Landsat-derived data to map vegetation type conversion in southern California shrublands

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INTRODUCTION

Shrublands dominate southern California and provide valuable ecosystem services. However, they are increasingly being converted to non-native grasslands, owing to reduced fire return intervals along with drier conditions. This vegetation type conversion (VTC) has been documented at small scales, but landscape scale assessments are limited. We explored the use of a Landsat-derived dataset of vegetation cover– RCMAP – to map where shrubland conversion has occurred since 1986.

METHODS

RCMAP (Rangeland Condition Monitoring, Assessment, and Projection) is a raster dataset (30 m) with relative vegetation cover assigned to each 30 m pixel: annual herbaceous, perennial herbaceous, sagebrush shrub, non-sagebrush shrub. It was developed using neural network models applied to 56,000 field plots, Landsat multispectral images, and topographic information to predict vegetation cover for each year 1985-2023 across the western U.S. (Rigge et al, 2021).

Can RCMAP be used to map shrubland conversion to annual herbaceous grassland?

First, we examined per pixel trendlines for the time series of the annual herbaceous and non-sagebrush cover components. Trendline rasters the slope of trendlines are included in the RCMAP data (Shi et al, 2022).

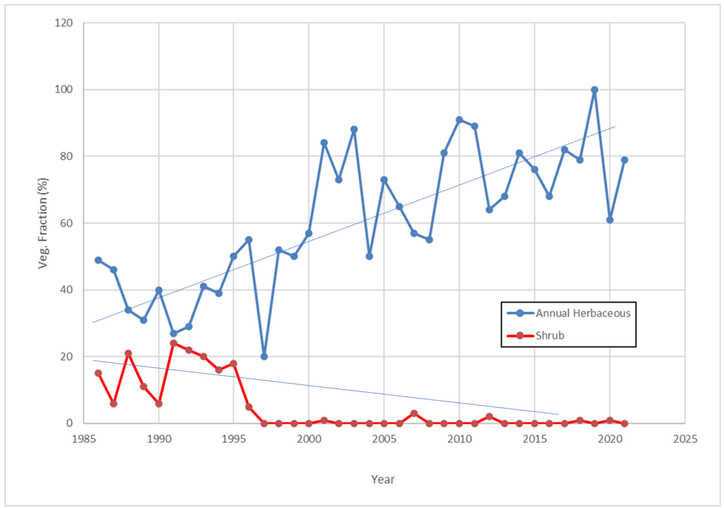

Figure 1. RCMAP delivers Landsat-derived annual vegetation cover fractions for the year 1985 – 2021. Fitted trendlines for the time series values of the annual grass/forb and non sagebrush shrub components were used to define type conversion.

How did we define chaparral decline and conversion?

Based on Syphard et al 2022 and Dewees et al 2022 we set the trendline slope thresholds as follows:

Decline: Slope annual herbaceous 0.25 to 0.50 and slope shrub -0.50 to -0.25

Conversion: Slope annual herbaceous > 0.50 and slope shrub < 0.5

Second, we created raster layers of shrubland conversion and decline by applying the two decision rules (Figure 2).

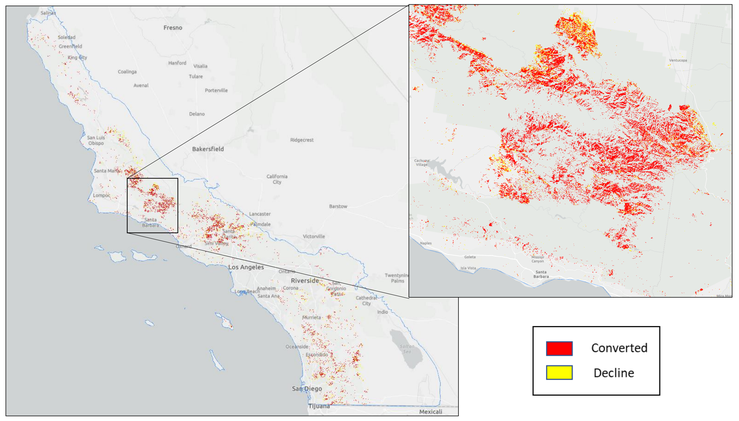

Figure 2. Maps of shrubland decline and conversion to annual grassland derived from RCMAP in the shrubland dominated region of southern California. Pixel size = 30m.

Third, we compiled the RCMAP data into time series charts for selected sites classified as converted and examined the image archive in Google Earth for visual evidence of conversion.

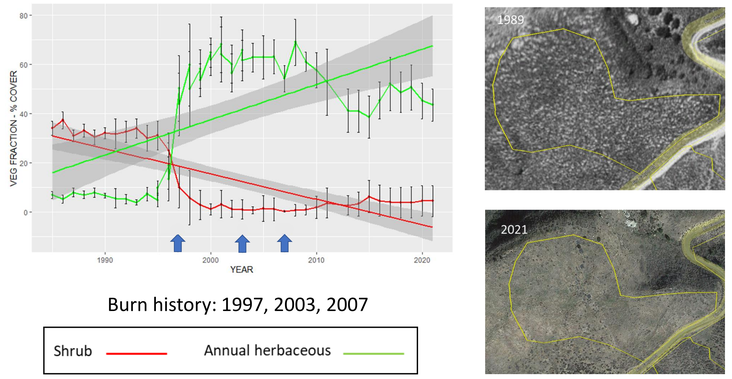

Figure 3A. Time series (1985–2022) of RCMAP annual herbaceous and non-sagebrush shrub components for a site near Lake Piru, Los Padres National Forest, Ventura Co. CA. Vertical bars are the standard error of the mean for the pixels within the site polygon. Burn history is indicated by blue arrows (FRID data, Safford and Van de Water 2014). Images at right are from Google Earth.

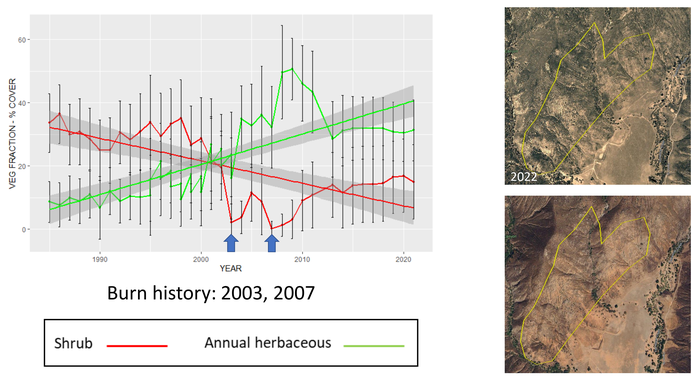

Figure 3B. As above, showing a site along Temescal Creek, Cleveland National Forest, San Diego Co. CA.

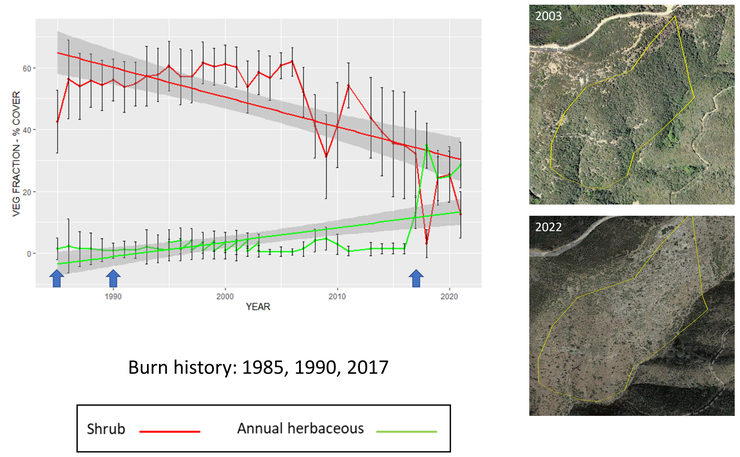

Figure 3C. Same as Figure 3A for a site along Nordhoff Ridge, Los Padres National Forest, Ventura Co. CA.

FINDINGS

RCMAP, although originally developed for sagebrush ecosystems, shows promise for estimating shrubland type conversion in the southern California region. Our 'virtual validation' of 25 sites (converted and unconverted) using historical aerial imagery indicates that RCMAP does track shrubland conversion accurately in most cases.

However, there are likely many areas that are classified as converted where the 'conversion event' (i.e. where annual herbaceous cover surpasses shrub cover) is within the last ten years (In Figure 3C, this is 2017). To detect this, future efforts could use a more nuanced approach to time series analysis, such as segmentation or curve fitting. Shrub recovery may take 10 years, perhaps longer under drought conditions.

There is mounting evidence that decreasing fire return interval is driving conversion to annual grasslands, with drought playing a supporting role (Pratt 2022). However, these preliminary results indicate conversion begins after the first fire in at least 18 years and is well established when subsequent fires occur. In the majority of our converted sites, the 'conversion fire' occurred in 2003 and secondarily 2017; a significant drought event (PDSI <= -4 for at least 1 year) preceded both these years. A deeper analysis using more sites is needed to identify patterns related to drought, site productivity, and pre-fire vegetation.

As Landsat closes in on 40 years of consistent data, datasets like RCMAP are increasingly useful to explore vegetation change phenomenon such as VTC. These results are a first approximation, further investigation and refinement are planned.

FURTHER INFORMATION

QR code for pdf of poster and references

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