



Evaluating Rainfall Trends at Hisar (Haryana) in the Semi-arid Zone of North India

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Abstract: The present study focuses on assessing the trend and variability in rainfall at Hisar (Haryana) situated in semi-arid zone of north India. The region faces adverse effects of moisture deficit almost every year. Normally, eight months a year except monsoon season (June-September), the potential evapotranspiration demand exceeds the rainfall. In this study, rainfall, one of the most important climatic variables was analyzed on basis of long-term historical data recorded at Hisar station. Daily rainfall data of 44 years period (1970 to 2014) was processed to study the monthly and seasonal variability. Mann-Kendall test and Sen's slope estimator were used for determining the trend and slope magnitude. The outcome of these statistical tests revealed both, rising as well as falling trends of precipitation over different time periods in a year. Starting and ending time of monsoon showed a significant shift. Overall, the rainfall showed an increasing trend of @ 2.3 mm year⁻¹. The seasonal trend analysis revealed a significant increase in rainfall during pre-monsoon season but no major change during the post-monsoon period.

Key words: Hisar, rainfall, trend analysis, Mann-Kendall (MK) test, Sen's slope estimator, MAKESENS.

Changes in climate have influenced natural and human systems and recent findings indicate that global warming is more pronounced than expected. The impact would be more in the tropical areas i.e. region of developing countries, including India. Increasing temperature trends of 0.6°C during last century and noticeable changes in rainfall events (high, low and medium) over India have been observed (Rathore *et al.*, 2013; Goswami *et al.*, 2006). It is likely that in a warmer climate heavy rainfall would increase with change in intensity. This could lead to longer dry spells and a higher risk of floods (Rahman *et al.*, 2013). Changes in rainfall pattern would also have great impact on agricultural ecosystem especially of north western semi-arid parts of India.

As discussed in IPCC 5th Report (IPCC, 2014), the global ocean will continue to warm during the 21st century, with the strongest warming projected for the surface in tropical and Northern Hemisphere sub-tropical regions. In addition, changes in precipitation will not be uniform (Pachauri and Meyer, 2014). In the light of these projections, it can be assumed that rainfall pattern in dry regions of Haryana can also undergo considerable changes. Increasing

trend of annual rainfall in Haryana was also reported by India Meteorological Department (Rathore *et al.*, 2013).

The rise in average global surface temperature (0.74° over a period from 1906-2005) along with increase in number of warmer years during past decades have been observed by IPCC (Mandal *et al.*, 2013). It is also observed by IPCC that last three decades have remained successively warmer than preceding decades. The warming will also reflect regional contrast and faster warming would have intensive impacts on water cycle in general and in arid location like Hisar in particular where the annual rainfall averages to a mere 470 mm. The Arabian Sea branch of SW monsoon passes over the region without much rainfall as the Aravallis are parallel to it. It then reaches the lower Himalaya ranges where it joins the Bay of Bengal branch of SW monsoon which is already exhausted by then. Perhaps, this area is more susceptible to climate change as geographically, it lies in the transition zone between the hot dry climate of Thar Desert and cold sub-humid climate of Himalayas (Singh *et al.*, 2014).

Hisar station lies at latitude of 29°10'N and longitude of 75°46'E and an altitude of 215.2 m above mean sea level. It is representative

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