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DROUGHT ASSESSMENT USING STANDARDIZED PRECIPITATION INDEX: A REVIEW

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Abstract: The definition of drought is a prolonged period of dryness. It has a severe impact on rangeland eco systems. There are no easy ways for ranchers to combat drought. Rangeland plants are drought tolerant to some extent. Drought works in cycle of varying duration. Drought is measured in five stages with each stage getting dryer. Drought can also affect the lives of the people who depend on the land for their livelihood. Drought cannot be avoided; some places have it more often than others but at some point in time almost everyone will have or has had a drought. In this present study we have reviewed research papers to carry out SPI Index for drought assessment.

Keywords: Drought, assessment, Standardized Precipitation Index

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1. INTRODUCTION

A drought is a period of below average precipitation in a given region resulting in prolonged shortages in the water supply and surface water. It can have a substantial impact on the ecosystem of that region, it's also harm local economy. Annual dry season in the topics increase the chance of a drought developing and subsequent bush fires. Drought affect almost environment on the earth. Many plant species, such as those in the family cactaceae, have drought tolerance adaptation like reduced leaf area and waxy cuticles to enhance their ability to tolerate drought.

1.1 Drought scenario in India

Droughts, in general, are extreme hydrologic events causing acute water shortages which persist long enough to trigger detrimental effects on human, vegetation, animals and ecosystem over a considerable area. To a meteorologist, drought is the absence of rain, while to the agriculturist it is the deficiency of soil moisture in the crop root zone to support crop growth and productivity.[1]

Since last one decade of 21st Century, it has been observed that monsoon rains are deviating much from its predictions and the regions which never experience such a natural calamity comes under mild to acute drought-prone regions.[1] Out of 100 million people affected by drought in India, 25 million are from this region, spread over 17 districts of the state, and 7 million cattle are also affected. There is a 30% deficit of food grains in this region.[3]
While Erratic Distribution of Monsoon is the main cause of abnormal monsoon, the consequences of Early Withdrawal of Monsoon are generally quite serious and can create disastrous situations for the drought-prone areas of the country.[2]

To define, drought is taken to have occurred over an area where the annual average rainfall is less than 50-75% of the normal southwest (S-W) monsoon rains. The Indian economy, thus, has been described as a “gamble of monsoon” at Venkateswarlu, 2010. A look at the rainfall departure[1] and the corresponding food-grain production in India from 2000 to 2009 reveals that in the drought years of 2002 and 2009 the All India rainfall departure was −19.2% and −21.8%, respectively, leading to a drastic fall in food-grain production by 13.4 and 6.9%, respectively, as compared to the previous years, which received good monsoon rains.[2]

No.	Region	Mean annual rainfall distribution
1	33% - Low Rainfall Region	700 mm and less
2	35% - Medium Rainfall Region	751 -1125 mm
3	24% - High Rainfall Region	1126-2000 mm
4	08% - Very high Rainfall Region	>2000mm

Table:-1- Normal monsoon rains distribution in different region in India.[1]

1.2 Drought Scenario in Gujarat

Inadequate water resources pose a big threat to the economy, human activities, and livelihood in the Gujarat/Saurashtra regions of India. The drought in the Gujarat and Saurashtra regions may be due to the poor monsoon and winter rainfall last year. In Gujarat, 12.4% of the total area is affected by salinity, with EC>4,000 micro-mhos. Gujarat has replenish able groundwater resources of about 20.4 billion cubic meters (BCM).

Figure-A:- Drought affected regions of Gujarat state of India

Table 2 shows the status of the monsoon in the region. The significant drought years are 1982, 1985, 1986, 1987, and 1988; 1982 was a moderate drought year in the Saurashtra and Kutch regions, with more than 3,000 villages facing acute drinking water shortages.[3]

Table-2:-Status of monsoon in Gujarat, Saurashtra, and Kutch regions.

Year	Gujarat	Saurashtra/Kutch
1991	+91% to -19%	-20% to -59%
1992	+91% to -19%	+91% to -19%
1993	+91% to -19%	-20% to -59%
1994	+20% or more	+20% or more
1995	-20% to -59%	-20% to -59%
1996	-20% to -59%	+91% to -19%
1997	+20% or more	+20% or more
1998	-20% to -59%	+91% to -19%
1999	+20% or more	-20% to -59%

Literature Review

- **Ana A. Paul, Luis S. Pereira (2007):-** Using the SPI relative to 67 years data sets, a Markov chains approach has been utilized for several locations in Alentejo, southern Portugal, to characterize the stochasticity of droughts, which allowed predicting the transition from a class of severity to another up to 3 months ahead. Markov models were applied using both the homogeneous and non-homogeneous formulations. The results of the application of the Markov models are presented and discussed, showing in particular the usefulness of adopting a non-homogeneous formulation, which allows to differentiate predictions in relation to the initial month considered, thus understanding the probable evolution of a drought as influenced by the climate and, in particular, the seasonality of rainfall. However, these results, which are promising in view of drought management, require further developments and to be associated with other predictive tools of stochastic or physical nature. Possible approaches on using predictions of drought class transitions in view of drought risk management are also discussed.

- **Justin Sheffield, Eric F. Wood (2014):-** Drought is one of the leading impediments to development in Africa. Much of the continent is dependent on rain-fed agriculture, which makes it particularly susceptible to climate variability. Monitoring drought and providing timely seasonal forecasts are essential for integrated drought risk reduction. Current approaches in developing regions have generally been limited, however, in part because of unreliable monitoring networks. Operational seasonal climate forecasts are also deficient and often reliant on statistical regressions, which are unable to provide detailed information relevant for drought assessment. However, the wealth of data from satellites and recent advancements in large-scale hydrological modeling and seasonal climate model predictions have enabled the development of state-of-the-art monitoring and prediction systems that can help address many of the problems inherent to developing regions. An experimental drought monitoring and forecast system for sub-Saharan Africa is described that is based on advanced land surface modeling driven by satellite and atmospheric model data. Key elements of the system are the provision of near-real-time evaluations of the terrestrial water cycle and an assessment of drought conditions.

- **Zengchao Hao, Amir AghaKouchak(2014):-** Drought is by far the most costly natural disaster that can lead to widespread impacts, including water and food crises. Here we present data sets available from the Global Integrated Drought Monitoring and Prediction System (GIDMaPS), which provides drought information based on multiple drought indicators. The system provides meteorological and agricultural drought information based on multiple satellite-, and model-based precipitation and soil moisture data sets. GIDMaPS includes a near real-time monitoring component and a seasonal probabilistic prediction module. The data sets include historical drought severity data from the monitoring component, and probabilistic seasonal forecasts from the prediction module. The probabilistic forecasts provide essential information for early warning, taking preventive measures, and planning mitigation strategies. GIDMaPS data sets are a significant extension to current capabilities and data sets for global drought assessment and early warning.

- **B.Narasimhan, B.Narasimhan (2005):-** Drought is one of the major natural hazards that bring about billions of dollars in loss to the farming community around the world each year. Drought is most often caused by a departure of precipitation from the normal amount, and agriculture is often the first sector to be affected by the onset of drought due to its dependence on water resources and soil moisture reserves during various stages of crop growth. Currently used drought indices like the Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) have coarse spatial (7000–100,000 km^2) and temporal resolution (monthly). Hence, the distributed hydrologic model SWAT was used to simulate soil moisture and evapotranspiration from daily weather data at a high spatial resolution (16 km^2) using GIS. Using this simulated data the drought indices Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI) were developed based on weekly soil moisture deficit and evapotranspiration deficit, respectively. SMDI was computed at four different levels, using soil water available in the entire soil profile, then soil water available at the top 2 ft. (SMDI-2), 4 ft. (SMDI-4), and 6 ft. (SMDI-6).

- **Saeid Morid ,Vladimir Smakhtin (2006):-** Drought monitoring is an essential component of drought risk management. It is normally performed using various drought indices that are effectively continuous functions of rainfall and other hydrometeorological variables. A number of drought indices have been introduced and applied in different countries to date. This paper compares the performance of seven indices for drought monitoring in the Tehran province of Iran. The indices used include deciles index (DI), percent of normal (PN), standard precipitation index (SPI), China-Z index (CZI), modified CZI (MCZI), *Z*-Score and effective drought index (EDI). The comparison of indices is based on drought cases and classes that were detected in the province over the 32 years of data, as well as over the latest 1998–2001 drought spell. The results show that SPI, CZI and *Z*-Score perform similarly with regard to drought identification and respond slowly to drought onset. DI appears to be very responsive to rainfall events of a particular year, but it has inconsistent spatial and temporal variation. The SPI and EDI were found to be able to detect the onset of drought, its spatial and temporal variation consistently, and it may be recommended for operational drought monitoring in the Province. However, the EDI was found to be more responsive to the emerging drought and performed better.

CONCLUSION

Drought monitoring is an essential component of drought risk management. Drought is one of the major natural hazards that bring about billions of dollars in loss to the farming community around the world each year. From this reviews of many research papers it is concluded that by Standard precipitation index method we can predict drought.

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