Assessment of compound dry and hot extremes over India using a copula-based multivariate standardized index.

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Abstract

Compound dry and hot extremes (CDHE) during the Indian summer monsoon significantly affect agriculture. Due to climate change, the frequency, spatial extent and severity of CDHE have changed over several parts of the world. Understanding the variability of CDHE is critical for designing adaptation strategies to reduce the adverse impacts on agricultural systems. In particular, traditional assessments have focused on the variability of frequency and spatial extent using the quantile-based approach. However, counting the number of events excess over the threshold helps to understand the variability in frequency and spatial extent but fails to detect the changes in the severity. Further, limited studies have investigated the changes in CDHE severity over India. Hence, in the present study, the variability of CDHE severity is assessed during the summer monsoon from 1951 to 2020 over homogenous regions of India using a copula-based Standardized Compound Event Indicator. A significant increase in the severity of CDHE during the summer season was found in eight homogenous regions out of ten. The most vulnerable regions are northeast India and peninsular India, and interestingly, a significant decrease in the severity is observed for the north rain-belt Western Himalayan region. In addition, a significant increase in the spatial extent of the CDHE severe category is also found in all the homogenous regions over the past three decades. This study highlights that severe CDHE is associated with a high risk of severe agricultural drought for a large part of the country. Uni-variate assessments based on precipitation or temperature can underestimate the risks associated with CDHE if there is a strong dependence among the drivers.

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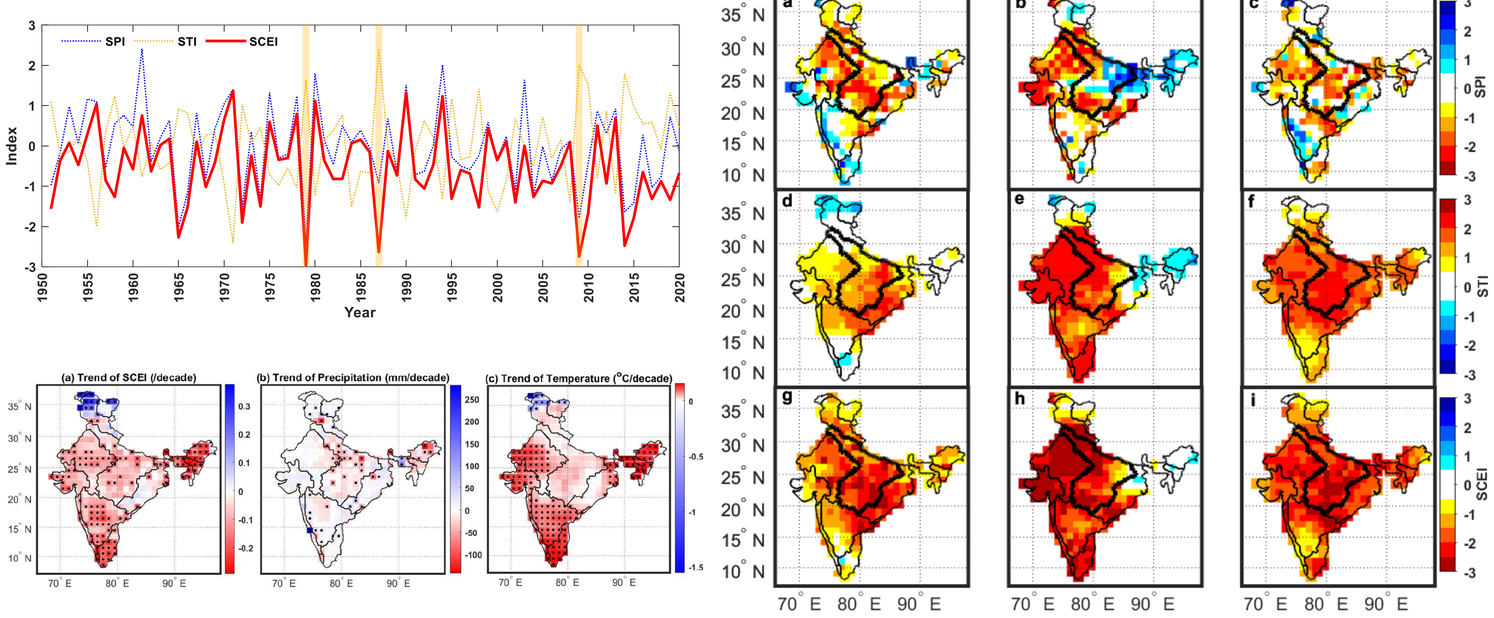
Background and Motivation

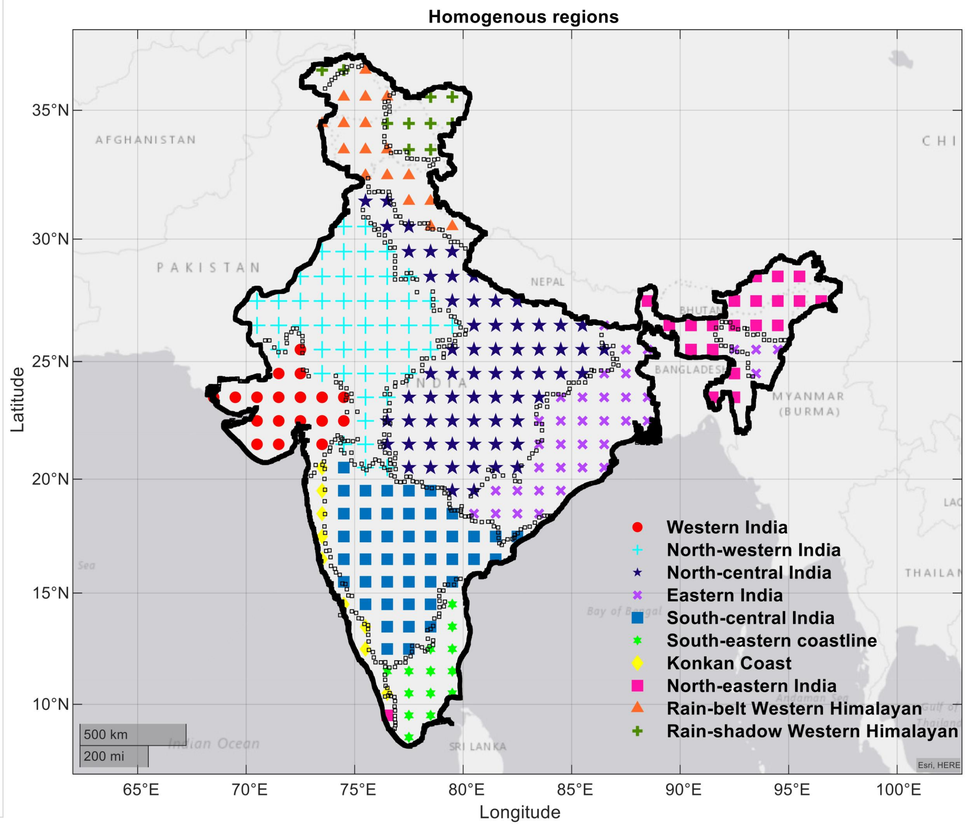
- ISM precipitation is crucial for agricultural activities… India has witnessed compound dry and hot summers that occurred during 1957, 1972, 1979, 2002, 2009 and 2014, causing a significant crop yield reduction[1].
- Widespread increase in compound dry and hot extremes is likely to pose a substantial challenge to the future food security of billions of people….
- Present study disentangle compound dry and hot extremes and identify climate change hotspots.

Comparison of Compound Dry and Hot extremes (SCEI) with Dry (SPI)/Hot(STI) extremes

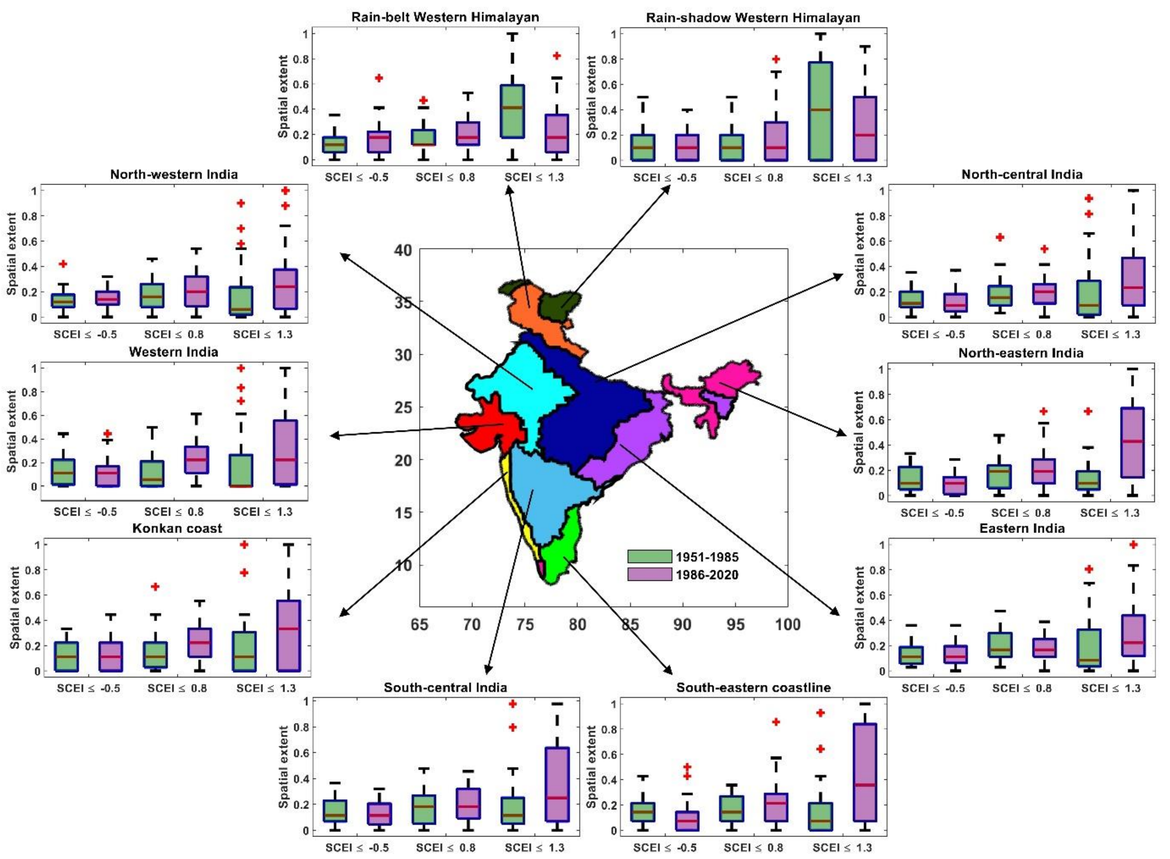


Comparison of SCEI (Standardized compound event indicator) with SPI (Standardized Precipitation Index) and STI (Standardized Temperature Index) during JJAS for the period 1951-2020

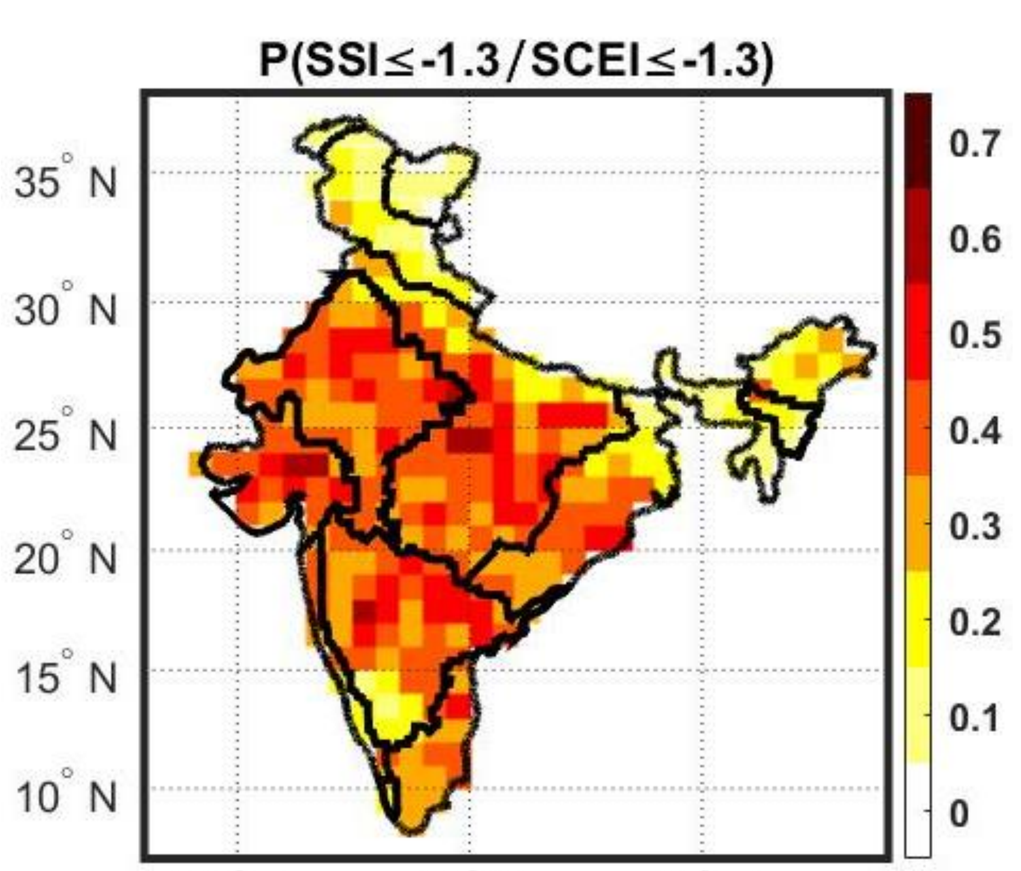
Homogenous regions of India



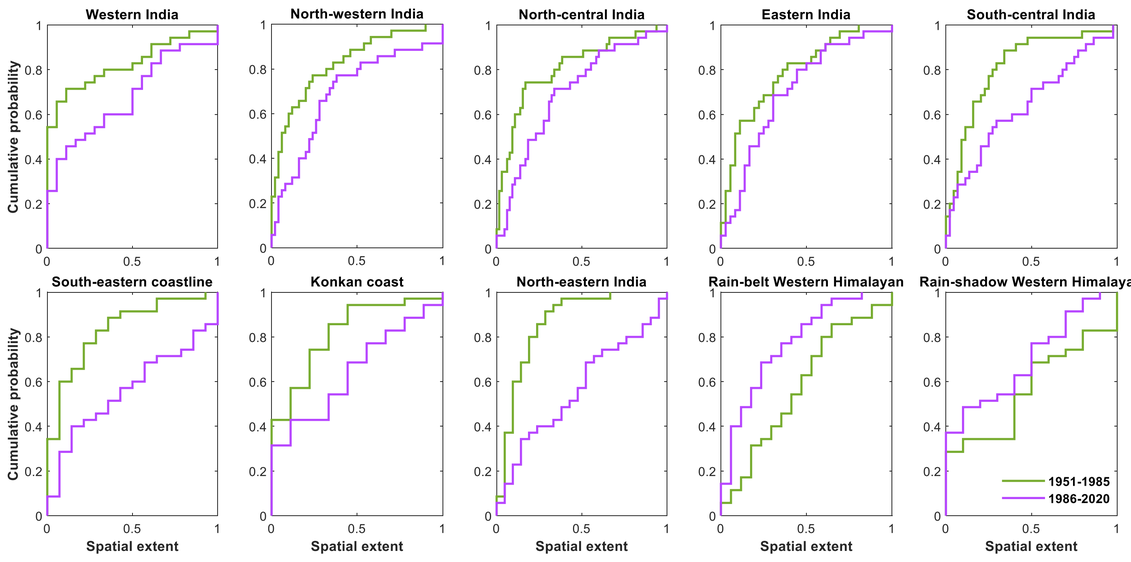
Spatial extent of SCEI severity



Implications to agricultural drought



The conditional probability of SSI≤-1.3 given the values of SCEI≤-1.3 for JJAS during the period 1951-2020 across Homogenous regions of India.



Conclusions

- Study finds a significant change in the statistical distribution of compound dry and hot extremes of severe category for the past three decades
- The changing pattern of spatial extent of compound extremes has implications to increase in the widespread agricultural droughts..

Remarks

Know more…..

Acknowledgements

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[1] R.K. Guntu, and A. Agarwal, Scientific reports, 11, 16447 (2021).