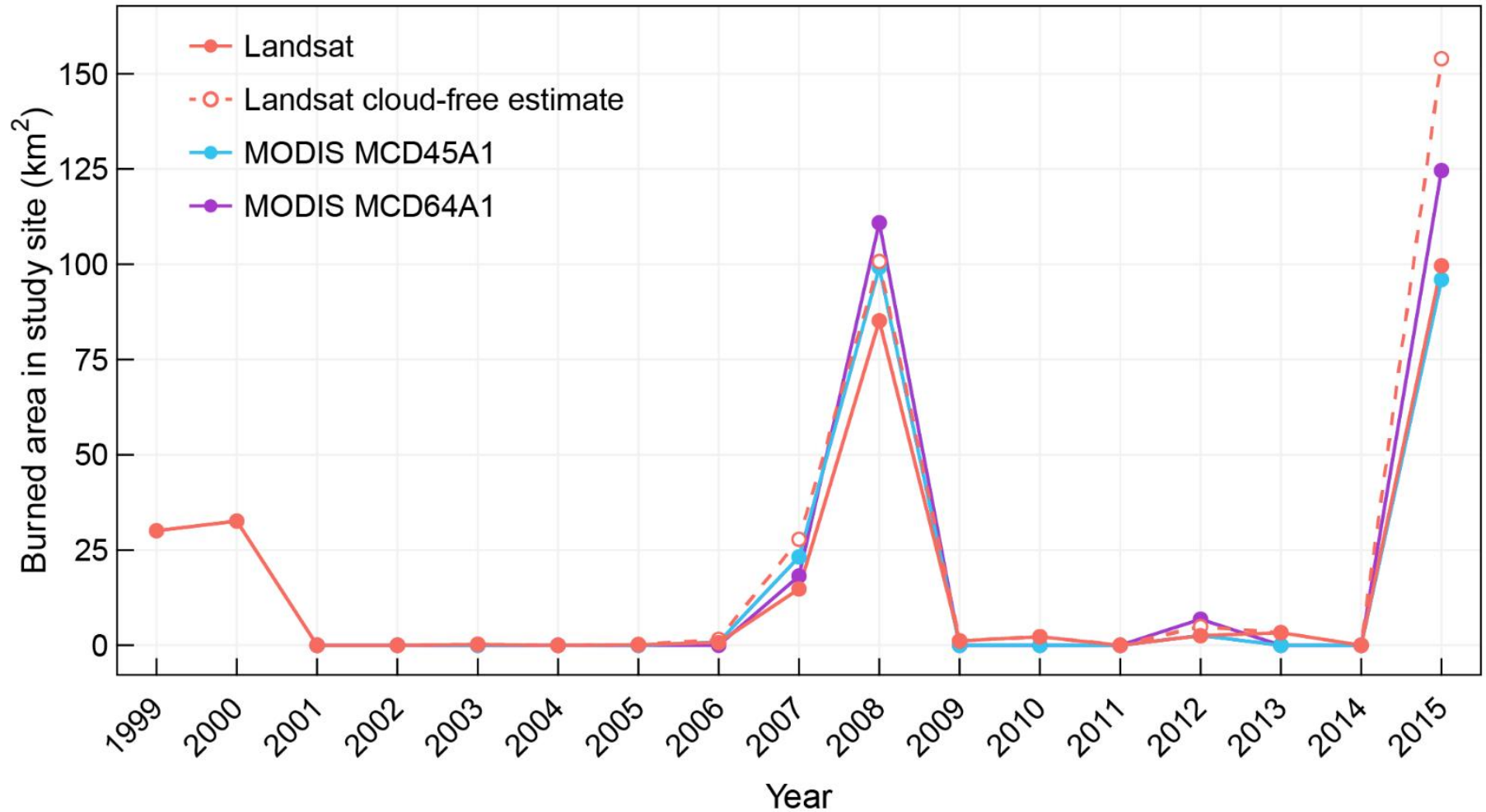
Landsat: 274 km²

MCD45A1: 260 km²

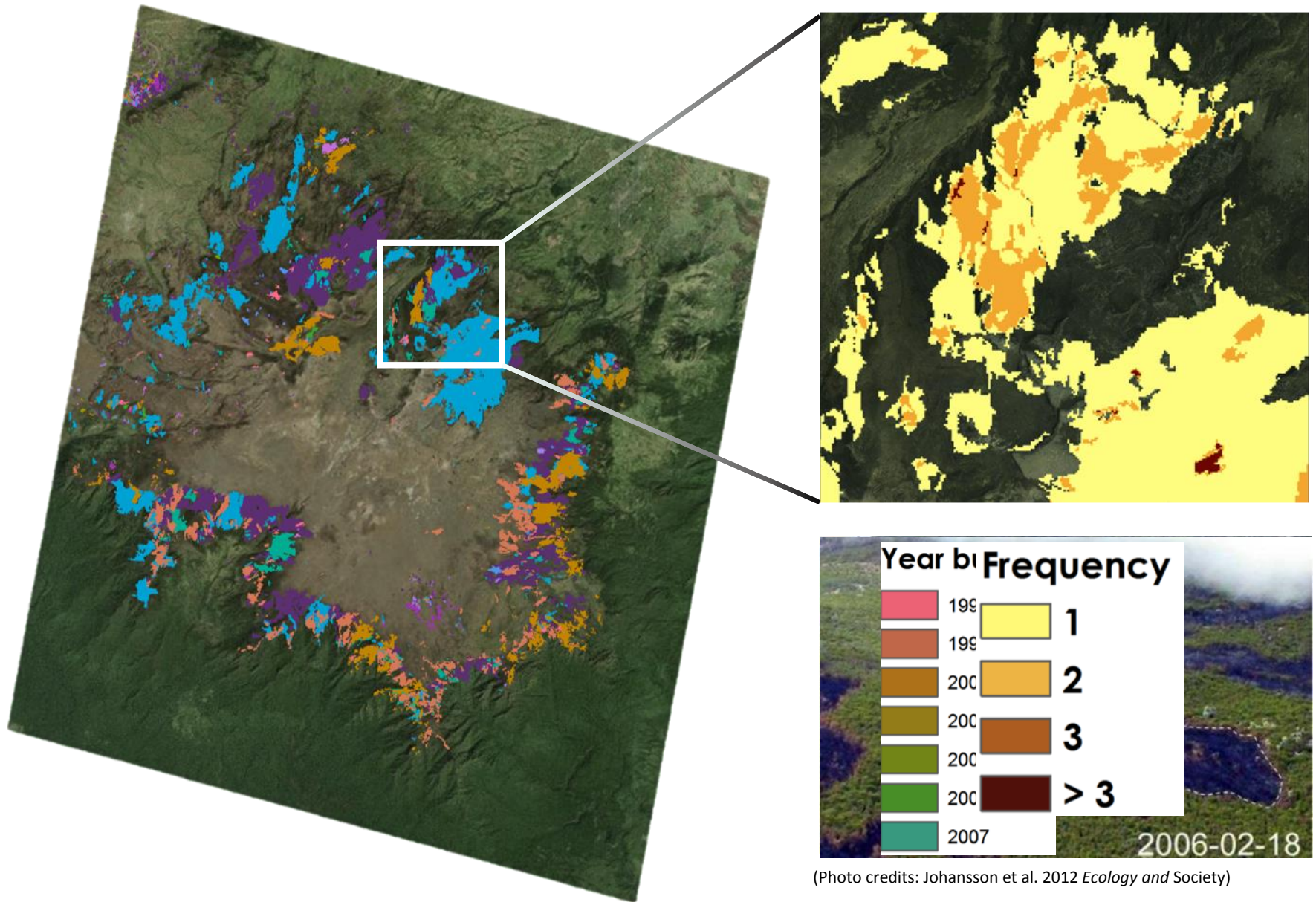
MCD64A1: 222 km²



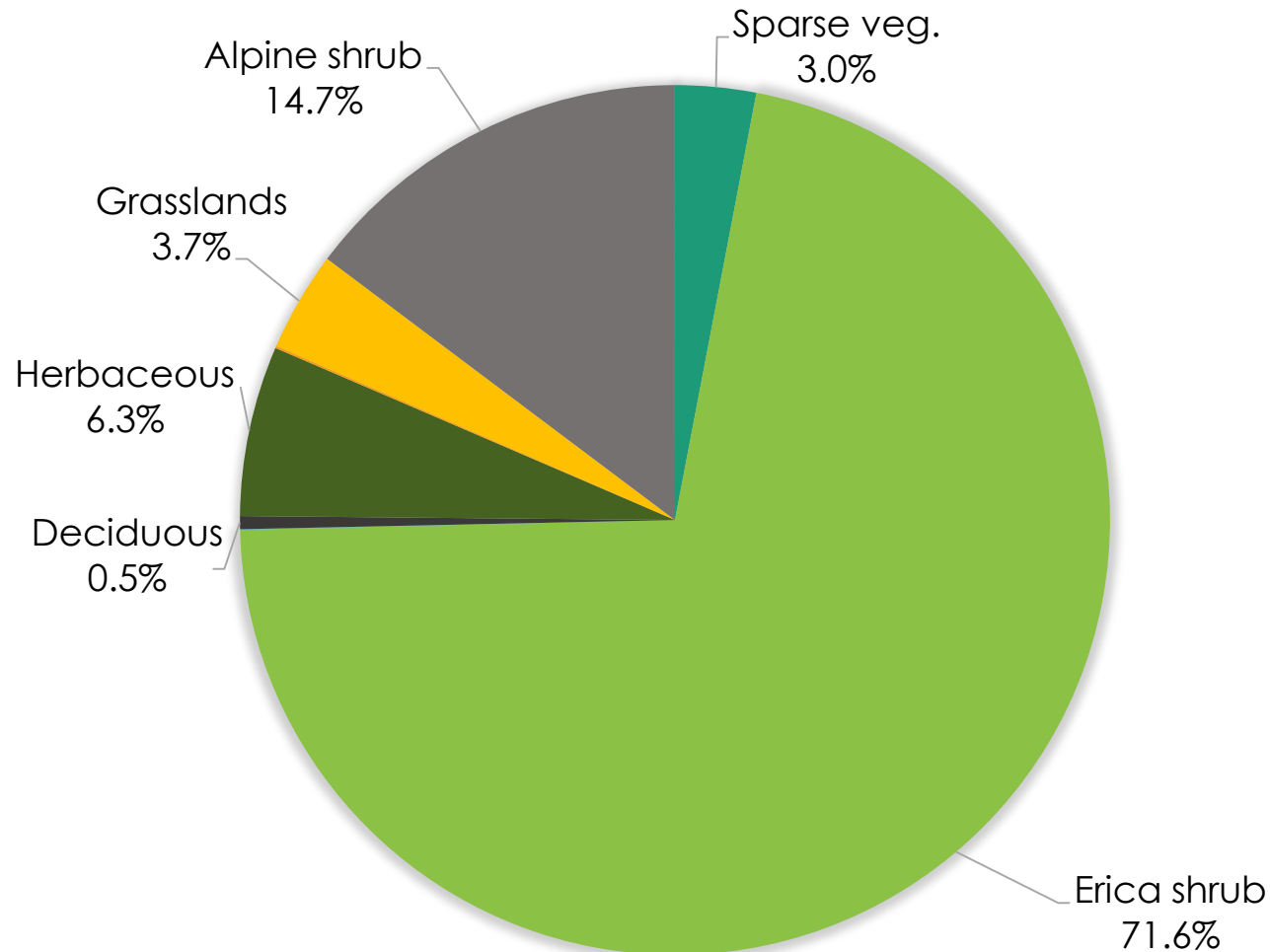
Landsat and MODIS time series



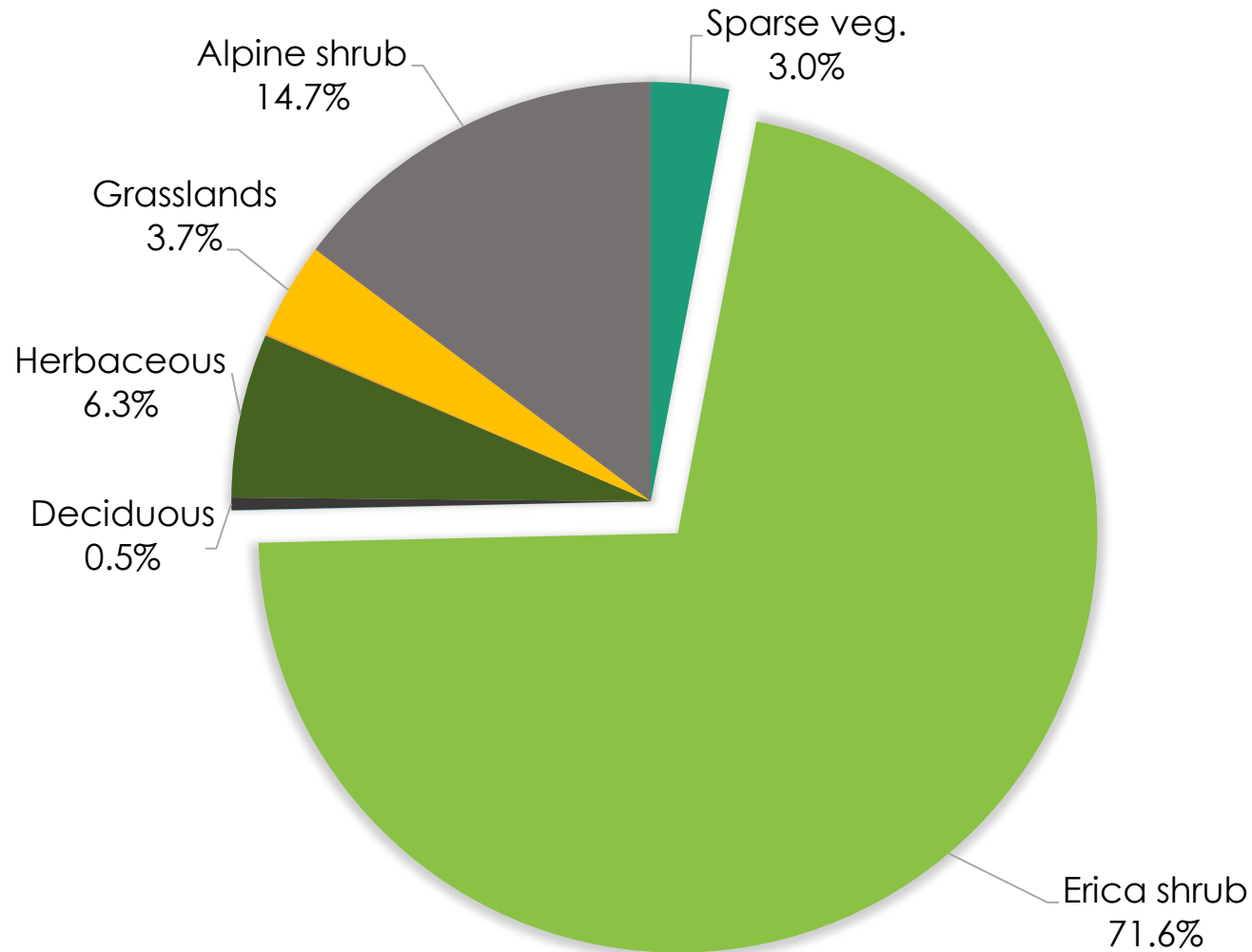
Spatial patterns of burning



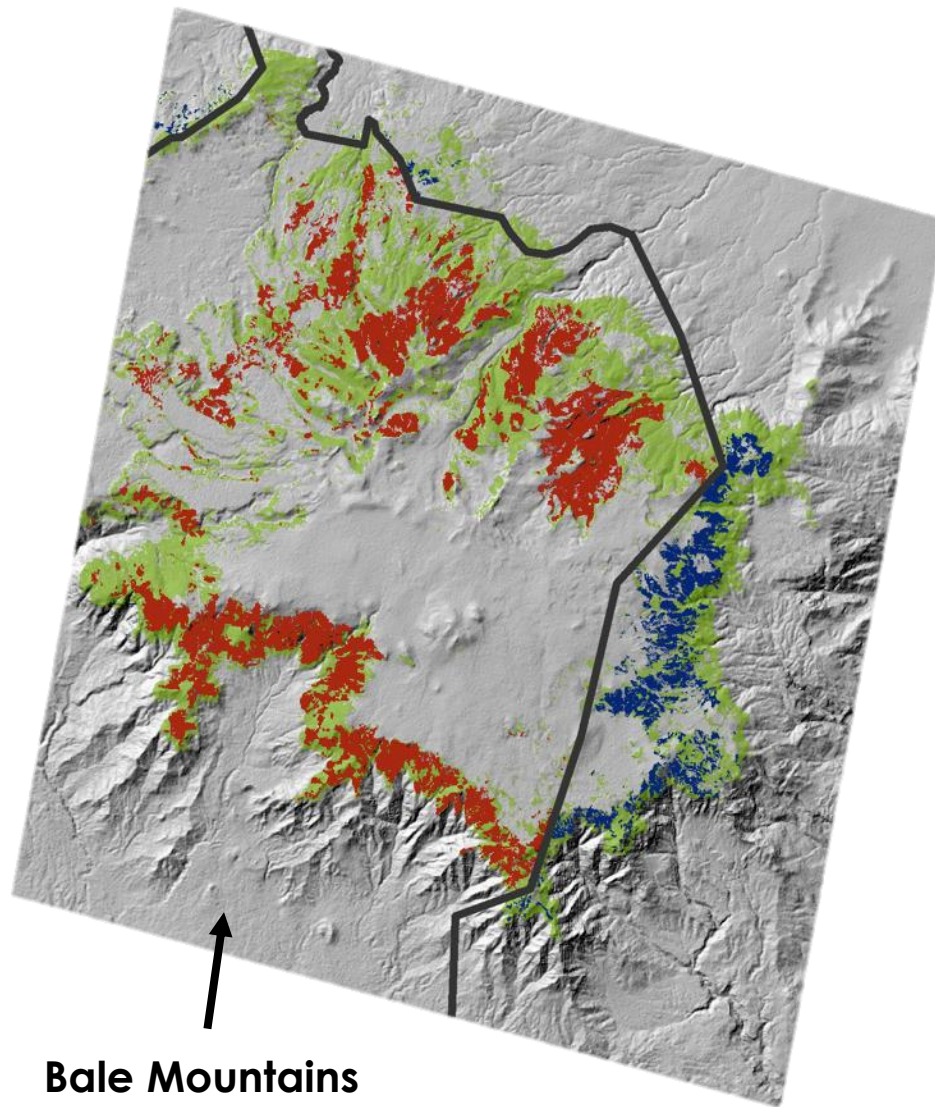
Vegetation types burned



Vegetation types burned



Ericaceous shrub burned



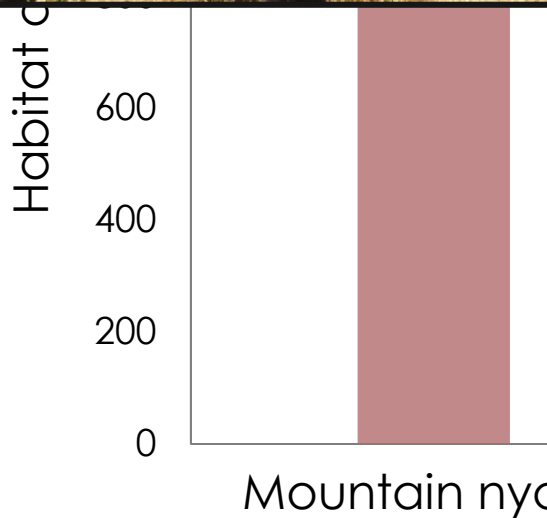
- Erica shrubland
- Burned inside park
- Burned outside park

Bale Mountains
National Park

Wildlife habitat burned



■ Burned
■ Unburned



Discussion



Errors and uncertainties

- ▶ Gaps in the Landsat record for the region.
- ▶ Scan line interpolation.
- ▶ Potentially omitted fires due to cloud cover.

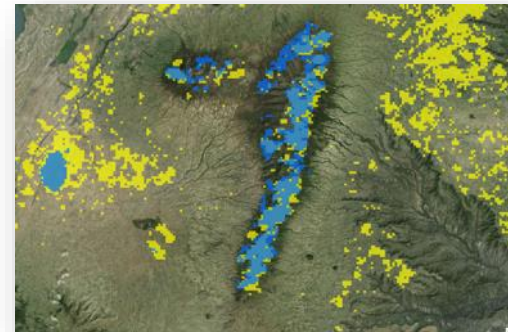
Conclusions

- ▶ **35% of ericaceous vegetation burned** in the Bale Mountains between 1995-2015, but **few areas experienced repeated fires**.
- ▶ **LandsatLinkr expedites pre-processing**, but data gaps and cloud cover remain challenging for time series analysis in remote, tropical alpine regions.
- ▶ **Final products for partners:**
 - ▶ Maps and spatial data of fire extent and frequency (1995-2015)
 - ▶ Spectrally comparable and composited tasseled cap time series (1973-2015)

Future work



Density analyses



Galama Mountains



Sentinel 2 data



Incorporate field data

Acknowledgements

Advisors

Dr. Paul Evangelista, Natural Resource Ecology Laboratory,
Colorado State University

Partners

The Murulle Foundation

Natural Resource Ecology Laboratory, Colorado State University

Others

Nicholas Young, The Murulle Foundation and Natural Resource Ecology Laboratory, Colorado State University

Justin Braaten, Oregon State University

Brian Woodward, NASA DEVELOP

Dr. Amanda West, Colorado State University