Interaction between disturbances and their effects on the recovery of a heterogeneous Mediterranean landscape in South America

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Abstract

Fires and droughts are important drivers of disturbance in Mediterranean forests. Despite this, there is a gap of knowledge of the effect of climate change and particularly the interaction of longer periods of drought with other disturbance processes in remnants of native forests. As the frequency of these events is expected to increase in the future, it is important for forest managers to understand recovery patterns and the response of vegetation to these interactions. The objective of this work is to quantify the effects of the interaction of drought and fires in the recovery of Mediterranean-type forests at a local scale in South America using field data, satellite images, and trend analysis. These forests have experienced significant reductions in their extension and fragmentation, and in recent years have been subjected to the longest drought since there are records and that occurred between 2010 and 2020. Using a time series of Landsat satellite images (1986-2020) and the fire registry of the National Forestry Corporation (CONAF) we evaluate the relationship between the Normalized Difference Vegetation Index (NDVI) and other vegetation indices with characteristics measured in the field to evaluate the recovery after a fire event. We quantify the temporal trends of the NDVI to discover the location, direction, and timing of the change. In addition, we evaluate the interaction of climate, soil, and topography by forest type. We observe that the NDVI recovery slope is less steep in burned areas in the periods after 2015, exacerbating in topographic conditions of northern exposure (of the southern hemisphere). Even for the time period analyzed, some areas were reported where recovery levels still do not show a significant positive trend. We also observed a difference in the recovery of areas that experienced high severity fires versus low or intermediate severity fires in a period of drought, the recovery of areas exposed to a high severity fire takes twice as long to recover. These results indicate that the vegetation recovery processes can be negatively affected by the drought that occurs before, during, and after fires. Our analysis identifies spatially explicit patterns of short- and medium-term trends in these "new" regimes of prolonged droughts and fires, providing insight into forecast warmer and drier weather conditions so that our results can serve as a general framework for the resource management of these highly stressed areas, which can be applied to similar Mediterranean ecosystems.

INTERACTION BETWEEN DISTURBANCES AND THEIR EFFECTS ON THE RECOVERY OF A HETEROGENEOUS MEDITERRANEAN LANDSCAPE IN SOUTH AMERICA

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MOTIVATION

Understand the changes that ecosystems like the Mediterranean landscape in South America experience due to climatic, ecological and anthropic disturbances and how these affect the landscape in the context of climate change for decision-making in the territory.

What is the interaction between drought and wildfires and their effects in recovery patterns in the Mediterranean sclerophyllous forests ?

GOALS

Quantify interaction effects between drought and wildfires in sclerophyllous forests.

1. Analyze the spatial location, the direction of the trend, and the timing of the forest's spectral change.

2. Determine the relationship between spectral change and vegetation productivity after fire and drought, taking into account influences on climate and topography.

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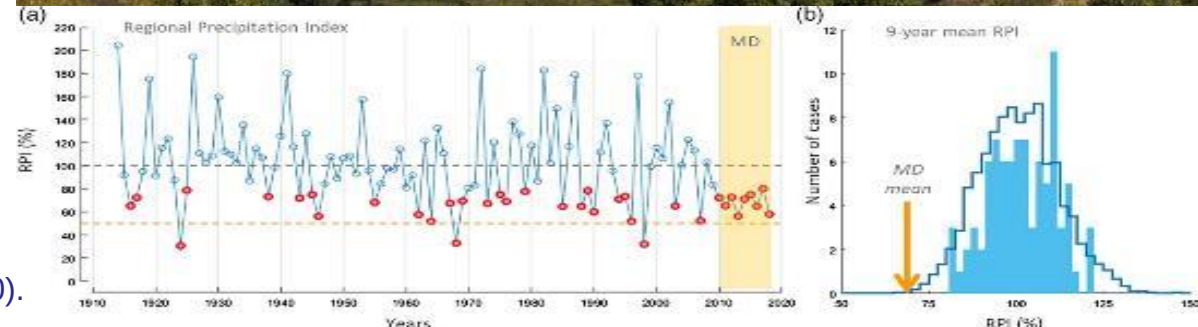
BACKGROUND

Mediterranean region

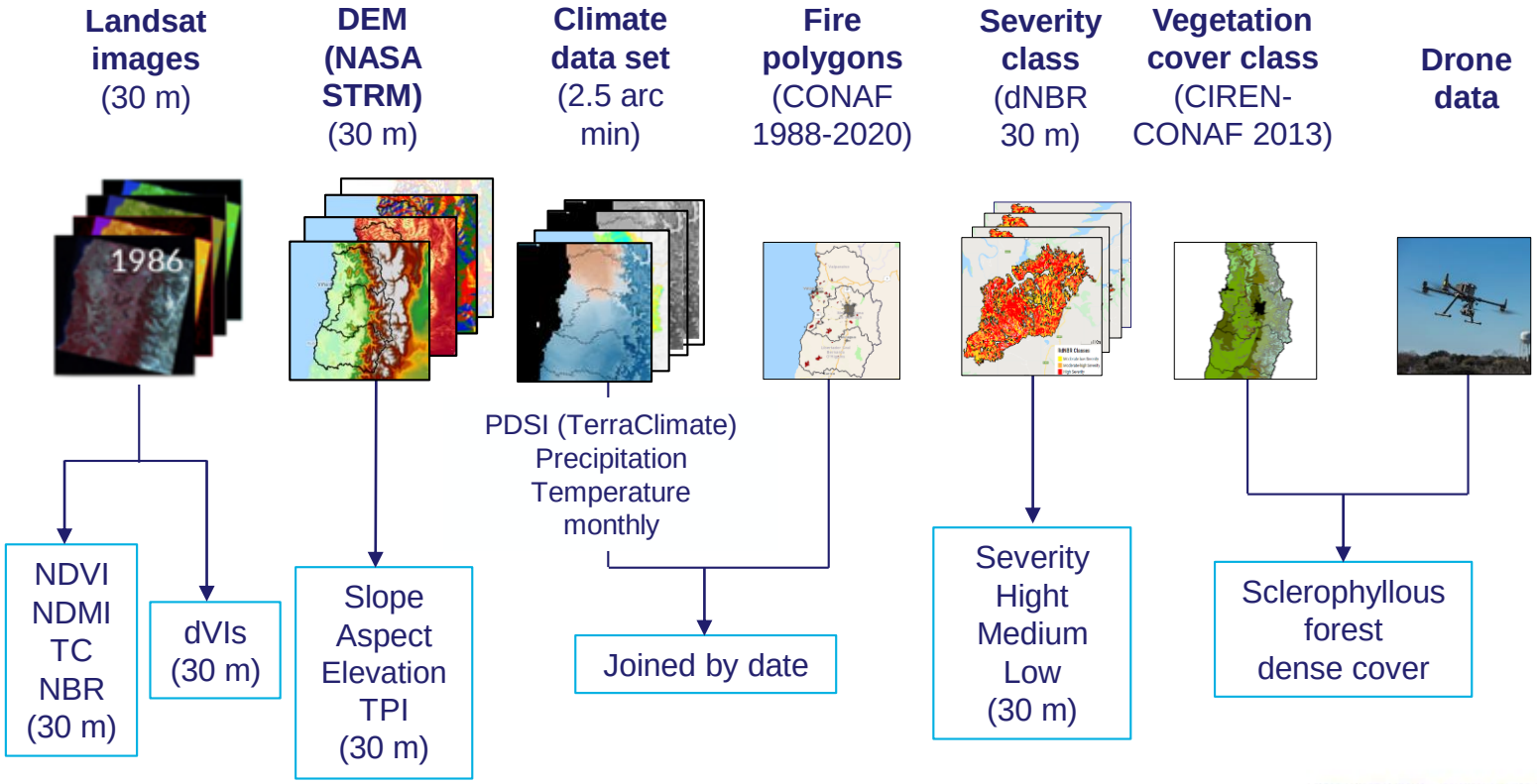
- One of the world's biodiversity hotspots (Myers *et al.*, 2000).
- Region exposed to intense transformations in its landscape as a result of anthropogenic activities.
- Increase in the frequency and intensity of natural phenomena as a consequence of climate change: mega-drought, mega-fires.
- Poorly monitored regions.



(Garreaud et al., 2020).

MATERIAL & METHODS

- Satellite and climate data
- Field data
- Trend analysis
- Driver analysis (model)



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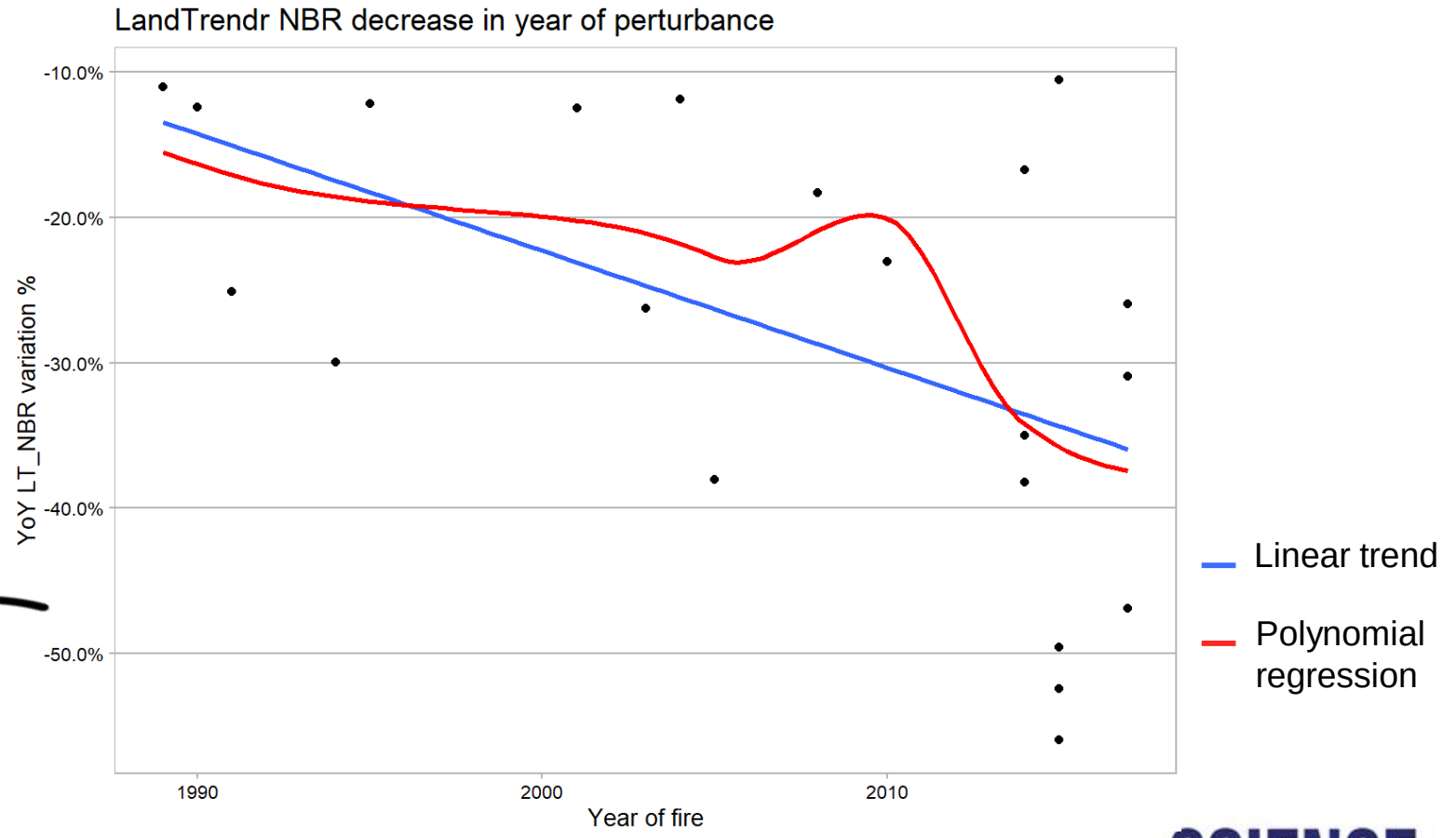
RESULT

Fires LT-NBR

NBR value dropped as a percentage in the year the fire occurred compared to its previous value



The loess regression, it seems that the drop in NBR values were grater or more severe in the years with drought, after 2010.

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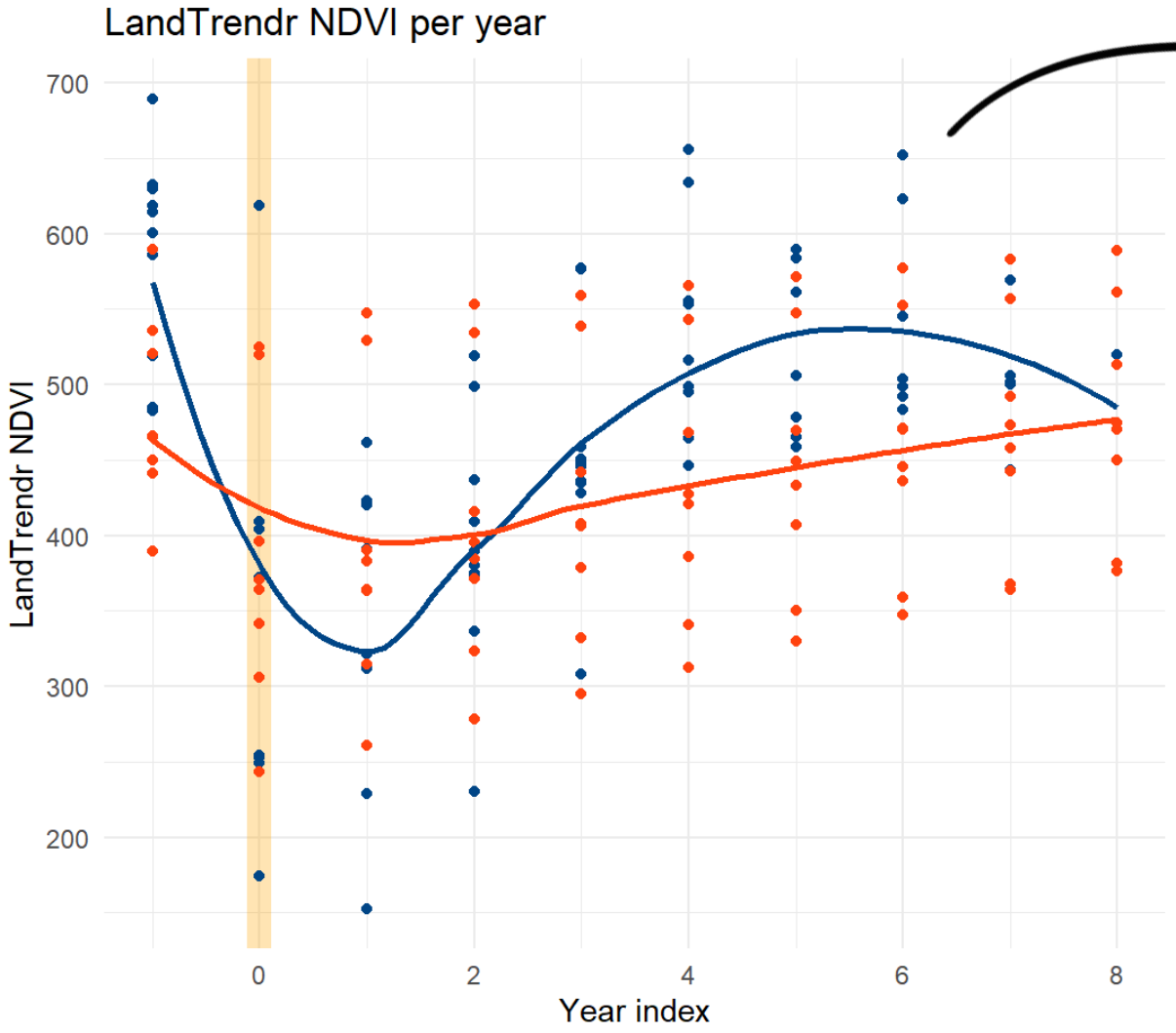
RESULT

NDVI Recovery

Aligned every disturbance, in this case fires, to the same year scale from -1 to 8.



DROUGHT

The level of recovery doesn't completely reach the NDVI levels from before the disturbance, it even seems to decrease in the last years as the drought became more severe.

Fire year groups

- Drought (after 2010)
- Non drought (before 2010)

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RESULT

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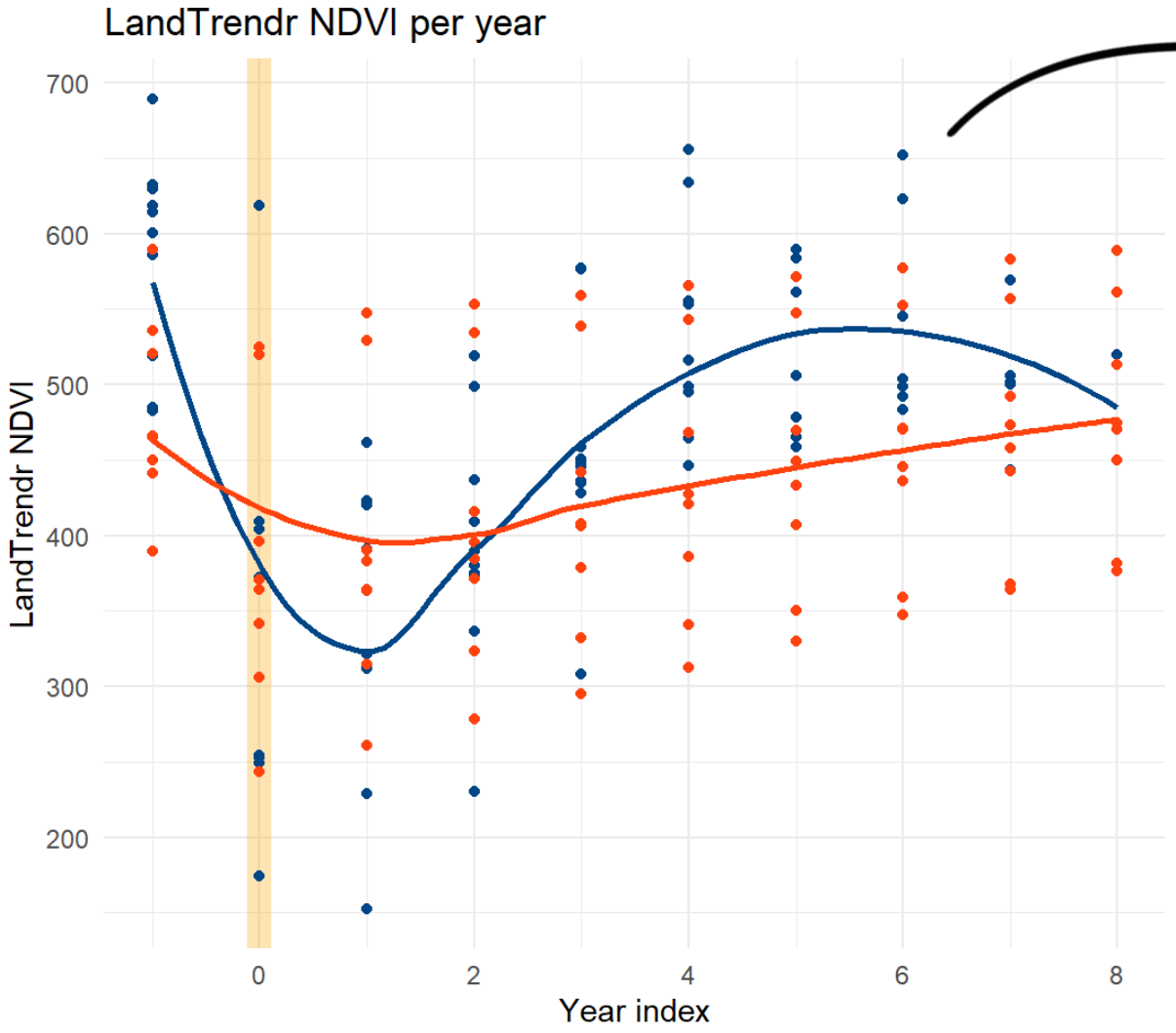

NON DROUGHT

Show more extended periods to recovery but they reach a point where the value of the NDVI returns to the levels prior to the fire.

Fire year groups

- Drought (after 2010)
- Non drought (before 2010)

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GO FOWARD

- We will take a deeper look into the samples. We will include more variables to the model like spectral indices associated with humidity, topographic and climate variables.
  - each fire
  - between fires

- Validate some points in the field, which were delayed due to the pandemic.

NDVI(+4&8 Yfire) ~ Dvi + Slope + Aspect + Elevation + TPI + PDSIpre + PDSI post + mean air temperature + mean precipitation + NDVI(preDr)

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INSIGHTS

- We feel confident that we can use time series data and detection algorithm in this case LandTrend inputs to provide relevant information for this analysis.
- Remote sensing offer various opportunities to generate valuable inputs for the monitoring of ecosystems and to support the country's commitments to safeguard the natural assets, mainly associated with Sustainable Development Goals.
- Even though our results are inconclusive so far, we believe it is possible to identify potential new fire regimes and forest recovery based on climate change condition.
- This research can contribute to the monitoring of the forest status of large areas of forest for climate and ecologically intelligent decision making.

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THANK YOU

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