Fire-driven changes in landscape water use: A diurnal, multi-ecoregion perspective

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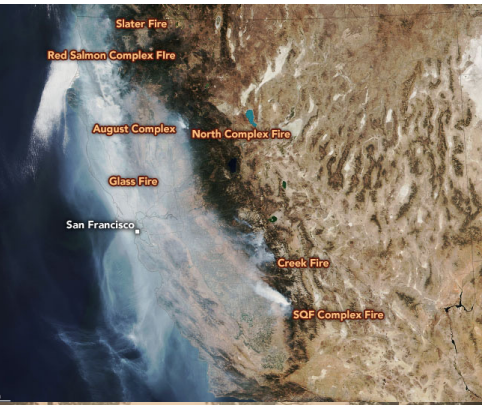
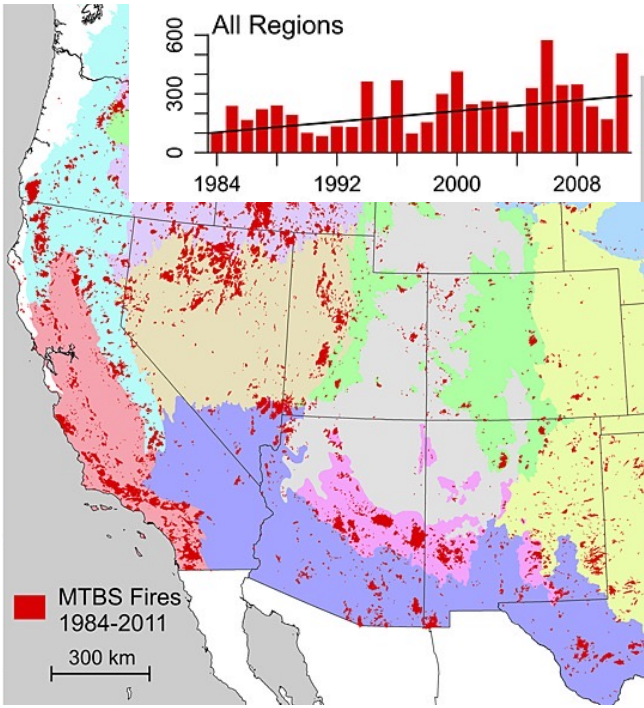
Wildfires in California impact society and ecosystems

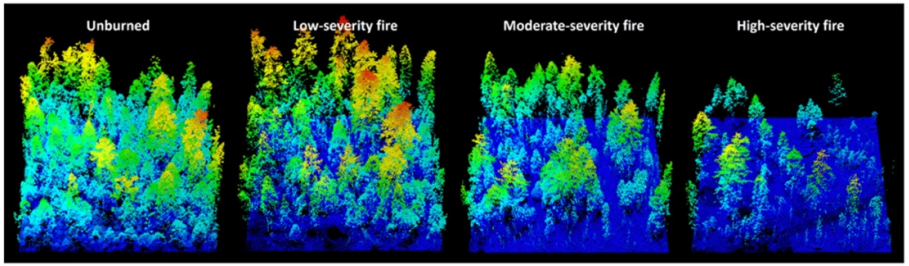


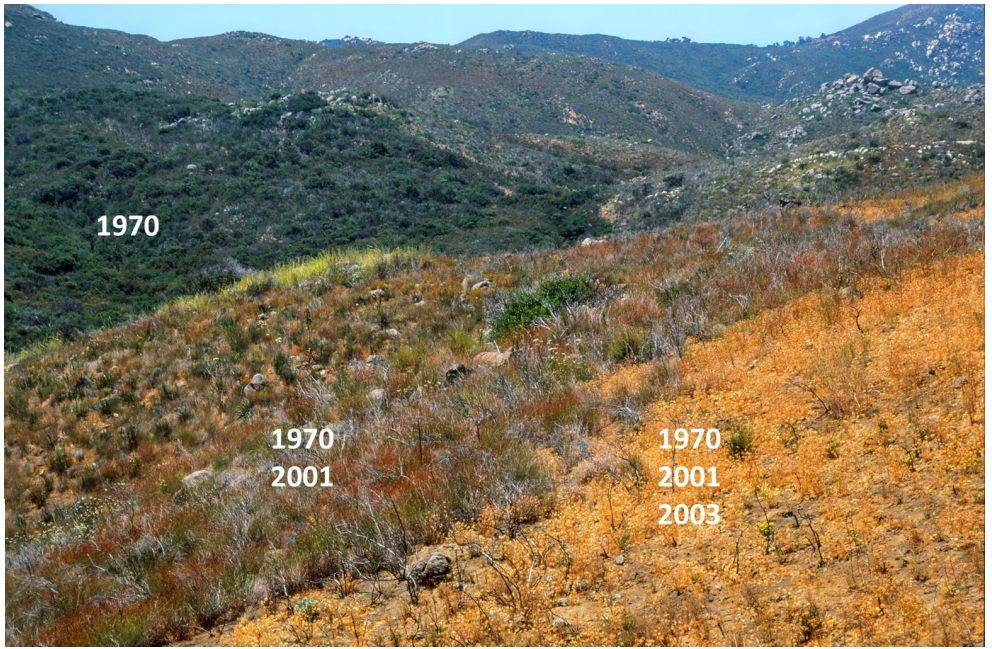
- Wildfires are starting earlier in the year… [Westerling, 2006]
- And are increasing in frequency and intensity in the Western United States… [Dennison et al., 2014]
- And are exacerbated by the Western US's worst megadrought in 1200 years [Williams et al., 2022a]



Wildfire changes the landscape

- Wildfires dramatically alter landscapes via *ecological type conversions*
- Wildfires alter *microclimates* by changing local albedo, land surface temperature and vapor-pressure deficit, among others [Coop et al., 2020]

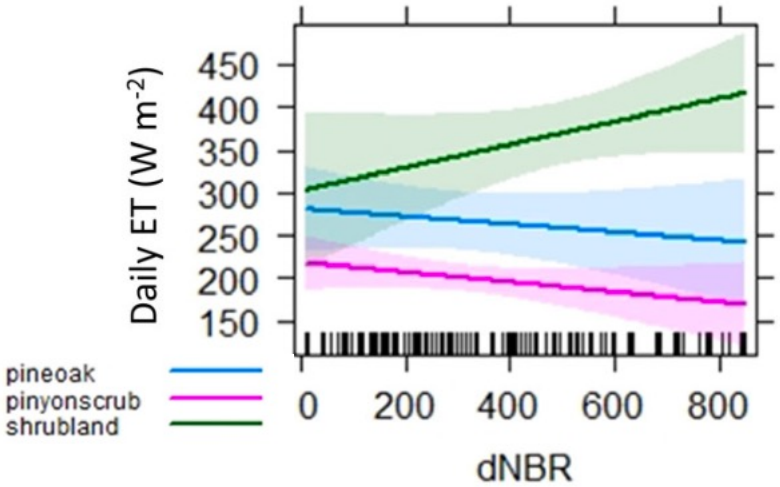




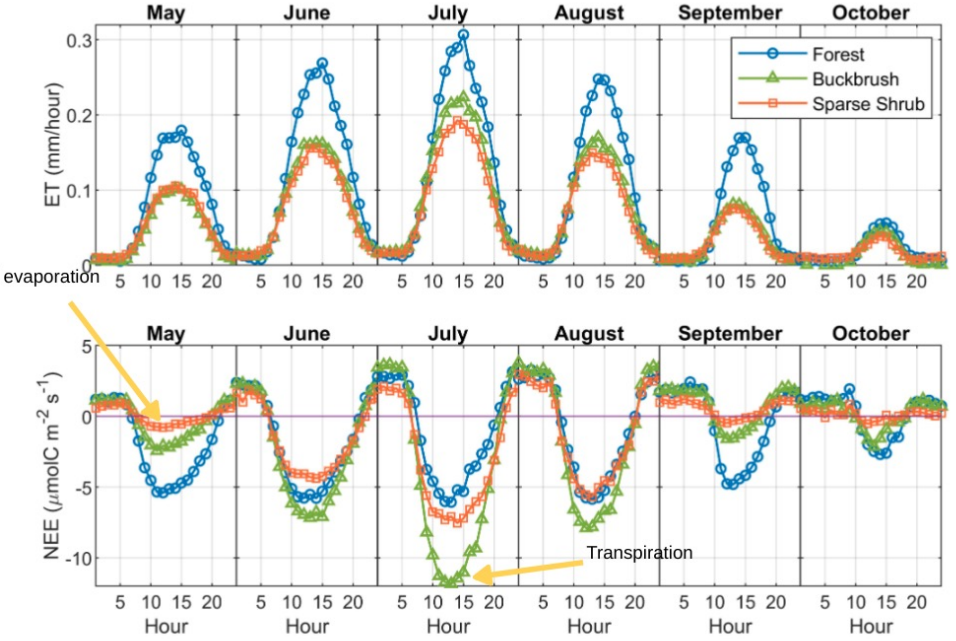
Chaparral is eventually replaced by grasses following repeat wildfire events in the San Gabriel Mountains, Southern California
Source: californiachaparral.org

Ecological type conversions influence Landscape Water Use: species composition & WUE effects

- Vegetation water use varies by species, season, and time of day



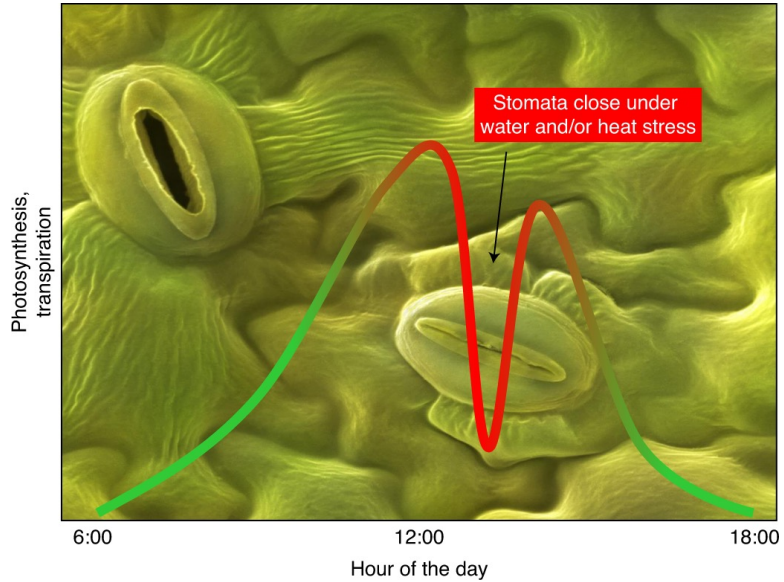
ET and fire severity effects in Arizona, USA.
Source: Poulos et al. 2021



ET and NEE from flux sites in a subarctic alpine catchment
Source: [Nicholas and Carey, 2021]

Ecological type conversions influence Landscape Water Use: microclimate effects on water use

- Microclimate shifts (e.g. LST, net radiation, VPD) thus are expected to impact stomata closure/opening among survivors

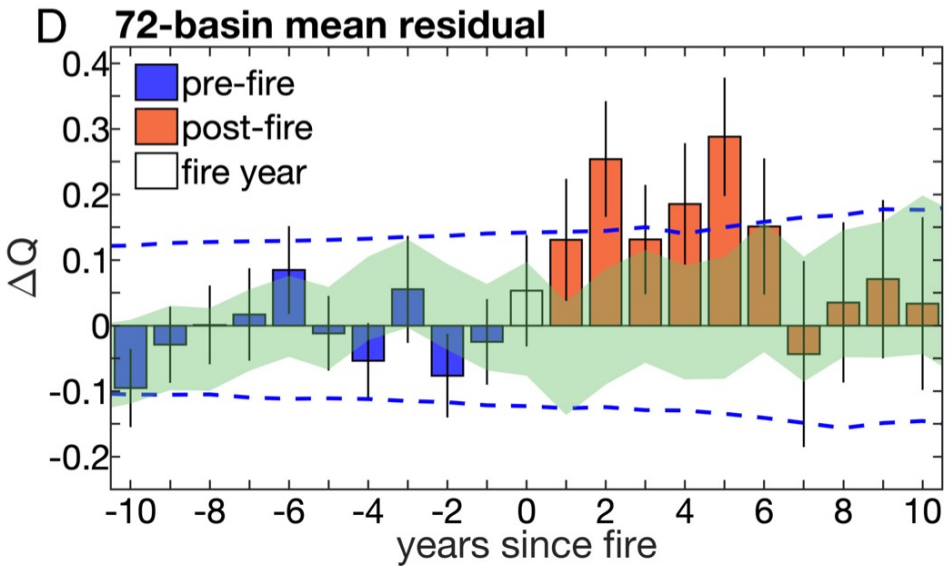


Stomata close under water/ heat stress
Source: [Xiao et al., 2021]

Image source: John Shepard Wiley

Ecological type conversions influence Landscape Water Use: impact on water balances

- Wildfire-driven conversions from forest to grassland may decrease plant water use and enhance runoff [Williams et al., 2022b]
- Vegetation also affects hydrology by influencing soil structure/depth and modulating surface energy balance



Western US basin mean runoff increase post-fire
Source: [Williams et al., 2022b]

Objectives

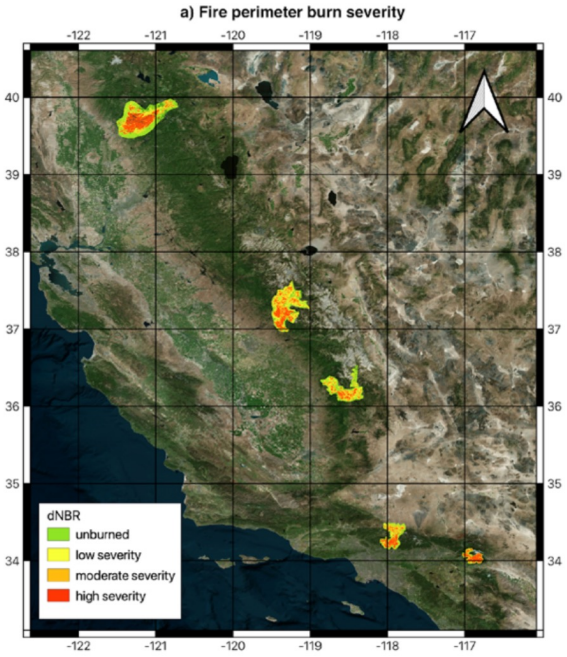
The primary objectives are to:

- (1) Determine **changes in microclimates and landscape water use** pre- and post-fire for major wildfires across California ecoregions.

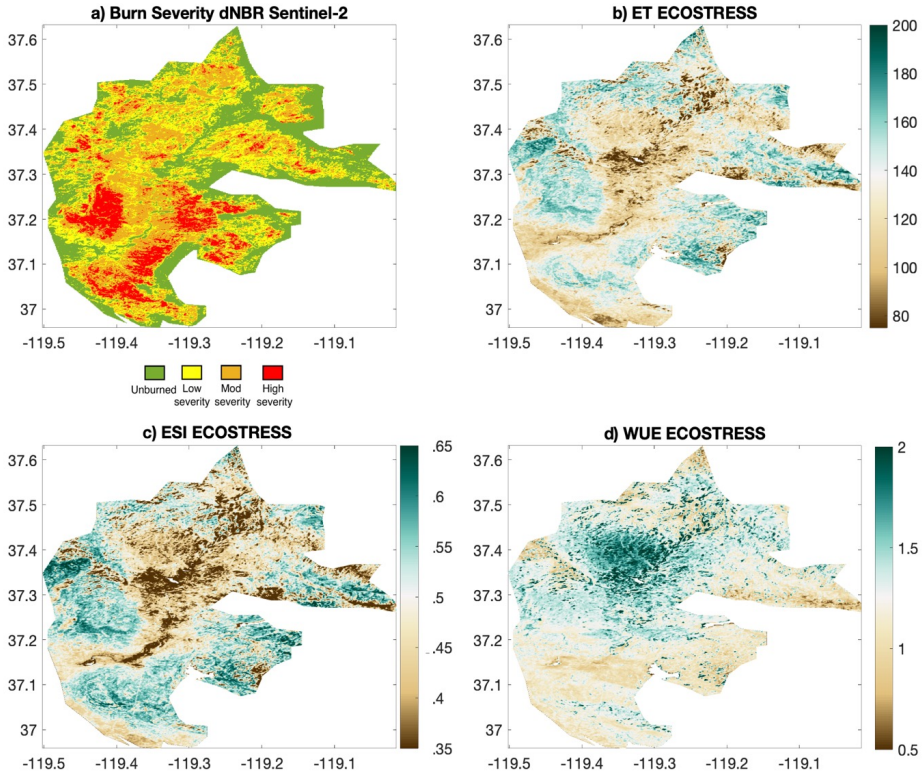
- (2) Determine the impact of **wildfire-related ecological type conversions on ET** by looking at diurnal and seasonal cycle of ET

- (3) Quantify wildfire-related changes in the **balance between precipitation, evapotranspiration, and streamflow** across California water basins, and in the balance between **temperature and atmospheric humidity** that together drive heat stress.

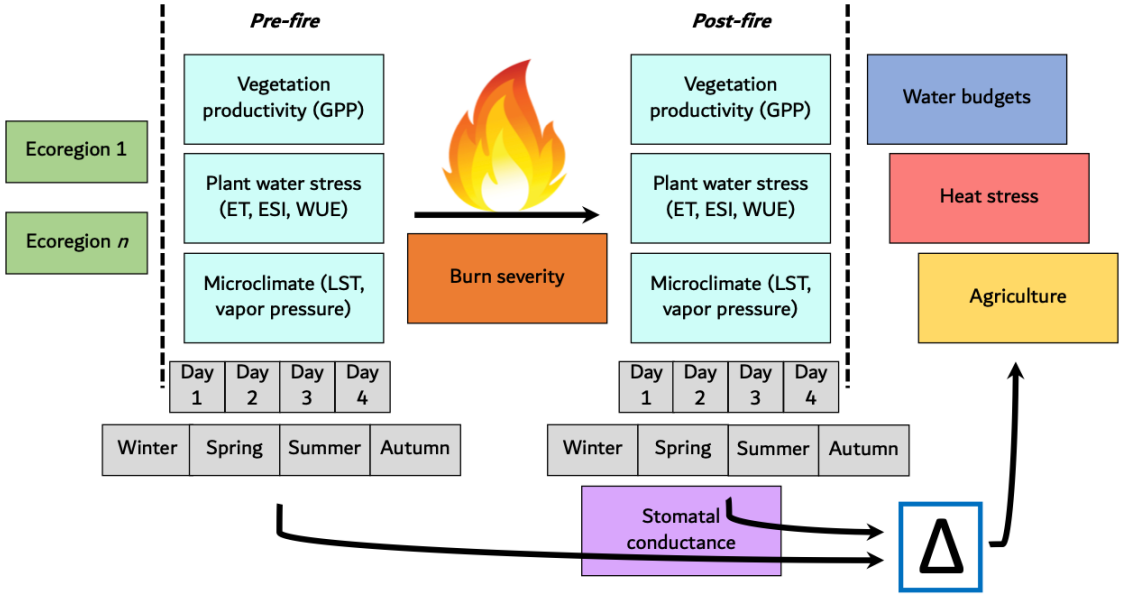
ECOSTRESS 70-m plant-stress data reveals patterns of burn severity for California wildfires of 2020



[Pascolini-Campbell et al. 2022, GEB]



Objective 1: Determine changes in microclimates and landscape water use



1) **microclimate** (as described by LST and humidity)
2) **plant water use** (as described by ET and WUE)
3) **land cover** (i.e. vegetation type)

Objective 1: Determine changes in microclimates and landscape water use

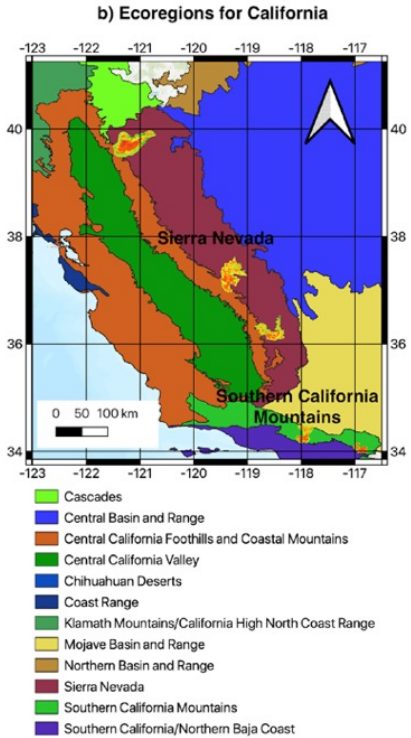


Table 1-1. Study region details. See Figure 1-2b for ecoregion map.

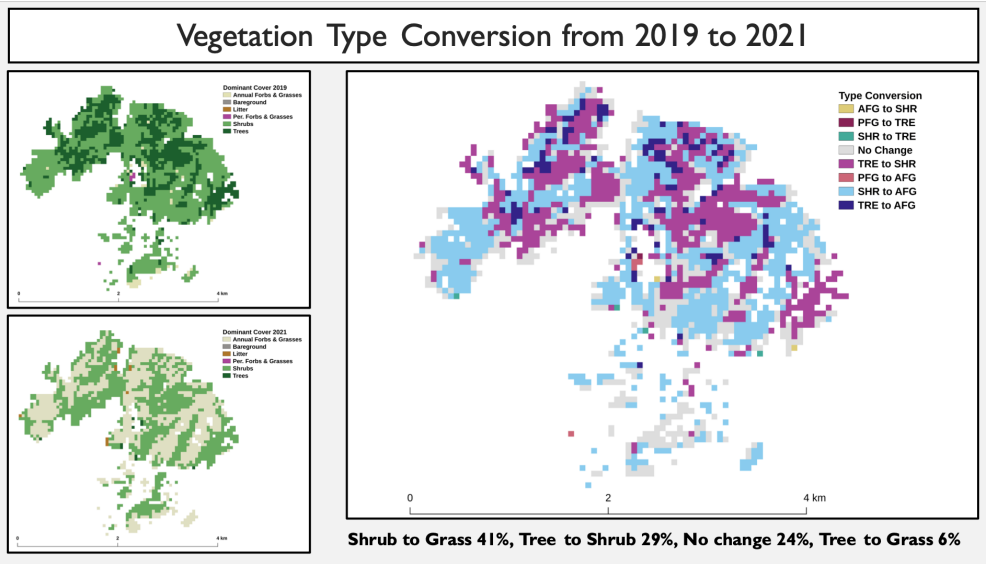
Wildfire (year)	Ecoregion	Landscapes Burned	Area (km^2)	Flux tower as unburned control
Apple (2020)	S. Calif. Mountains	Forest	134	US-SCf
Bobcat (2020)	S. Calif. Mountains	Forest, suburbs, desert	469	US-SCw
CZU Lightning Complex (2020)	Coastal Range	Coastal forest	352	
Grant (2020)	Central Calif. Valley	Grassland	20	US-Ton
LNU Lightning Complex (2020)	Central Calif. Coastal Mountains	Forest, suburbs, vineyards	1,469	
North Complex (2020)	Sierra Nevada	Forest	1,291	US-Blo
Alisal (2021)	S. Calif. Coast and Mountains	Chaparral, coastal forest	69	US-SCg

We will focus on 7 California wildfires in different ecoregions
Validate against Fluxnet where possible (fire-adjacent locations)

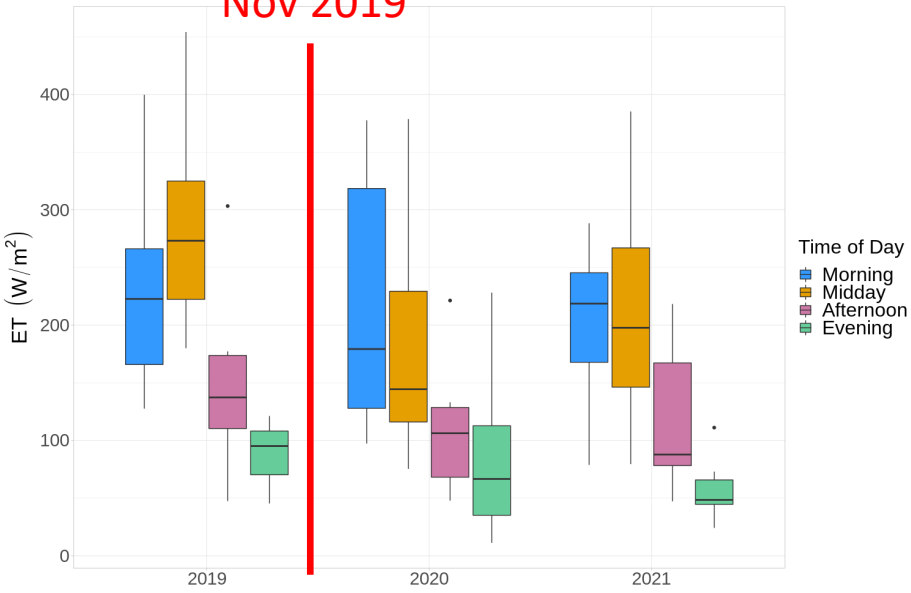
Objective 2: Determine the impact of wildfire-related ecological type conversions on ET with ECOSTRESS and OCO-2/3

…focusing on changes in the diurnal and seasonal cycle of ET

Preliminary results: Cave Fire, 2019, CA



Cave Fire, Nov 2019

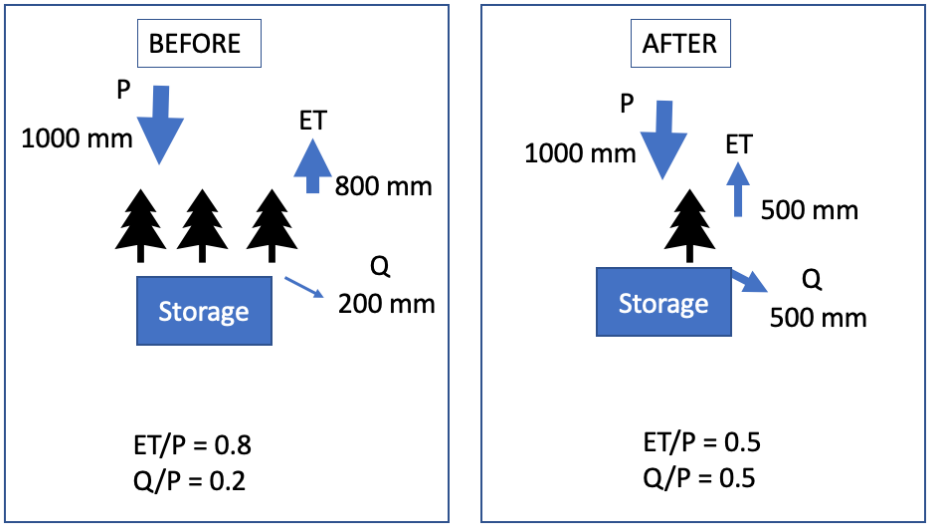


Source: Marie Johnson, Phd candidate U. Montana (JPL intern)

Objective 3: Quantify fire-related changes in the balance between precipitation, evapotranspiration, and streamflow across California water basins, and in the balance between temperature & atmospheric humidity

(a) wildfires lead to enhanced streamflow and reduced humidity
(b) these effects vary according to ecoregion

P – ET – Q = Water Storage change



Proposed Datasets

- **ECOSTRESS (LST, ET, WUE, ESI)**
- **OCO-2/3 (SIF)**
- **Fluxnet (eddy covariance ET)**
- **Sentinel-2/Landsat (burn severity)**
- NLCD (land cover)
- PRISM, GEOS-5 (meteorology)
- USGS (streamflow)

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Thanks