# Evaluating Response of Southern California Chaparral Landscapes to Short-interval Fire and Drought (1984-2018)

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**Abstract**

Regrowth after fire is critical to long-term persistence of chaparral shrub communities in southern California. This region is subject to frequent fire, habitat fragmentation, and protracted droughts linked to climatic change. Short-interval fire (SIF) is considered an inhibitor of recovery and cause of "type conversion" in chaparral, based on field studies of small extents and limited time periods. Sub-regional scale investigations based on remotely sensed data, however, suggest that SIF may explain little variance in postfire chaparral recovery. Drought may contribute to poor recovery or worsen the impact of repeated, short-interval fires. Previous studies have not shown whether drought reduces chaparral recovery significantly across the region, while variations in response among community types and climate zones are not well resolved. This research evaluates a regional pattern of chaparral recovery, based on series of Normalized Difference Vegetation Index (NDVI) from annual, June-solstice Landsat images (1984–2018). High resolution aerial images were used in validation and calibration. The main objectives were (1) to assess effects of fire-return interval and number of burns on chaparral recovery using 0.25 km2 sample plots (n = 528) which were paired and stratified for experimental control, and (2) to explain recovery variations across the region based on geospatial climate, vegetation, soil, terrain, and temporal drought metric data (seasonal precipitation, climatic water deficit (CWD), and Palmer Drought Severity Index (PDSI)) from 982 locations. Results suggest that SIF is most impactful in sites that burned three times within 25 years. More substantial effects were observed due to drought. In particular, ecotonal chaparral bounding the Colorado Desert is most subject to drought impact. We also highlight utility in landscape-scale predictors of drought impact on recovering chaparral, including Very Atmospherically Resistant Index (VARI).

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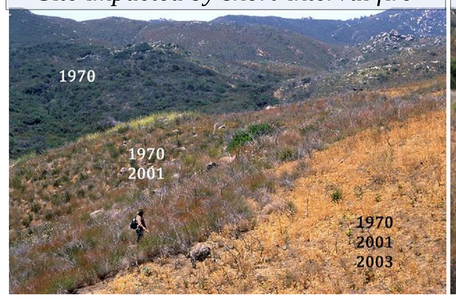
## Rationale & Study Areas

### Rationale

- Postfire vegetation recovery is *critical* to ecological resilience and stability
- Chaparral shrublands are subject to *frequent fires* and *severe droughts*
- *Low resilience* and *conversion* to exotic grass observed in *small-scale studies*
- Regional *pattern* and *controls* on resilience are poorly understood
- Satellite remote sensing enables *regional-scale* evaluation of recovery

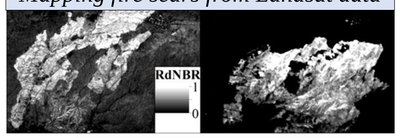
*Site impacted by short-interval fire*




*Site impacted by drought*

### Regional fire history

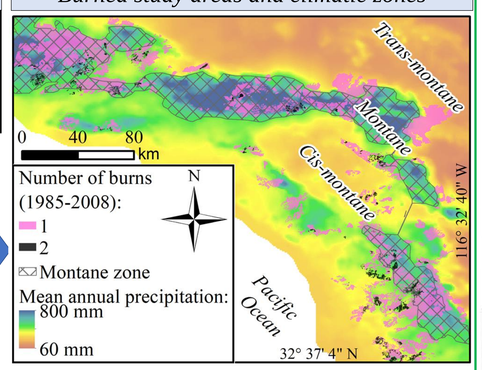
*Mapping fire scars from Landsat data*





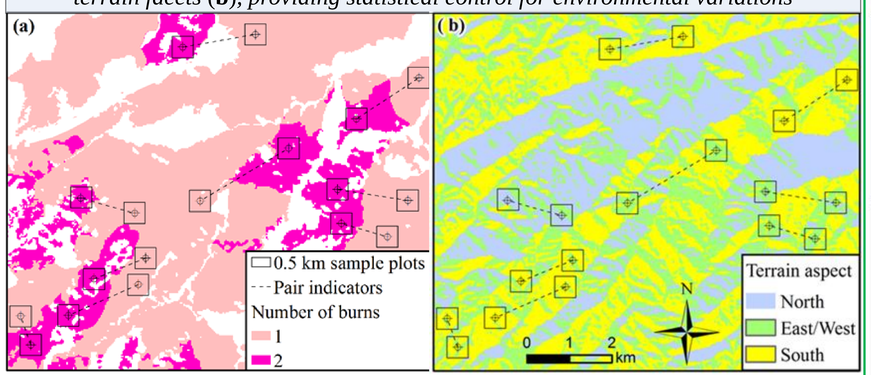


*Burned study areas and climatic zones*




### Analysis site selection

*Selection of sample plots from neighboring 1-burn and 2-burn sites (**a**), on consistent terrain facets (**b**), providing statistical control for environmental variations*



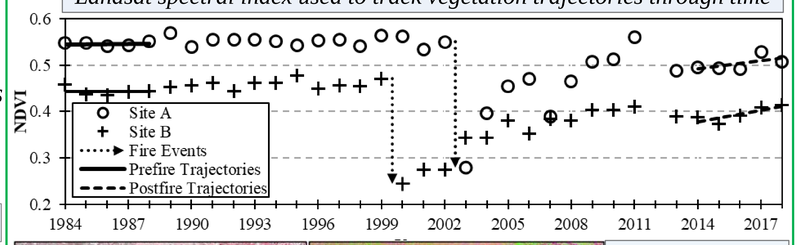

### Research Questions

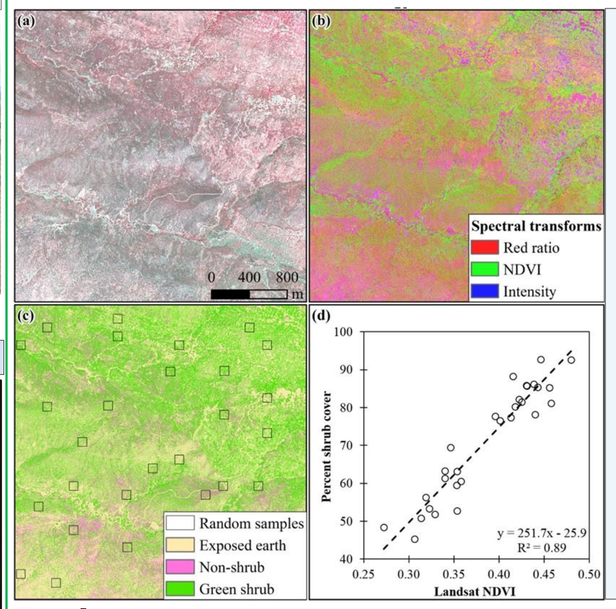
1. Do short-interval fires significantly diminish postfire recovery?
2. How do severity and timing of drought affect recovery?
3. Which variables best predict drought impact at landscape scales?

## Methods, Validation, & Data Product

### Landsat pixel-based estimates of postfire recovery

*Landsat spectral index used to track vegetation trajectories through time*

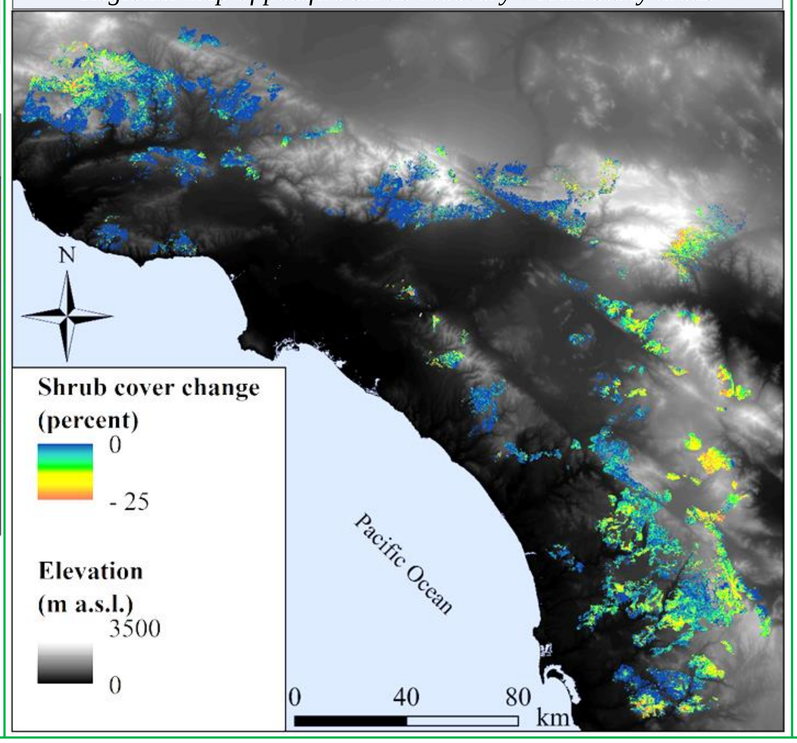



Training plots used to determine empirical relations of Landsat NDVI to shrub cover and change in shrub cover. Formulas for 74 plots throughout region applied in localized manner for calibration and accuracy assessment.

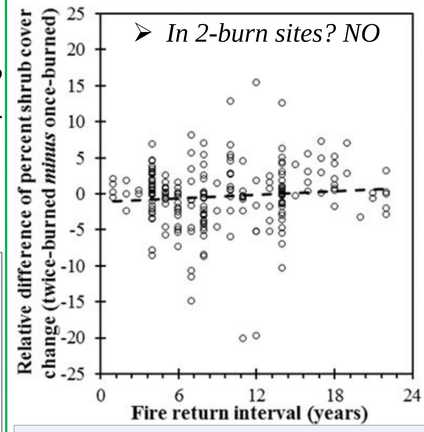
### Results

*Regional map of postfire shrub recovery within study areas*

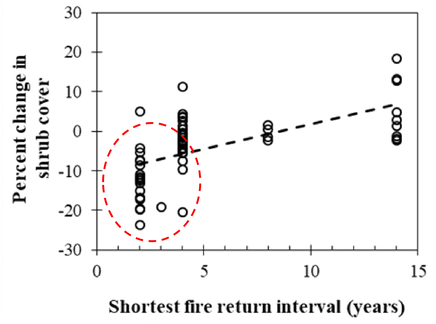



## Statistical Analysis & Interpretations

*Significant effects of short-interval fire on recovery?*

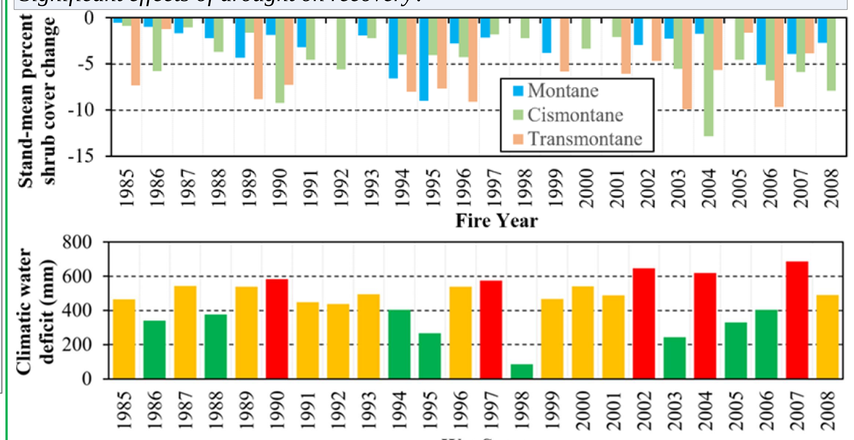



- *In 2-burn sites? NO*
- *In 3-burn sites? YES*




- *Especially at intervals < 4 years*

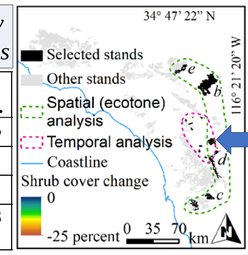
*Significant effects of drought on recovery?*



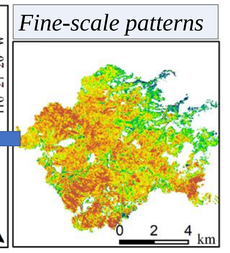

- *Climatic zone, soils, and plant community explain 30% of regional pattern*
- *Drought accounts for ~40 percent of recovery variation amongst xeric sites*

*Landscape-scale predictors of recovery in drought-impacted, xeric ecotone sites*

| Variable | *p* | *t* | β Coef. |
|---|---|---|---|
| *Elevation* | <0.001 | -6.00 | -0.35 |
| *Plant community* | <0.001 | 10.27 | 0.12 |
| *Soil Permeability* | <0.001 | -7.85 | 0.14 |
| *Visible Atmospherically-Resistant Index* | <0.001 | 18.45 | -0.38 |




*Fine-scale patterns*




### Conclusions

- Drought is a significantly greater control on recovery than fire interval
- Drought impact most severe near inland deserts, at middle elevations
- Landscape-scale drought impact somewhat predictable from spatial data
- Conservation and fire control should focus on vulnerable sites

### Acknowledgements

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