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Short Comminucation

Regional level long-term rainfall variability assessment using Mann-Kendall test over the Odisha state of India

A. K. PRABHAKAR[1*], K. K. SINGH[1], A. K. LOHANI[2]

[1]*Department of Civil Engineering, National Institute of Technology, Kurukshetra, India*

[2]*National Institute of Hydrology, Roorkee, India*

**Corresponding author E-mail: ajayprabhakar2@gmail.com*

The climatic variability severely affects the environment, water availability, agriculture, food security, etc. particularly in the developing countries like India.In India rainfed agriculture covered about 68 per cent of the total cultivated area and more than 40 per cent of human and 60 per cent of livestock population (Sharma and Soni, 2006). It has been reported that there would be reduction in average runoff and water availability by 10-30 per cent during middle of this century. The frequency of rainfall showed the decreasing trend and the extreme events of rainfall showed the rising trends (Goswami *et al.*,2006). Patra *et al.* (2012) have reported the insignificant decline trend in annual and monsoon rainfall and the increasing trend in winter and summer season rainfallin Odisha state. While Attri *et al.* (2018) have shown non-significant increasing trend in rainfall in arid region of India.

The present study highlights the district wise rainfall variability and trend analysis for the Odisha State using 113 years (1901-2013).The gridded rainfall data procured from Indian Meteorological Department (IMD) Pune with the resolution of 0.25° latitude x 0.25° longitude has been used in this study.The long-term (1901-2013) annual average rainfall of state of Odisha is approximately 1438 mm.The average weighted monthly rainfall for each district have been estimated according to the number of grids lies inside the boundary of each district.The whole year is categorized into different seasons mainly: winter season rainfall (December–February), pre-monsoon rainfall (March-May), monsoon rainfall (June–September), and post-monsoon rainfall (October–November), for investigating the spatial and temporal changes in rainfall. Standard normal homogeneity test (SNHT) and the Mann-Whitney Pettit (MWP) test have been applied to detect the probable break point in the entire time series (Pettitt, 1979). The Mann Kendall (MK) test, a non-parametric test is considered as better than other parametric tests for detection of monotonic rainfall trends in time series data. Also, the positive and negative values shows the increasing and decreasing trends in rainfall respectively(Mann 1945; Kendall *et al.* 1975).

Both SNHT and MWP test showed that 1945 was the most probable break point in rainfall series of Odisha State (Table 1). The decreasing trend in annual and monsoon time series during 1901-2013 is observed in most of the districts of the Odisha state, however few districts viz. Baleshwar, Cuttack, Dhenkanal, Gajapati, Ganjam and Jagatsinghpur showed significant increasing trend.

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Table 1: MWP test, SNHT test and MK test for rainfall in Odisha state (1901–2013)

Districts/State	MWP Test			SNHT Test			MK Test	
	P value	Year	Trend	To value	Year	Trend	Annual	Monsoon
Angul	0.34	1963	*Ho*	4.13	1963	*Ho*	-0.34	0.28
Baleshwar	0.15	1924	*Ho*	6.81	1912	*Ho*	1.88	2.39
Baragarh	0.01	1961	*Ha*	11.63	1961	*Ha*	-1.55	-1.59
Bhadrak	0.14	1952	*Ho*	8.41	1946	*Ho*	-0.38	-0.06
Bolangir	0.04	1961	*Ha*	5.12	1961	*Ho*	-1.55	-1.01
Boudh	0.05	1944	*Ha*	8.37	1963	*Ho*	-1.25	-1.48
Cuttack	0.01	1989	*Ha*	13.33	2000	*Ha*	2.15	1.97
Deogarh	0.26	1982	*Ho*	4.76	1982	*Ho*	0.13	0.87
Dhenkanal	0.00	1982	*Ha*	13.62	1982	*Ha*	2.19	2.05
Gajapati	0.55	1977	*Ho*	4.27	1979	*Ho*	1.09	2.01
Ganjam	0.46	1976	*Ho*	6.37	2012	*Ho*	1.42	2.05
Jagatsinghpur	0.02	1989	*Ha*	10.32	1989	*Ho*	2.2	1.56
Jajpur	0.21	1924	*Ho*	5.77	1924	*Ho*	1.34	1.09
Jharsuguda	0.00	1952	*Ha*	14.68	1961	*Ha*	-2.89	-3.01
Kalahandi	0.37	1989	*Ho*	6.52	2000	*Ho*	0.27	0.81
Kandhamal	0.23	1963	*Ho*	4.47	1933	*Ho*	-0.81	0.44
Kendrapara	0.47	1912	*Ho*	5.18	1912	*Ho*	1.09	0.96
Keonjhar	0.32	1946	*Ho*	4.00	1946	*Ho*	-0.05	-0.21
Khordha	0.14	1989	*Ho*	6.31	1989	*Ho*	-0.09	0.07
Koraput	0.00	1962	*Ha*	10.34	1962	*Ho*	-2.34	-2.79
Malkangiri	0.10	1959	*Ho*	11.14	2002	*Ho*	-0.81	-0.12
Mayurbhanj	0.68	1970	*Ho*	5.76	2012	*Ho*	0.93	1.28
Nabarangpur	0.26	1947	*Ho*	5.58	2002	*Ho*	-0.95	-0.3
Nayagarh	0.08	1989	*Ho*	7.94	2000	*Ho*	0.34	0.68
Nuapada	0.00	1961	*Ha*	14.35	1961	*Ha*	-3.16	-2.44
Puri	0.31	1989	*Ho*	4.79	1989	*Ho*	-0.43	-0.25
Rayagada	0.91	1913	*Ho*	2.86	1908	*Ho*	0.76	1.04
Sambalpur	0.04	1946	*Ha*	7.51	1961	*Ho*	-1.58	-1.58
Sonepur	0.11	1944	*Ho*	4.51	1944	*Ho*	-1.01	-1.23
Sundargarh	0.00	1953	*Ha*	15.27	1953	*Ha*	-3.03	-2.87
Odisha State	0.27	1945	*Ho*	3.96	1945	*Ho*		

H_0, H_a represents homogeneous and heterogeneous series at significance level of 5% respectively

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