International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

Assessment of Drought Severity using Standard Precipitation Index in Ahmednagar District, India

Harsh Ganapathi[1]

[1] *Masters of Technology in Water Science and Governance, TERI School of Advanced Studies, New Delhi*

Abstract - *Ahmednagar district of Maharashtra State in India has always been in the limelight in the recent years whenever India suffers a drought. The geographical location and the inadequacy of rainfall in Ahmednagar district over the past few years when compared to the average rainfall of the country make it one of the most vulnerable places to suffer a meteorological drought. The unpredictability and the unknown severity of drought to occur in the future years alleviates the possibility of the drought management and drought mitigation strategies to fail eventually since drought can either be meteorological, agricultural or hydrological in nature. This paper discusses a measure the severity of meteorological drought severity using the historical data of precipitation as the major indicator. The Standard Precipitation Index (SPI) is computed and is used as an index for the prediction of drought severity and frequency of drought occurrence. The result can be used as a way forward to be ready with the water management and drought mitigation strategies to reduce the socio-economic losses incurred.*

Key Words: Meteorological Drought, Standard Precipitation Index, Mitigation strategies, Severity

1. INTRODUCTION

Ahmednagar is the largest district in Maharashtra also attains a historical standpoint. It lies in the western Maharashtra zone which is in the low precipitation zone also known as the scarcity zone in terms of the agro-ecological zones of Maharashtra [13]. The district has also been known to face 8 drought years since 2000 [12]. It is also one of the major sugarcane growing states in Maharashtra, sugarcane being one of the water guzzlers put intensive pressure on the water usage and a decline in sugar production would affect the financial status of the districts economy. The Standard Precipitation Index is an effective way of analyzing dry weather cycles and wet weather cycles. A minimum of 30-year precipitation data is required to compute the SPI but a data of more than 60-year data is often analyzed [6]. The SPI was designed to quantify the precipitation deficit for different timescales. A drought occurs when the SPI is continuously negative and reaches -1 or less. A 1-month and 3-month SPI is generally used to analyze meteorological drought while a SPI of a greater timescale is used to analyze meteorological or hydrological drought [6]. SPI for different timescales help in studying the drought trend in a geographical location using historical precipitation data. This research focusses on predicting the drought severity in Ahmednagar district using the precipitation data from 1901 to 2106.

2. METHODOLOGY

2.1 Study Area -Ahmednagar, Maharashtra

Ahmednagar is the largest district in Maharashtra having an area of 17418 square kilometers [16]. The district lies in three distinct landforms which are: the central plateau, the western hilly region and the northern and southern plains [14]. The western hilly region is completely covered by forests. The major rivers contributing to the waters in the district are the Godavari River and the Bhima River [14]. The Pravara, Mula, Adhala and Mahalungi are some of the major tributaries to the Godavari River [14].

The entire district is covered by immense quantities of loose basalt stones of all sizes which is also popularly known as the 'Deccan Trap' [16]. Ahmednagar experiences a desert climate having an average temperature of 24 degrees Celsius and an average rainfall of 345mm annually [16]. Since the district lies in the rain-shadow region of the western Ghats and receives low rainfall it is categorized into the scarcity zone in the agro-climatic zone of the state of Maharashtra.

Ahmednagar is also known for its sugar production [15]. It is one of the largest sugarcane cultivators in Maharashtra despite having very low rainfall. There are a total of 30 sugar factories in Ahmednagar, 21 Co-operative and 9 Private crushing around 81 tons of sugarcane every day [15]. The availability of good quality groundwater is difficult to attain due to the various pollution of the groundwater due to the effluents from the distilleries and the paper and pulp industries in accord with the sugar industries [15]. Groundwater development has been carried out by the state government and the central government departments, but still the overall stage of groundwater development in the district of Ahmednagar is only 79.89% and hence an additional and planning of the groundwater development and conservation is in need [16].

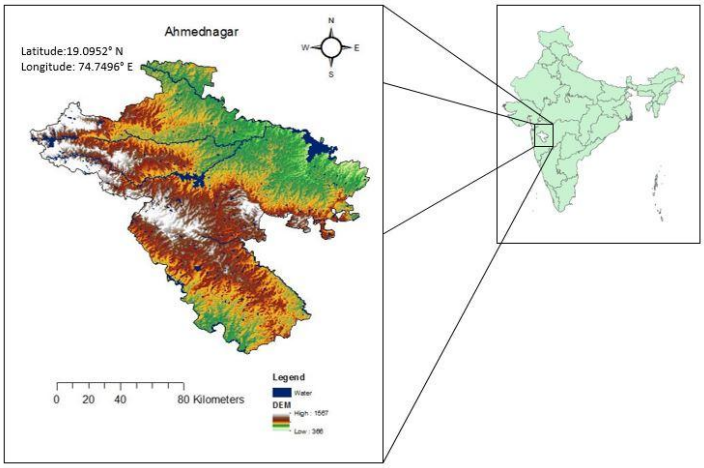


Figure 1: Study Area: Ahmednagar district

2.2 Standard Precipitation Index (SPI)

SPI was calculated using the precipitation data from 1901 to 2016 obtained from Indian Meteorological Department (IMD) for the timescales of 1,3,6,9,12,24 and 48 months.

SPI is calculated using the formula.

$$SPI = \frac{X - x_m}{\sigma}$$

Where X =precipitation of the station X_m = Mean Precipitation and σ =standard deviation [6].

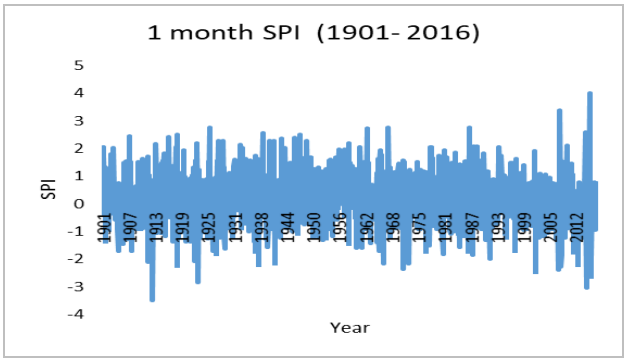
Table 1 defines the drought intensities resulting from the SPI [6].

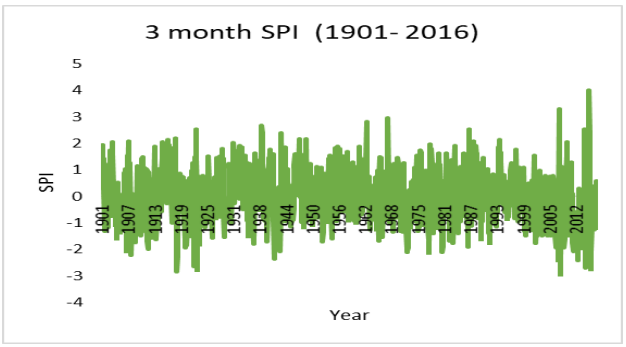
Table 1: SPI and the intensity of dryness and wetness

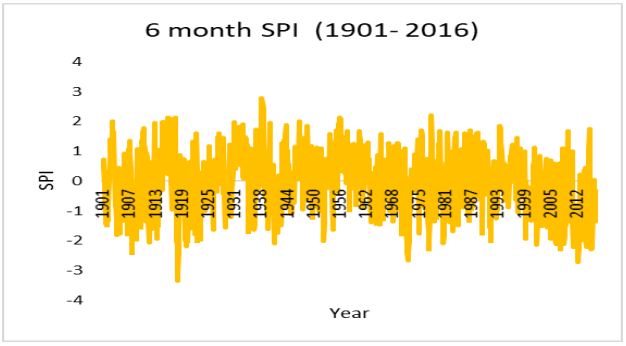
SPI Values	Intensity
2.0 and more	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Very dry
-2 and less	Extremely dry

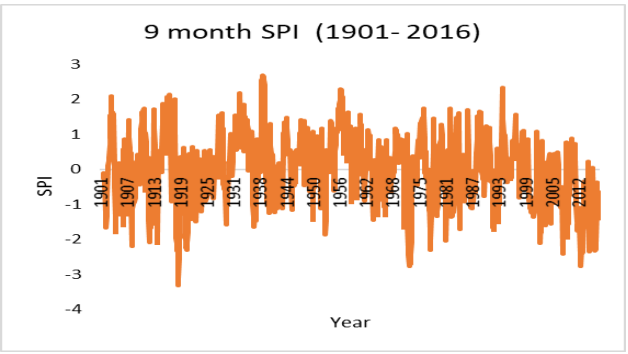
3. RESULT

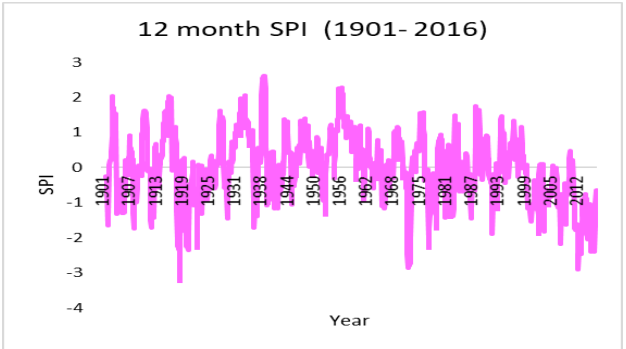
The SPI values were obtained for the timescales of 1,3,6,9,12,24 and 48 months from 1901 to 2016 for the Ahmednagar district are as shown in the figure 2 and a 30 year SPI for the timescales are as shown in figure 3.











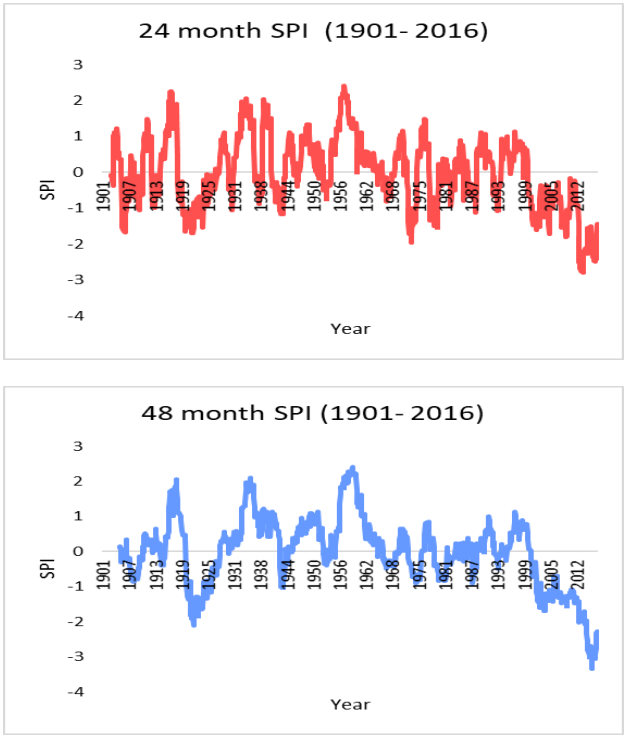


Figure 2: Year wise SPI from1901 to 2016 for Ahmednagar district for the time scales of 1, 3, 6, 9, 12, 24, 48 months

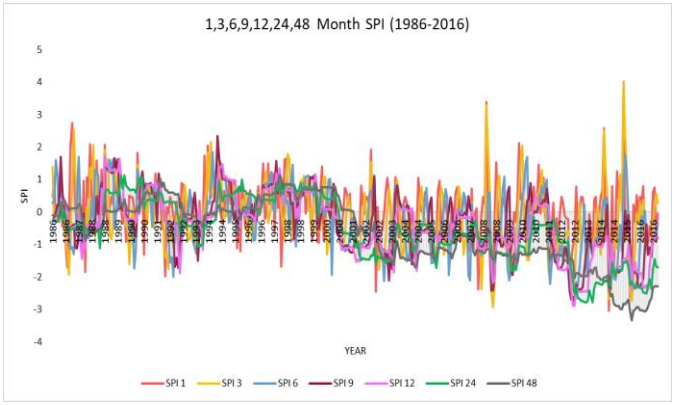
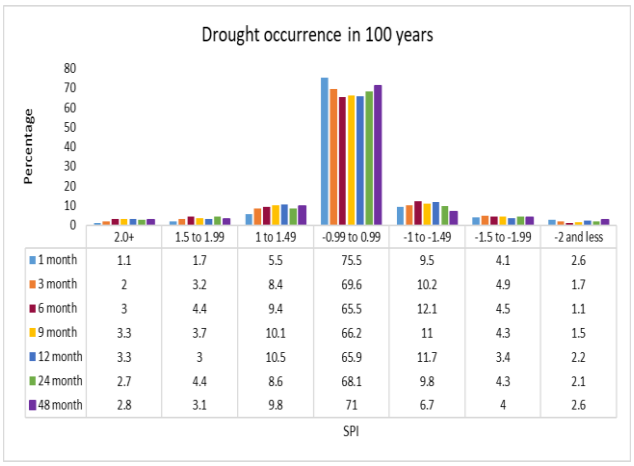


Figure 3: 30 Year SPI for the years from 1986 -2016 of Ahmednagar district for the timescales of 1, 3, 6, 9, 12, 24 and 48 months.

Figure 4 and figure 5 shows the probability of the occurrence of drought and the severity of occurrence of drought for different SPI's. It is seen that 65 to 75 percent chances are of a near normal condition whereas a moderately dry and a severely dry conditions can occur at an average of 10 percent and 5 percent respectively. An extreme condition of drought has a 2 percent chance of occurrence on an average. While figure 4 shows that a near normal condition occurs once every year or once in every two years. A moderately dry condition for a 1, 3, 6, 9, 12, 24, 48 months' time scale would occur once in every 11, 10, 8, 9, 9, 10, 15 years respectively. Similarly, a severely dry condition for 1, 3, 6, 9, 12, 24, 48 months' time scale would occur once in every 24, 20, 22, 23, 29, 23, 25 years respectively, and an extremely dry condition for 1, 3, 6, 9, 12, 24, 48 months' time scale would occur once in every 39, 59, 91, 67, 46, 48, 39 years respectively.



	2.0+	1.5 to 1.99	1 to 1.49	-0.99 to 0.99	-1 to -1.49	-1.5 to -1.99	-2 and less
1 month	1.1	1.7	5.5	75.5	9.5	4.1	2.6
3 month	2	3.2	8.4	69.6	10.2	4.9	1.7
6 month	3	4.4	9.4	65.5	12.1	4.5	1.1
9 month	3.3	3.7	10.1	66.2	11	4.3	1.5
12 month	3.3	3	10.5	65.9	11.7	3.4	2.2
24 month	2.7	4.4	8.6	68.1	9.8	4.3	2.1
48 month	2.8	3.1	9.8	71	6.7	4	2.6

Figure 4: Drought occurrence in 100 years for the different extremities and different timescales

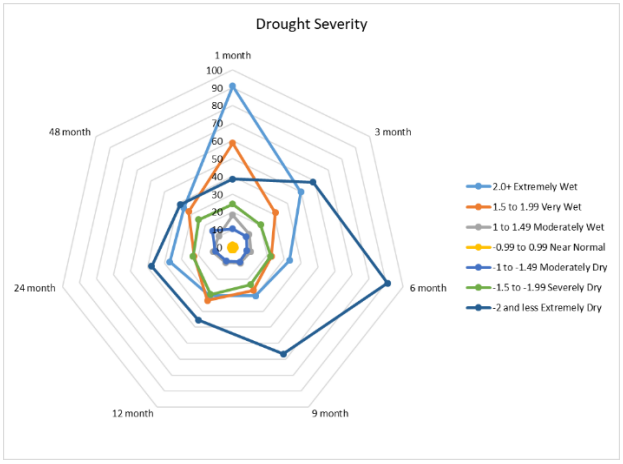


Figure 5: Drought severity for the different extremities and different timescales.

4. CONCLUSIONS

Ahmednagar district is a meteorological drought prone region having an average precipitation far lesser than the average precipitation of India which itself is not a conclusive statement as India is diverse in its topographic and climatic conditions and hence SPI is used as a tool for drought assessment in this case. Standard Precipitation Index is a technique to assess the drought trend for a region based on the historical records of precipitation data. It can be computed for multiple timescales and a computation for a shorter timescale of 1,2,3 month SPI can be helpful in providing early warning of drought and help to assess the drought severity. It is spatially consistent and allows comparison between different locations and climate, also its probabilistic nature gives it a historical context well suited for decision making. But the limitations of SPI lies in it being

solely dependent on the precipitation data while vital component for drought assessment for SPI like evapotranspiration, potential evapotranspiration and soil-water balance component are not estimated.

REFERENCES

[1] Manual for Drought Management. (2009). New Delhi: Department of Agriculture and Cooperation Ministry of Agriculture, Government of India New Delhi.

[2] Nagarajan, R. (2011). Drought assessment. Dordrecht: Springer.

[3] Monacelli, G. (2005). Drought Assessment and Forecasting. Pruhonice, Czech Republic: World Meteorological Organization.

[4] Bachmair, S., Svensson, C., Hannaford, J., Barker, L. and Stahl, K. (2015). A quantitative analysis to objectively appraise drought indicators and model drought report. In: Journal of Hydrology.

[5] Joetzjer, E., Douville, H., Delire, C., Ciais, P., Decharme, B. and Tyteca, S. (2013). Hydrologic benchmarking of meteorological drought indices at interannual to climate change timescales: a case study over the Amazon and Mississippi river basins. Hydrology and Earth System Sciences, 17(12), pp.4885-4895.

[6] World Meteorological Organization (WMO) (2012). Standardized Precipitation Index User Guide. Geneva: World Meteorological Organization (WMO).

[7] Lackstrom, K., Dow, K., Ferguson, S., Kettle, N. 2011. Understanding Needs for a Drought Early Warning System: Urban Water Systems in North Carolina. Research Report: CISA-2011-01. Carolina Integrated Sciences and Assessments. Columbia, SC: University of South Carolina

[8] Guhatakurta, P. and Saji, E. (2012). Trends and variability of monthly, seasonal and annual rainfall for the districts of Maharashtra and spatial analysis of seasonality index in identifying the changes in rainfall regime. Pune: India Meteorological Department.

[9] Drought.unl.edu. (2017). National Drought Mitigation Center. [online] Available at: http://drought.unl.edu/ [Accessed 17 Oct. 2017].

[10] Imd.gov.in. (2017). India Meteorological Department. [online] Available at: http://www.imd.gov.in/Welcome%20To%20IMD/Welcome.php [Accessed 15 Sept. 2017].

[11] Farmer.gov.in. (2017). Farmer Portal. [online] Available at: http://www.farmer.gov.in/ [Accessed 23 Oct. 2017].

[12] (NIC), N. (2017). Department of Agriculture, Maharashtra State: [online] Mahaagri.gov.in. Available at: http://www.mahaagri.gov.in/CropWeather/AgroClimaticZone.html [Accessed 16 Sep. 2017].

[13] Ahmednagar.gov.in. (2018). -जिल्हाधिकारी कार्यालय, अहमदनगर. [online] Available at: http://ahmednagar.gov.in/ [Accessed 5 Feb. 2018].

[14] Vsisugar.com. (2018). Maharashtra State Sugar Statistics - Sugar Production, Sugarcane Crushed, Sugar Recovery, Sugar Map of Maharashtra. [online] Available at: http://www.vsisugar.com/india/statistics/maharashtra_statistics.htm# [Accessed 3 Feb. 2018].

[15] GOVT OF INDIA, MINISTRY OF WATER RESOURCES, CENTRAL GROUNDWATER BOARD (2014). GROUNDWATER INFORMATION AHMEDNAGAR DISTRICT MAHARASHTRA. Nagpur.