Spatio-temporal Analysis of Drought in Present and Future Climate Change Using a Large Ensemble of d4PDF Warming Scenarios Over GRB, India

〇Khagendra P. BHARAMBE, Yoshihisa SHIMIZU, Sameh A. KANTOUSH, Tetsuya SUMI, Mohamed SABER

Introduction

Climate change caused by anthropogenic global warming is a serious concern as it is predicted to have severe and widespread negative socioeconomic consequences worldwide (Jhong, 2019). The report from Intergovernmental Panel on Climate Change (IPCC) emphasized that most of the world's water resources are expected to be subject to the adverse effects of climate change (Carter et al., 2007). Frequent heavy precipitation events and severe droughts are also likely to increase due to a greater degree of fluctuation in precipitation and temperature. The Indian Community, especially from the central part, is facing the critical problem of climate change through frequent droughts, affecting water resources and agricultural food security. Rainfed-agriculture is particularly affected due to unpredictability and variability in rainfall amount.

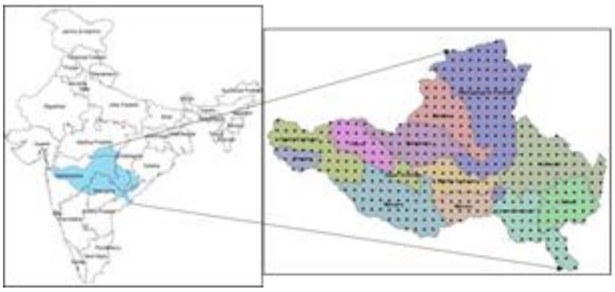

Figure 1: Study area and station grid locations.

Godavari River basins **(Figure 1)** is one of the main water resource bodies in central India, so it is crucial first to identify the precise impact of climate change and variability on river basin for effective water management. Hence, this research has been focused on mitigating the effects of increased future climate variability and the frequency of droughts and proposing an adaptation strategy for integrated river basin management under the worst-case scenario.

Methodology

The Spatio-temporal modeling approach by Sen's slope estimation using Mann Kendall's test was applied to investigate the variability and magnitude of change in climate variables and drought indices. The long-term high-spatial-resolution climate data were used to analyze the impact of climate change on droughts and associated impact on agriculture crop production to quantify the drought impact and identify feasible drought risk mitigation strategies (Figure 2).

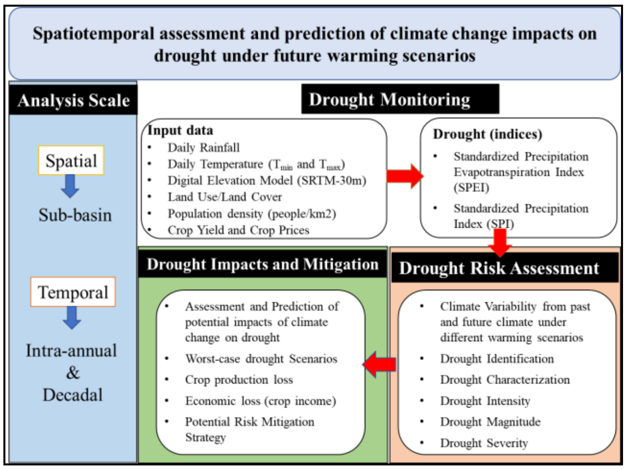

Figure 2: Research approach and overall framework.

The observed meteorological data was obtained from the Indian Meteorological Department (IMD) over the past 40 years of the reference period (1980-2019). In addition, the future projection data with different warming scenarios (optimistic, +2K-menace 2^0C increase by mid-21st century, and pessimistic,

+4K-meance 4^0C increase by the end of 21^{st} century) under the perception of worst-case climate change scenario (RCP8.5) was obtained from d4pdf simulations over the periods (2031-2050) and (2051-2100), respectively.

Results

<u>Spatiotemporal Variability and Projected Change in Drought Occurrences</u>

The results found that spatially 75% area (nine sub-basins out of 12) showed a negative SPEI (–ve) trend (*<u>highlighted by green color in the map</u>*), indicating increased drought risk and vulnerability. In contrast, only three sub-basins showed a positive (+ve) SPEI trend (*<u>presented by purple color and dark black circle</u>*), indicating the reduced drought vulnerability and risk during the past four decades over GRB (**Figure 3**).

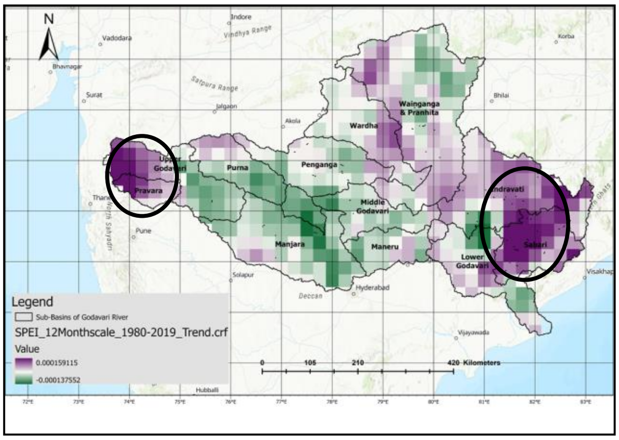

Figure 3: Spatial variation and change in drought

Whereas, it has shown increased trend with more severity in the future period (**Figure 4**). Both drought duration and severity magnitudes have shown increased under both future warming scenarios. The severe drought in 2009 (**Figure 5**) has reduced the overall crop production by 20 to 40%. Rice output has declined by 15 million tons than the previous season, which caused food grain scarcity inflation by 17 to 20%. And, it is projected that there is a possibility that long-duration dry spells may occur in the future. As a result, this study recommends considering a crop rotation strategy that includes less water-intensive crops and drought-resistant crop varieties in increased drought risk areas.

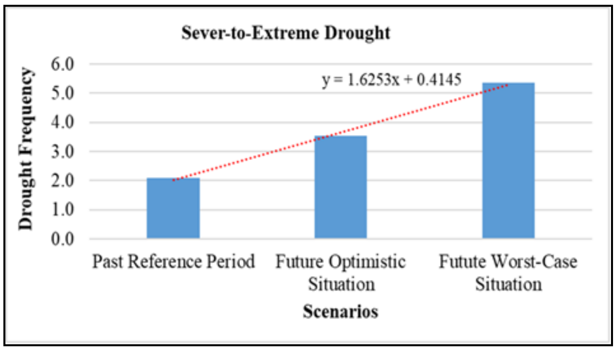

Figure 4: Temporal (decadal-average) variation of droughts & impacts projection under future warmings.

<u>Impacts of Drought and Mitigation Strategy</u>

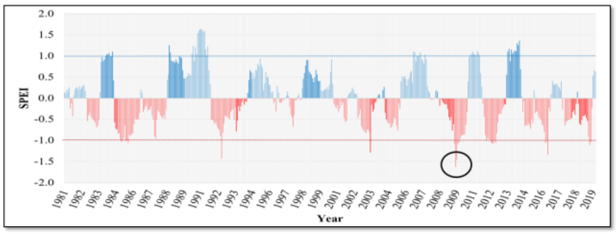

Figure 5: Intra-annual drought variability and impacts

Conclusion

Drought is most significant constraints for crop production, addressing this issue is extremely crucial to evaluate the risk associated with agricultural crop production and the economy of the farming community at Godavari River Basin in India.

References

Jhong, B. (2019). Spatial Assessment of Climate Risk for Investigating Climate Adaptation Strategies by Evaluating Spatial-Temporal Variability of Extreme Precipitation, Springer Nature, 3377–3400.

Carter, T. R., et al. 2007. General guidelines on the use of scenario data for climate impact and adaptation assessment. Geneva: IPCC, Task Group on Data and Scenario Support for Impact and Climate Assessment.