# Remote Sensing of Post-Fire Geomorphological Changes Within Bennett Creek Watersheds

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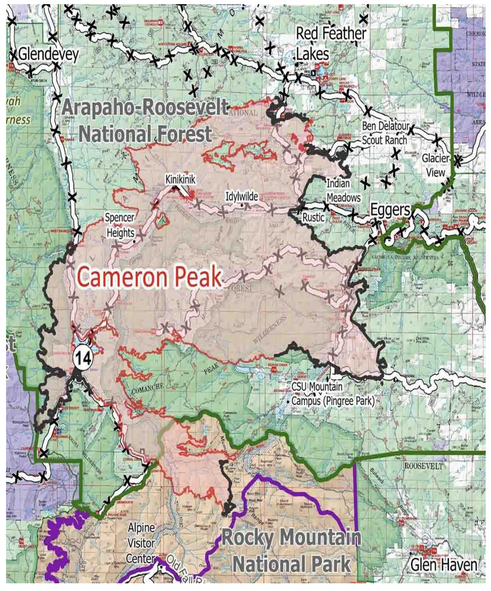
## Background

**The Cameron Peak Fire was the first in CO recorded history to burn over 200,000 acres. It was considered controlled on January 12, 2021.**




## Research

**Question:**
- What morphological changes occur in response to a major fire event across an entire watershed?
- Does sediment movement on slopes decrease as more time passes after fires?

**Goals:**
- Evaluate use of Uncrewed Aerial Vehicles (UAVs) for Structure from Motion (SfM) surveys
- Develop SfM data optimization and processing workflow for creating high resolution Digital Elevation Models (DEMs).
- Determine how best to measure sediment transport and deposition.

**Objectives:**
1. Observe changes of channels and hillslopes between the start of summer and end of summer.
2. Obtain two different metrics for quantifying sediment changes.

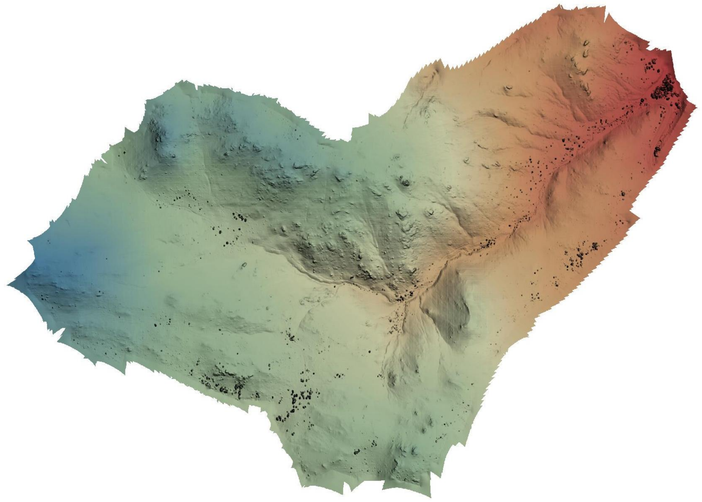
## Methods & Preliminary Findings

**Development of the Cameron Peak Fire research program began with the collaboration between the United States Forest Service, US Department of Agriculture, and the CSU Walter Scott Jr. College of Engineering.**

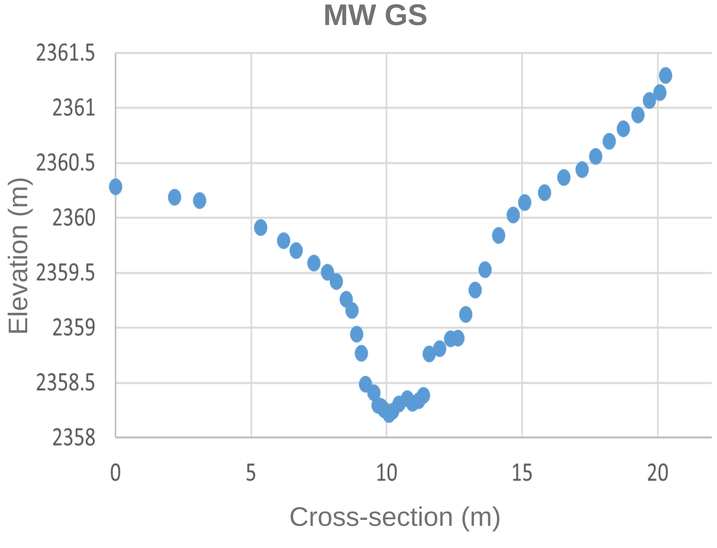
- Delineate watersheds and sub-regions of study
- Establish Global Navigation Satellite System (GNSS) ground survey points
- Conduct RTK-GNSS assisted drone flights of watershed areas
- Analyze drone imagery through 3D software to construct Digital Elevation Models
- Difference initial summer DEMs with final summer DEMs to quantify volume of induced sediment runoff/deposition through watershed

**Fieldwork**
- Hike to best base station location for remote connection with aircraft. Commonly with RTK base station, UAV, and personal equipment.
- Active UAV flight time over survey area. Greater areas demand efficient planning of flights, longer flight times, and more equipment.
- Use of Topcon survey equipment to gather cm level accurate georeferenced points. Primarily used for stream cross-section and longitudinal profile data.

**UAV Statistical Processing**
- Bennett Creek watershed is split into six sub-catchments.
  - *Three were mulched by the USFS and three were not, this was done to test differences in movement*
- Each section is further delineated into separate flight areas for planning
- UAV flight paths of area created from flight areas in the planning software
- Geotagged images are collected along each flight path
- Flight images are then imported to Metashape
- Alignment and optimization of photos, reducing three types of errors, and building models is done through the Metashape software
- Completion of the DEM models for all catchments can be stitched together for a full map of the Bennett watershed
- Difference early summer and late summer DEMs of each section for final analysis
- Final maps are generated and distributed to stakeholders



**Digital Elevation Model**: Eastern Bennet Creek watershed that underwent mulching




**Stream Cross Section**: Western delineation of the Bennet Creek watershed. Slopes of this stream were mulched at some point along its path.
- OPUS corrections are applied using the following:
$= \sqrt{((Northing_B - Northing_A)^2 + (Easting_B - Easting_A)^2 + P_0)}$
- Survey points run perpendicular to stream flow.
- Points are used to quantify future channel migration.

## Discussion & Limitations

**Discussion:**
- Previous research suggests sediment transport is greatest with steep slopes and higher levels of burn severity
- Hillslope rills on the order of 10 cm were detected from the DEM of Difference
- Widespread erosion occurred on hillslopes with little groundcover while greatest incision occurred in-channel far upstream of the outlet

**Limitations:**
- Area of watershed is too large for single day flight. Possibility for dramatic day to day variability
- Highly dependent on weather conditions to obtain data.
- Data collection did not begin until a year or so after the fire. Missing data from first year of morphological changes.

## Next Steps

In upcoming years, the team will prioritize watersheds in the East Troublesome burn area while continuing Bennet Creek data collection.
- Further optimization of image analysis.
- Multi-year qualitative differencing of models.
- Close collaboration with USFS, USDA, CSU Drone Center, and Dr. Nelson's Laboratory.
- Consistent practices for data collection at both start/end of summer.

## Selected References

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**Acknowledgements: Students and Faculty of Warner College of Natural Resources and Walter Scott Jr. College of Engineering.**
**This research is funded by Colorado Water Conservation Board, Coalition for the Poudre River Watershed, and the City of Greeley**