Application of Geoinformatics for Modelling Drought Dynamics in Odisha State, India

Synopsis

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Drought generally occurs when a region consistently receives less precipitation. It is a most devastating natural hazards which impact on the agriculture and economy of a state. In this research, various climatic and space based remote sensing datasets are utilized to delineate the drought dynamics, its cause, future prediction and technique for field scale soil moisture and drought mapping. Analysis of physical and cultural settings of Odisha clearly brings out that southwest monsoon has large impact and control on the agriculture of Odisha state. Mapping of drought dynamics of Odisha state over two decades using SPI and SPEI depicts that 2000, 2002, 2004, 2009, 2010, 2013 and 2015 are predominantly drought affected years , while the mild to moderate droughts are seen in Odisha in most of the years. The spatial distribution and mapping of drought characteristics i.e., drought frequency, drought severity and drought event shows that in most of the districts drought frequency is high though Odisha has experienced severe drought various occasions. Monsoon drought is most significant as it affects the Kharif crop, however, post monsoon droughts are also seen in Odisha. The drought pattern in Odisha is random, but few districts like Nuapada, Kalahandi, Bolangir, Rayagada, Ganjam, Bargarh, Malkangiri and Phulbani are chronically affected by droughts. The major climatic factors affecting drought in Odisha are precipitation, temperature, soil moisture, evapotranspiration, ground water storage, El Nino/ La Nina and IOD. The main reason of drought over Odisha state is variability of the onset of south west monsoon and the quantum of rainfall affecting the kharif crop resulting in severe droughts. Positive anomaly of the land surface temperature (LST) is observed which results in the increase of evapotranspiration ,decrease in soil moisture and ground water storage. The combined effect is severe agricultural drought. ENSO and IOD is the controlling factor of air circulation over Indian Ocean significantly impacting on the south west monsoon which in turn, affects the drought situation of Odisha. Odisha as coastal state gets highly influence by the rainfall variability.

Short and long-term drought scenario prediction, using NorESM2-MM CMIP6 GCM model predicted precipitation and temperature datasets, suggests that in the year of 2023, 2027, 2029, 2031, 2036, 2040, 2048 and 2050, more than 50% of area under the state of Odisha will be under drought. The analysis also indicates that predicted minimum and maximum temperature may increase approximately 2°C and 1.5°C respectively in this period (2023 to 2050). Temperature anomaly is also positive after 2040. In the predicted drought map, the pattern is random and the state may suffer severe droughts in the future. Enhancement of agricultural drought and soil moisture mapping by downscaling the spatial resolution of LST from coarse to medium/ finer resolution (250 m) with the help of NDVI is attempted and to derive VHI and TVDI for mapping of soil moisture and drought. . The downscaled 250 m resolution LST depicts higher spatial details compared to 1000 m resolution LST. Similar pattern with higher details is observed in the fine resolution VHI and TVDI. Entropy function is used to validate the generated VHI and TVDI maps of 250 m resolution. Larger intra-pixel variability is seen which suggests that high-resolution maps are useful for drought and soil moisture mapping and monitoring over the study area. Due to the daily availability of MODIS VNIR and thermal data, this technique may improve the probability of daily or weekly field/ regional drought and soil moisture mapping. The high frequency spatio-temporal pattern of drought/ soil moisture will certainly help the state authority for drought management and policy formation. Delineation of agricultural drought affected areas has been carried out with the help of multi-temporal Sentinel 1 SAR and landsat optical datasets for the monsoon period based on correlation between NDVI and SAR backscatter as SAR data is weather independent and sensitive to dielectric property of the soil moisture. The result shows that it is feasible to delineate drought affected areas using SAR data. Therefore, in the coastal region where cloud affects the optical data, SAR could be a potential source of drought mapping. In Odisha only 20 % agricultural area is covered by canal irrigation, therefore better drought management, irrigation system development is required for drought mitigation. The entire study reveals that management and mitigation of drought is essentially required in Odisha state.

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