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Estimation of Water Stress and Identification of Priority Areas for Irrigation over the Drought Prone Semi-Arid Region of India

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Abstract

Marathwada division of Maharashtra is one of the semi-arid regions of India where the agricultural conditions are highly vulnerable to the scanty rain and severe droughts. Over this area, significantly depleting groundwater level and low amount of monsoon rains demands for a good irrigation system for maximum crop cultivation and day-to-day activities. Therefore, this study estimates the spatio-temporal water and vegetation stress to make out the sensitive regions of Marathwada where irrigation network is necessary. The area-specific water requirement is based on the water demand for crops from that particular area. The rate of Evapotranspiration (ET) with potential ET (PET) directly represents the field-specific crop water demands, hence; to understand their relevance we have analyzed the monthly ET and Normalized Difference Vegetation Index (NDVI) by the data acquired from Moderate Resolution Imaging Spectrometer (MODIS) for the period of 2001 to 2017. Water deficiency of particular region is highly dependent on the rainfall vagaries of that area. Therefore, the monthly rainfall product from Tropical Rainfall Measuring Mission (TRMM) was also studied. Station based groundwater data, Soil profile, Land use land cover etc. were the other datasets considered to prioritize the areas for building the irrigation facilities. Study area as a whole, a significant correlation was observed between ET and NDVI. Among the eight districts of Marathwada, Latur, Parbhani Aurangabad and Hingoli were the regions where higher water stress was noticed. On the temporal scale (from last 17 years) maximum water scarcity was noticed over the year 2002-2003 and 2014 -2015. Ensemble bi-decadal analysis of five different drought indices with the aid of IMD observations shows water stress as a proxy variable for drought monitoring. Hence the proven correlation between ET, NDVI and water stress from this study, gives the new interdisciplinary approach to deal with the drought hazards and to priorities the drought-affected area which demands more concern.

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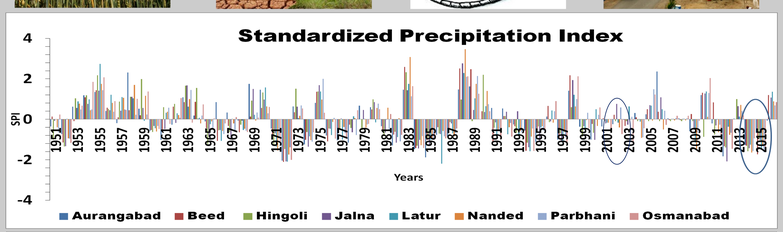
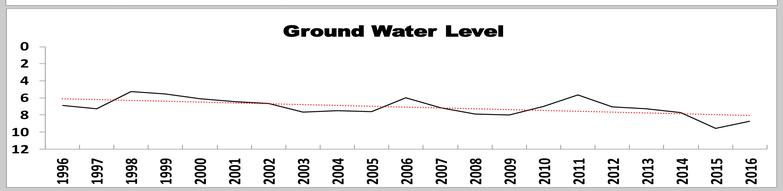
Introduction

►Drought and water stress are one of the highest destructive climate based hazards.
►Agro-economic countries like India are highly sensitive to water crises and droughts.
►Over the Marathwada region of India, significantly depleting groundwater level and low amount of monsoon rains demands for a good irrigation system for maximum crop cultivation and day-to-day activities.
►Therefore the present study gives the new approach to priorities area's for irrigation.

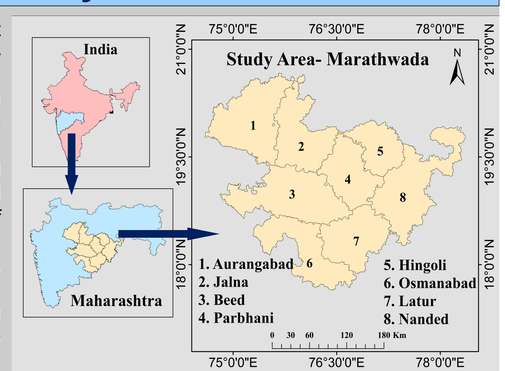
Crop Yield degradation	Desertification	Farmer Suicides	Socio-economic





Study Area

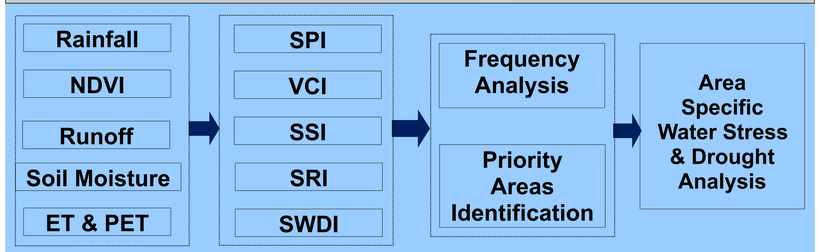
►This study has been carried out over the sub-divisions of Marathwada-Maharashtra, India.
►The overall geographical area covered by Marathwada is 64434 Sq. Km.
►This area lies on the lee ward side of the Western Ghats and forms the central portion of Maharashtra.
►Maximum Temperature= 43^{0}C,
►Minimum Temperature =11^{0}C.
►Annual average precipitation ranges between 600mm to 700mm.



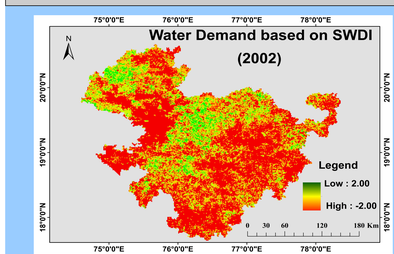
Data Used

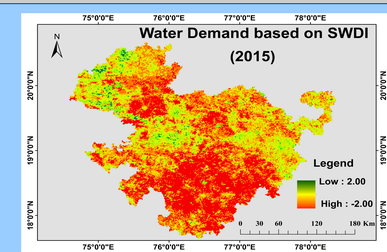
No.	Data	Period	Details
1	Rainfall	1951– 2017	IMD (Station based), TRMM(0.25*0.25 degree)
2	Ground Water	1996-2016	Water Res. Infio. system
3	ET, PET, NDVI, LST	2001-2017	MODIS (0.5 & 1 km)
4	Soil Moisture, Runoff	2001-2017	MERRA (0.5*0.5 degree)

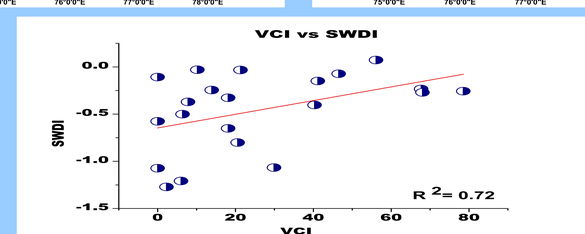
Methodology



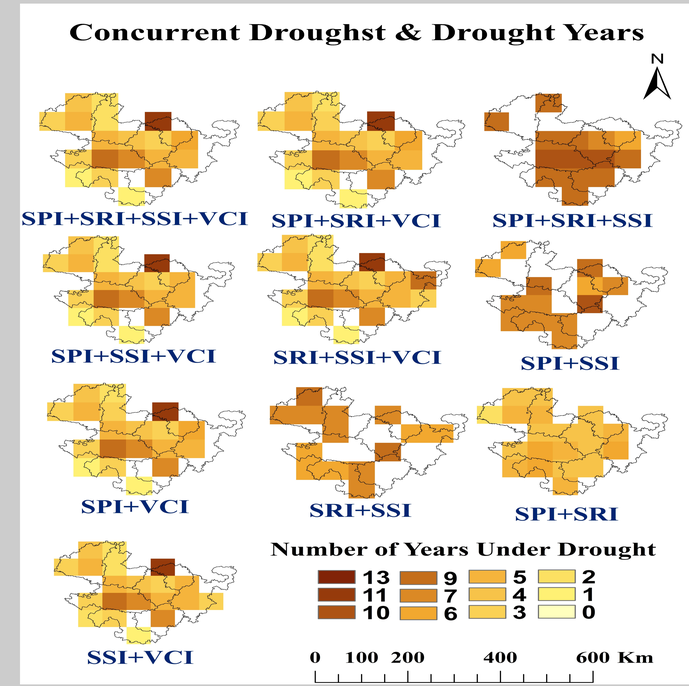
Results







Index	Relationship	Sign	Significance
SPI vs SRI	73%	+ve	No
SPI vs SSI	37%	+ve	No
SPI vs VCI	41%	+ve	No
SWDI vs VCI	83%	+ve	Yes



Conclusions

►The newly developed Standardized Water Demand Index (SWDI) is highly correlated with the vegetation stress (VCI), therefore it can be used to estimate the water stress combine with the other drought indices.
►From last two decades, high intensity of water stress and droughts was noticed over the adjoining years eg. 2002-2003, 2008-2009 and 2014-2015.
►2015 was one of the most drought-affected years since last two decades, in which 53% of the study area was under high water stress.
►As per the various drought indices, Nanded, Parbhani and Latur are the areas which are highly under water stress. From last 17 years, post-monsoon season as a whole, seven times moderate to extreme drought condition was noticed over the 19% of the study area.
►This high frequency of severe to extreme drought is a major concern towards agriculture, which also demands for good irrigation and better management policies.

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