Temporal changes and dynamics of dryland ecosystem variables and their relation to aridity

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BACKGROUND

ESA CCI FELLOWSHIP: AridLand. The response and resistance of global tropical drylands to increasing aridity

Why? Because global climate change is leading to prolonged droughts, heat waves and increasing aridity.

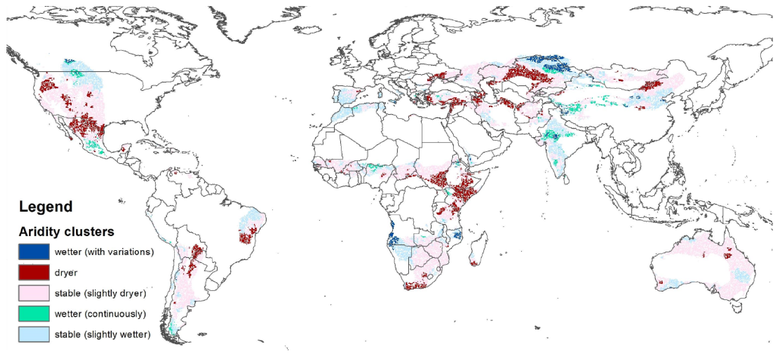
We have a good understanding of past aridity trends: progressive **enlargement of global drylands** as well as **dryland-like conditions** and mechanisms gaining importance **in more humid areas**.

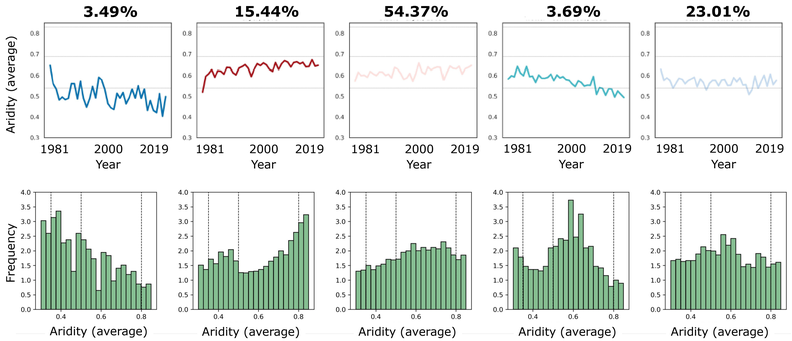
BUT knowledge about temporal dynamics, responses and resistance of drylands to increasing aridity remains unknown.

RQ1: How does climatological aridity change between 1981 and 2019?

RQ2: Do observed changes in aridity relate to changes in key ecosystem variables?

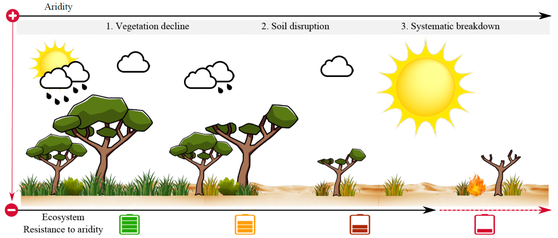
Clusters of similar trends in climatological aridity from 1981-2019





HYPOTHESIS

Increasing aridity promotes thresholds on the structure and functioning of drylands. *(Berdugo et al. 2020)*



HIGHLIGHTS

RQ1 We identify **5 dominant temporal oscillations** in aridity between 1981 and 2019 with distinct spatial patterns.

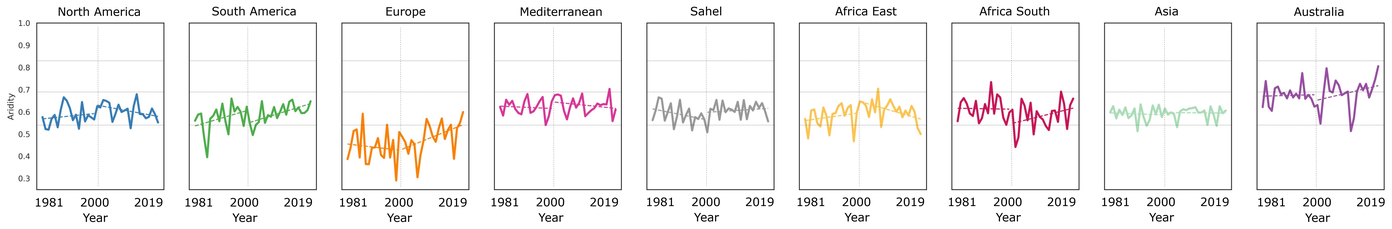
Correlation: Trends in EVs are generally well correlated with trends in aridity – regional differences.

RQ2

Partial dependence: Changes in key ecosystem variables can be related to changes in aridity. Example: NDVI inversly related to aridity.

RQ1 Trends in aridity are not linear. Change around 2000.

Average aridity over time (1981 - 2019)



DATA and ANALYSIS FRAMEWORK

Aridity = 1 – (Precipitation/ Potential Evapotranspiration)

Ecosystem variables (EV):

Vegetation
- *Vegetation productivity* – Copernicus NDVI
- *Vegetation cover* – X-VOD (AMSR-E/ 2)
- *Vegetation functioning* – SeRGS (based on Copernicus NDVI – ERA-5 precipitation)
- *Terrestrial live biomass* – Xu et al.

Climate
- *Surface and air temperature* (ERA-5)
- *Cloud Fraction* (CCI)
- *Plant functioning* – VPD

Soil
- *Top layer soil moisture* (ERA-5, layer1)
- *Root zone soil moisture* (ERA-5, layer 2-3)
- *Albedo* (ERA-5)
- *Soil properties (composition, carbon, …)*

other
- *Fire frequency, Population density, …*

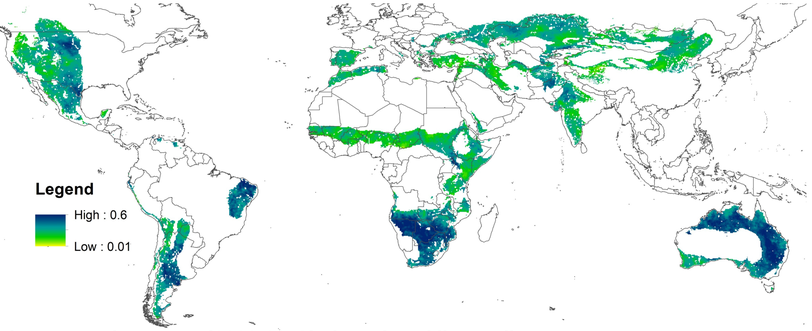
At the **global** tropical dryland scale

25km spatial resolution

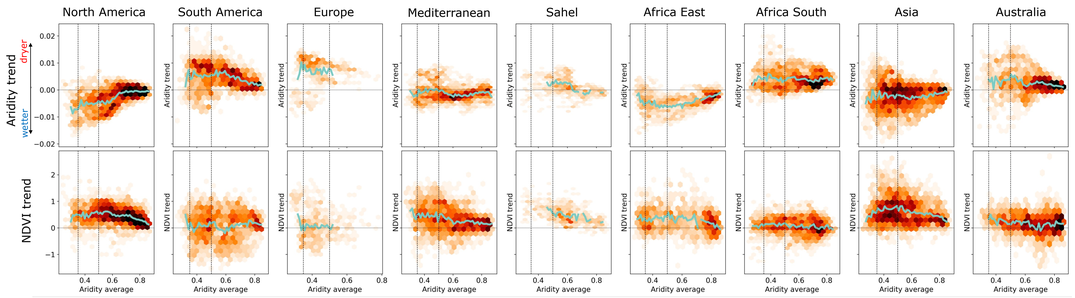
Temporal resolution: **Yearly** from 1981/ 2000 to today

Mean R^2 value

for the correlation between trends in aridity and all Evs (2000-2019)



Aridity and NDVI trends (2000-2019) along the aridity gradient



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