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Using remote sensing estimates of precipitation and evapotranspiration to assess the spatial characteristics of Chilean megadrought

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Droughts have been traditionally monitored and analysed using ground-based data. However, developing countries usually do not have a dense network of meteorological stations to allow a reliable characterization of the spatio-temporal variability of key meteorological variables. In the last decades, remote sensing techniques have become a promising alternative to provide a spatial characterisation of drought-related variables and to quantify drought impacts.

In this study we attempt to evaluate -for the fist time- the suitability of the combined use of state-of-the-art satellite-based precipitation (P, CHIRPSv2) and potential evapotranspiration (PET, MOD16) estimates to characterise the spatial distribution of the so called “Chilean megadrought”, which has affected the central-southern territory of Chile (29ºS-46ºS) during the last decade. Satellite data were collected for the period 2000-2014, and then the Standardized Precipitation Index (SPI) was used to analyse the impact of precipitation deficits on drought events, while the Standardized Precipitation Evapotranspiration Index (SPEI) was computed to take into account the simultaneous contribution of temperature and precipitation changes on drought characteristics. SPI and SPEI were evaluated at 12-month temporal scale, because they reflect long-term meteorological patterns and should tend towards zero unless a clear trend is undergoing. Drought events are operationally described in terms of its duration, severity, maximum intensity and spatial extent, using the theory of runs with a threshold of -0.84 to identify the onset and duration of drought events.

Results obtained with SPI-12 and SPEI-12, evaluated in December of each year, reveal negative values in all the study area during the megadrought (2010-2014), indicating a general deficit of precipitation and potential water availability (P-PET). The total duration of drought events increased importantly during the megadrought in comparison to previous years, reaching 40-45 months of duration (3.5 out of 5 years), with SPEI-12 identifying longer durations in some particular regions within the study area. Total severity also increased during megadrought, with values 3-4 times larger than those observed during the previous period, and with stronger severities identified with SPEI-12 in comparison to those identified with SPI-12. The maximum intensity of drought events presented a "salt and pepper" spatial pattern during all the study period, with local differences between the maximum values identified with SPI-12 and SPEI-12.

Findings of this work are expected to support the future implementation of an operational drought monitoring platform and to efficiently allocate economical resources devoted to mitigation in drought affected areas.