Drylands: coupled ecosystems where bare areas determine the productivity of vegetated patches

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INTRODUCTION AND OBJETIVES

Drylands are the largest biomes in the Earth, covering around 40% of terrestrial land surface. They are high abiotic stress systems in which scarce precipitation and high potential evapotranspiration rates limit vegetation growth, which often appears forming patches occupying the most favourable positions within the landscape. During rainfall events, runoff is generated in open areas (runoff sources) and redistributed towards vegetation (runoff sinks), where it reinfiltrates. Water redistribution processes maximize resource availability for plants, and determines vegetation growth, coverage, and spatial distribution. This process depends mainly on topography and vegetation spatial pattern and coverage, which condition the ecosystem hydrological connectivity.

The aim of the study is to determine the relationship between water and nutrient redistribution from open areas and vegetation productivity.

METHODOLOGY

We analysed temporal series of the Normalized Vegetation Index (NDVI) obtained from SENTINEL-2 in 17 plots along an aridity gradient. NDVI is a surrogate of vegetation productivity and biomass. A water redistribution index was calculated by combining topographical information from a digital elevation model (DEM) and a vegetation cover classification from PNOA orthophotographs.

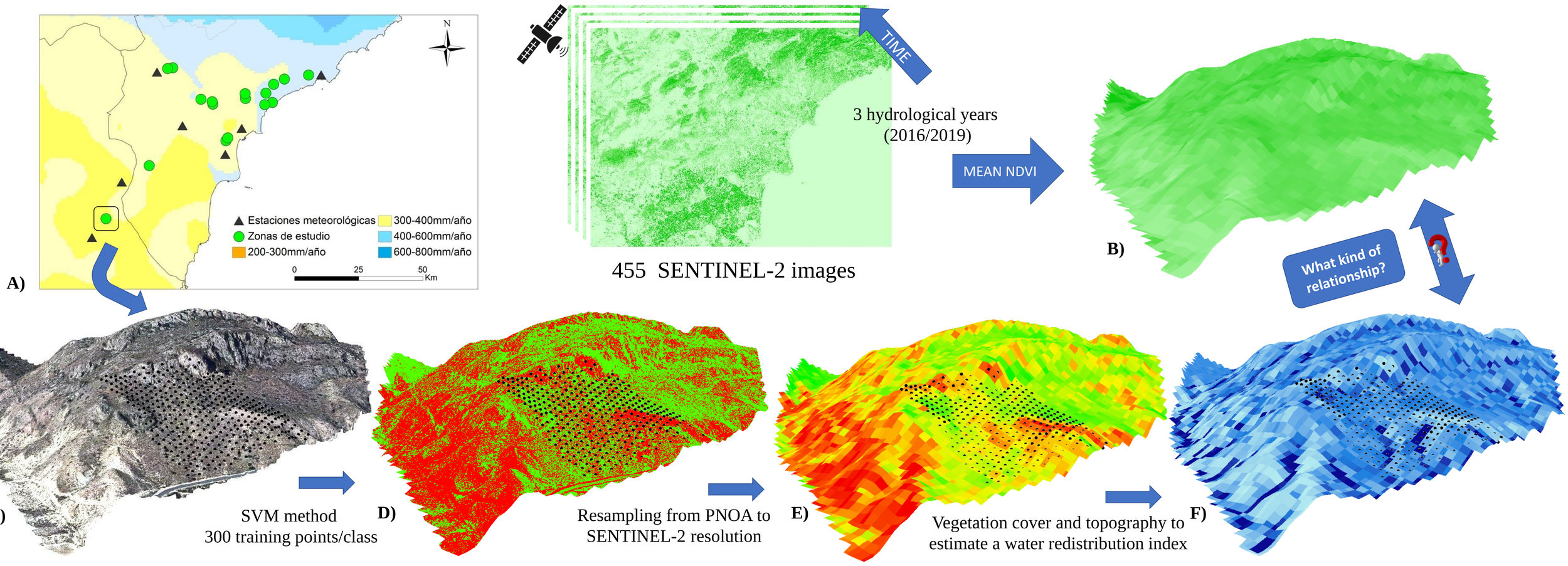
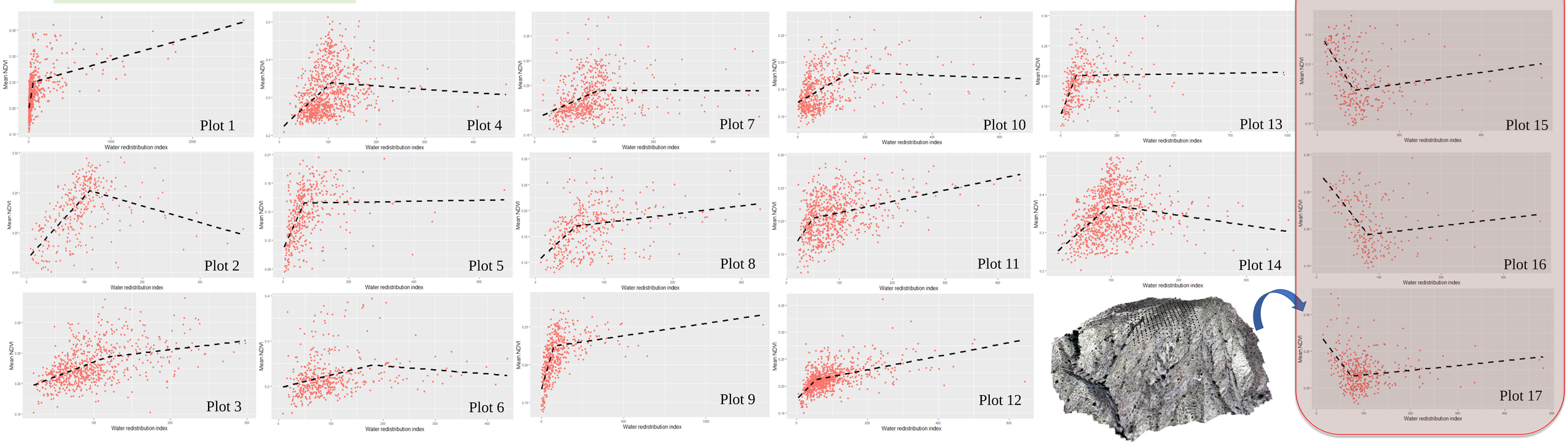


Fig.1. Localization of 17 study areas (A). Mean NDVI values for each study area during 3 hydrological years (B). PNOA orthophotography for each study plot (0.25x0.25m) was used to do a vegetation cover classification with support vector machine method (SVM) (C and D, respectively). The classification was resampled to SENTINEL-2 resolution (10x10) and used with DEM to calculate a water redistribution index that represents source-sink processes over the landscape by combining topographical information obtained and the role of vegetation in sinks (E and F, respectively). Black dots represent the study area in a hillslope.

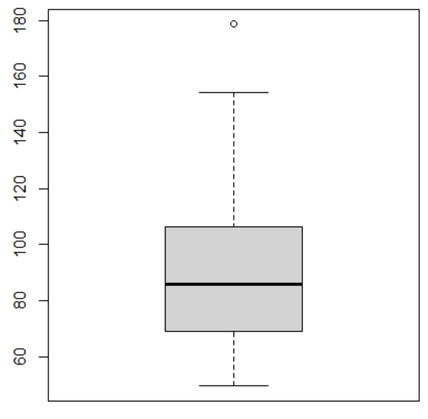
RESULTS AND DISCUSSION



Results shown a non-linear relationship between water redistribution and vegetation. NDVI increases as water redistribution index (m^2) did, until a certain point (break point). This occur when topography and vegetation pattern is not capable to infiltrate runoff generated from open areas, increasing the hydrological connectivity. An increase in ecosystem hydrological connectivity, increases water losses and reduce the water that the vegetation obtains locally, limiting the associated growth pulse.

Plots 15,16 and 17 shown an inverse pattern, due to vegetation cover is concentrated at the top of the hillslope decreasing at the lower part as consequence of degradation processes, where water accumulation is higher due to topography effects.

Connectivity feedbacks have important implications in drylands functioning by controlling ecosystem resistance and resilience. This process could be especially important under climate change, where water redistribution could ameliorate aridity increase effects.



Boxplot of breakpoints (m^2) in the plots

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