OPEN ACCESS

Global Journal of Research in Agriculture & Life Sciences
Volume 01| Issue 02 | Sept-Oct | 2021
Journal homepage: https://gjrpublication.com/journals/

Original Research Article

Statistical Assessment on Impact of Climate Change on Different Districts of Odisha

*Subrat Kumar Mahapatra[1] and Jayashankar Pradhan[2]

[1]Assistant Professor (Agril Statistics), School of Agriculture, GIET University, Gunupur, India
[2]SMS (Agro-Meteorology), Krishi Vigyan Kendra,OUAT, Gajapati, Odisha,India

Submission Date: 31 July 2021 | **Published Date:** 28 Oct. 2021

***Corresponding author:** smsubrat362@gmail.com

Abstract

The present experiment is conducted to know the effect of climate change on different districts of Odisha.This analysis was carried out with an objective to detect the trend analysis on variation of rainfall in all the thirty districts of Odisha from 1970-2018. Various statistical parameters such as mean, Coefficient of Variation (C.V), Skewness and Kurtosis value were estimated. Linear regression analysis, which is a useful parametric model used to develop functional relationships between variables was also applied to determine trend of rainfall for the study area. The statistics like annual maximum, mean, standard deviation, Skewness, kurtosis and coefficient of variation (CV%) for district wise monthly rainfall data of 40 year are calculated. These parameters help in explaining the characteristics of rainfall. The District's wise rainfall trend and temperature trend was analysed over a period of 40 years (1970-2018) using the most powerful non-parametric Mann Kendall rank test at 1%, 5%and 10% significant level. Annual and monsoon rainfall is increasing and decreasing at 5%and 10% significant level. The coefficient of variation ranged from 25% to 113% for the seasonal data value. By using the t-test trend of the monthly, seasonal and annual rainfall are also estimated. All the monthly, annual and seasonal rainfall data showed a positive skewness and kurtosis were calculated. It is estimated that the month of April, July, September and October follows an increasing trend whereas all the other monthly, seasonal and annual data follows a decreasing trend. The trend at monsoon temperature showed that most of districts have no trend but phulbani, Koraput, Malkangiri,Rayagada, Nayagarh and Puri are shown rising trend at 5% and 10% significant level.

Keywords: Rainfall trend, mean, c.v. skewness, kurtosis, t-test, Mann Kendall rank test.

INTRODUCTION

The state of Odisha highly depends on rainfall for agricultural production. But rainfall distribution is very erratic and uneven which results in heavy floods and droughts in different pockets of the state. Thus, agricultural production is very unstable. It is present in the eastern region of India which is again located in the subtropical belt of medium pressure. Here the hot and dry summer welcomes the wet humid monsoon which lasts about a few months. Charming autumn and a short and mild winter entertain human life. But here the climate is characterized by high temperature and medium rainfall. Topography however modifies the local climate greatly. The four meteorological seasons prevailing in the state are: winter (January to February), pre-monsoon season (March to May), south-west monsoon season (June to September) and north east monsoon season (October-December). The average annual rainfall of Odisha is almost 1482.2 milimetres out of which a major amount is being received during June to September. Failure of adequate rainfall causes scarcity of water while excess causes floods in monsoon but normal rainfall controls the yield.

The United Nations Framework Convention on Climate Change (UNFCCC) is attributed directly or indirectly to human activity which has a bearing on the global atmosphere. Essentially climate change is not the same as weather change. Change of weather is seasonal and temporary whereas climate change involves permanency in change of weather. The established meaning of climate is the measure of the average pattern of variation in temperature, humidity, atmospheric pressure, wind precipitation and other meteorological variables in a given region over a long period of time. It is different from weather and describes the short term conditions of these variables in a given region. In a narrow sense climate is average weather at least for a period of 30 years as per the World Meteorological Organization. The climate as

observed is now subject to significant change. The Climate of Odisha has been set up since ages and the seasons are monsoon, winter, summer, spring and autumn, occur at constant time and continue for a certain period. This climate of the state has been determined due to a number of factors such as location, ocean currents, forests, direction of prevailing winds, shape of land and influenced by humans to a great extent. The above factors have changed the climate of the state to a great extent recently. Climate change has become a matter of great concern. Odisha's seasons have all but vanished, its trees have altered their flowering time, and the farmers have changed their farming practices. Not only this, of the six seasons prevalent there seems only two summers and rain that have their effects on Lands of the state. Autumn, spring and winters have slowly vanished from the memory of the people. While summers have become longer, winters have become warmer and rains have shortened from above 120 to 90 days while becoming erratic beyond point... Climate is one of the main determinants of agricultural production. Throughout the world there is significant concern about the effects of climate change and its variability on agricultural production. Current climate variability and change is predicted to cause increasing global temperature and subsequently impact the rainfall. Agriculture is one of the most climate sensitive sectors as it is continuously and directly affected by temperature and precipitation. Climate changes pose significant economic and environmental risks worldwide.

REVIEW OF LITERATURE

Climate change effects to food security are in four dimensions, food availability, food accessibility, food utilization and food system stability. It will also have an impact on human health, livelihood assets and food production and distribution channels (FAO, 2008). Due to rising global population size, climate change will challenge agricultural production and food security (location of production, supply, volume, quality) and by 2080, agriculture output Least Developed Countries (LDCs) may decline by 20 percent due to climate change and yields could decrease by 15 percent on average, while output in industrial countries is expected to decrease by 6 percent (Masters *et al.,* 2010). It will affect about 200 million people and their families worldwide who live by fishing and aquaculture (Greg *et al.*, 2011).In India, Gross Domestic Product (GDP) may decrease up to 6.2% and agriculture production may decrease up to 24% by 2080 due to climate change (Zhai and Zhuang, 2009; and Zhao Et *al.,* 2009). However, variations between storm characteristics (duration and return period) were more pronounced for short- duration, high-intensity events than they were for long duration, low-intensity events. The sizable variation between historical and future rainfall intensities for short-duration events, however, generally supported the notion that precipitation intensity will be more severe in future decades (Endreny and Imbeah 2009). Gao et al. (2002) have applied stochastic hydrology methods to analyze the characteristics of annual inflow evolution of Miyun reservoir. It is obvious from their experiment that the annual inflow decreasing is mainly caused by human activities, such as extreme population increase and land use changes. Modeling the changes of in-flow to reservoirs has been studied by Dilini et al. (2013) for effective water management. Sahu et al. (2012) made use of an artificial intelligence technique called the self-organizing map (SOM) to perform trend and cluster analysis for the inflows into the flood-control reservoirs of Indiana. Along with SOM, this research also used the Mann-Kendall test and a revised Mann-Kendall test for regional analysis for northern reservoirs of Indiana. Sethy et al. (2015) performed a trend analysis for precipitation and inflows time series for Salia river basin of Odisha, India which is draining to Chilika lake using the Mann– Kendall test. In order to assess the impact of climate change ARNO model was used to simulate the inflows into Salia reservoir calibrating the observed inflow Dawson et al. (2015) have studied about trends in water quality and quantity for 11 major reservoirs of the Brazos and Colorado river basins in the southern Great Plains. Brown (2008) has found out that according to United Nation Population Fund's State of the world population 2009 there will be an increase in migration trends which would reach up to 200 million by 2050. Brooks (2003) made an attempt to develop a conceptual framework of risk, vulnerability and adaptive capacity that synthesizes a variety of approaches. By distinguishing between social and biophysical vulnerability the apparent conflict between different formulations of vulnerability in the climate change literature can be resolved. Chandran (2013) has tried to find out that Climate change is a human development issue which undermines expanding human potential, developing capabilities and enlarging freedom. Climate change poses major obstacles to progress in meeting the Millennium Development Goals (MDGs) and maintaining progress raising the Human Development Index (HDI). Climate change is closely linked to the broader sustainable development agenda to reduce poverty, child mortality and morbidity.

MATERIALS AND MATERIALS

The study period consists from the year 1970 to 2018. Daily Rainfall data of 40 years for the period 1970 to 2018 were collected from the SRC Odisha (2019), India meteorological department (IMD) website (http://www.Indiawaterportal.org/met data).Monthly, Seasonal(S-W Monsoon, Post Monsoon, winter and summer) and annual rainfall data were computed from daily rainfall data. Statistical Parameters such as Mean, standard deviation, Coefficient of variation, Skewness and Kurtosis of these rainfalls were calculated by using SPSS 20.0... The trend was analyzed using non- non-parametric Mann-Kendall test (Mann1945; Kendall, 1975). The MK test has been employed by a number of researchers to ascertain the presence of statistically significant trends in hydrological climatic variables such as temperature, precipitation with reference to climate change. The MK test checks the null hypothesis of no trend versus the alternative hypothesis of the existence of increasing or decreasing trend. The regional water resources study was done by analyzing the rainfall data for 30 districts of Odisha for the period of 1970 to 2018.

Variability analysis (Coefficient of variation): Assessment of rainfall variability through CV % appears to be quite simple. CV is abbreviated Coefficient of variation which is defined as the Standard deviation divided by the mean value of rainfall. It expresses the variability of rainfall in percentage.

Trend Analysis: A trend is a pivotal change over time exhibited by a random variable. Here, the magnitude of trend in a time series is determined by using regression analysis (parametric test). This method assumes a linear trend in the time series. In this particular study, the linear regression test was employed. For study purposes we have to work out trend analysis on an annual as well as seasonal basis.

Student t-test: Student t test was pioneered by W.S. Gosset (1908) who wrote under the pen name of *Student*, and later on developed and extended by Prof. R.A. Fisher.

Let $x_1, x_2 \dots \dots \dots x_n x_1, x_2 \dots \dots \dots x_n$ be the random sample of size 'n' form a normal population with a mean 'μ' and variance 'σ^2' then student's t-test is defined by statistic

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \sim t_{(n-1)} df$$

Mann Kendall Test: A stochastic process is a statistical process shown in (figure 4) involving a number of random variables depending on a variable parameter. If the variable parameter is the time, then the process becomes a stochastic time series in this analysis the in-flow series. The most important aspect of stochasticity is stationary.

RESULT AND DISCUSSION

In the present study trend analysis of annual, monsoon and temperature has been carried out. For this initially the available rainfall and temperature data was classified in the above period .Further Mann-Kendall test was applied for three significance levels i.e. 1%,5%and 10%.On the basis of Z-statistics of each significance level the trends in of Orissa has been determined. The trends in total rainfall, annual maximum rainfall, monsoon rainfall and total temperature were investigated through the Kendall's test for Orissa. The monthly data were used to compute seasonal and annual time series of total rainfall. The annual and monsoon rainfall and temperature trend at 5% and 10% significant level of 30 districts are shown below.

Table-1: (Annual trend and Z values of 30 districts)

SL.NO	DISTRICT	ANNUAL TREND		TEST STATISTICS VALUE (Z_VALUE)
		5%	10%	
1	ANGUL	No	No	0.77
2	BALESWAR	Rising	Rising	2.017
3	BARGARH	No	Falling	-1.75
4	BHADRAK	No	No	1.57
5	BOLANGIR	No	Falling	-1.85
6	BOUDH	No	No	0.41
7	CUTTACK	Rising	Rising	2.33
8	DEOGARH	No	Falling	-1.88
9	DHENKANAL	No	No	1.29
10	GAJAPATI	Rising	Rising	2.1
11	GANJAM	No	Rising	1.75
12	JAGATSINGHPUR	Rising	Rising	3.32
13	JAJPUR	Rising	Rising	1.97
14	JHARSUGUDA	Falling	Falling	-2.01
15	KALAHANDI	No	No	-0.37
16	KENDRAPARA	No	No	1.44
17	KEONJHAR	No	Rising	0.9
18	KHURDA	Rising	Rising	2.01
19	KORAPUT	No	No	1.18
20	MALKANGIRI	Rising	Rising	2.7
21	MAYURBHANJ	No	No	1.33

22	NABARANGPUR	No	No	-0.86
23	NAYAGARH	Rising	Rising	-2.48
24	NUAPADA	Falling	Falling	-2.84
25	PHULBANI	No	Rising	1.75
26	PURI	Rising	Rising	2.96
27	RAYAGADA	No	No	0.44
28	SAMBALPUR	No	No	-1.05
29	SONEPUR	No	No	-0.86
30	SUNDARGARH	Falling	Falling	-2.13

Table-2: MONSOON RAINFALL TREND AT 5% AND 10% SIGNIFICANT LEVEL OF 30 DISTRICTS

DISTRICT	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	5%	10%	5%	10%	5%	10%	5%	10%	5%	10%
ANGUL	No	No	No	Rising	No	No	No	No	No	No
BALESWAR	No	No	No	Rising	No	No	No	No	No	No
BARGARH	No	No	No	No	Falling	Falling	No	falling	No	No
BHADRAK	No	No	No	No	No	No	No	No	No	No
BOLANGIR	No	No	No	No	No	No	falling	falling	No	No
BOUDH	No	No	Rising	Rising	No	No	No	No	No	No
CUTTACK	No	No	Rising	Rising	No	No	No	No	No	No
DEOGARH	No	No	No	No	falling	falling	falling	falling	No	No
DHENKANAL	No	No	No	Rising	No	No	No	No	No	No
GAJAPATI	No	No	No	Rising	No	No	No	No	No	No
GANJAM	No	No	No	No	No	No	No	No	No	No
JAGATSINGHPUR	No	No	Rising	Rising	Rising	Rising	No	No	No	No
JAJPUR	No	No	No	No	No	No	No	No	No	No
JHARSUGUDA	No	No	No	No	Falling	Falling	Falling	Falling	No	No
KALAHANDI	No	No	No	No	No	No	Falling	Falling	No	No
KENDRAPARA	No	No	No	No	No	No	No	No	No	No
KEONJHAR	No	No	No	No	No	No	No	No	No	No
KHURDA	No	No	No	Rising	No	No	No	No	No	No
KORAPUT	Rising	Rising	No	No	No	No	No	No	Rising	Rising
MALKANGIRI	Rising	Rising	Rising	Rising	No	Rising	No	Rising	No	No
MAYURBHANJ	No	No	No	Rising	No	No	Falling	Falling	No	No
NABARANGPUR	No	No	Rising	No	No	No	No	No	No	No
NAYAGARH	No	No	No	Rising	No	No	No	No	No	No
NUAPADA	No	No	Rising	No	Rising	Rising	Rising	Rising	No	No
PHULBANI	No	No	Rising	Rising	No	No	No	No	No	No
PURI	No	No	No	No	No	No	No	No	No	No
RAYAGADA	No	No	No	No	No	No	No	Rising	No	No
SAMBALPUR	No	No	No	No	No	No	No	NO trend	No	No
SONEPUR	No	No	No	No	No	No	No	NO	No	No
SUNDARGARH	No	No	No	No	Falling	Falling	Falling	Falling	No	No

Table-3: MONSOON TEMPERATURE TREND AT 5% AND 10% SIGNIFICANT LEVEL OF 30 DISTRICTS

	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	5%	10%	5%	10%	5%	10%	5%	10%	5%	10%
ANGUL	No	No	No	No	No	No	No	No	No	No
BALESWAR	No	No	No	Rising	No	No	No	No	No	No
BARGARH	No	No	No	Rising	No	No	No	No	No	No
BHADRAK	No	No	No	No	Falling	Falling	No	Falling	No	No
BOLANGIR	No	No	No	No	No	No	Falling	Falling	No	No
BOUDH	No	No	Rising	Rising	No	No	No	No	No	No
CUTTACK	No	No	Rising	Rising	No	No	No	No	No	No
DEOGARH	No	No	No	No	Falling	Falling	Falling	Falling	No	No

DHENKANAL	No	No	No	Rising	No	No	No	No	No	No
GAJAPATI	No	No	No	Rising	No	No	No	No	No	No
GANJAM	No	No	Rising	Rising	Rising	Rising	No	No	No	No
JAGATSINGHPUR	No	No	No	No	No	No	No	No	No	No
JAJPUR	No	No	No	No	Falling	Falling	Falling	Falling	No	No
JHARSUGUDA	No	No	No	No	No	No	No	No	No	No
KALAHANDI	No	No	No	No	No	No	No	No	No	No
KENDRAPARA	No	No	No	No	No	No	No	No	No	No
KEONJHAR	No	No	No	No	No	No	No	No	No	No
KHURDA	No	No	No	Rising	No	No	No	No	No	No
KORAPUT	Rising	Rising	No	No	No	No	No	No	No	No
MALKANGIRI	No	No	Rising	Rising	No	No	No	No	Rising	Rising
MAYURBHANJ	No	No	No	Rising	No	No	No	No	No	No
NABARANGPUR	No	No	No	No	No	Falling	Falling	No	No	No
NAYAGARH	No	No	Rising	Rising	No	No	No	No	No	No
NUAPADA	No	No	No	No	No	Falling	Falling	No	No	No
PHULBANI	No	No	Rising	Rising	No	No	No	No	No	No
PURI	No	No	Rising	Rising	Rising	Rising	No	No	No	Rising
RAYAGADA	No	No	Rising	Rising	Rising	No	No	No	No	No
SAMBALPUR	No	No	No	No	No	No	No	No	Falling	No
SONPUR	No	No	No	No	No	No	No	No	Falling	No
SUNDARGARH	No	No	No	No	No	Falling	Falling	No	Falling	No

CONCLUSION

The economy of Odisha is fully dependent on agriculture. The quantity and spread of rainfall over the entire 30 districts are very important in this regard as most of our land is rain fed. It has been assessed that so many hectares of cultivable land can be brought under irrigation through major & medium irrigation projects. By the end of March 2020, irrigation facilities of 22.32 lakh hectares have been created. Still a large area remains un- irrigated and agriculture in this area totally depends on the rain. The information on quantification and its trend will definitely help planning and scheduling of our agriculture.

Our state has 7 majors and 45 medium irrigation storage structures comprising a live storage capacity of 153246 ham. Further mega lift irrigation storage is being initiated to improve the irrigation scenario. This is something interesting to note for planning soil and water conservation measure including water harvesting and also for planning irrigation to summer crops. The regression slope of annual and monsoon rainfall is almost close and have same pattern. Test of significance (t-test) at 5 % significance level was carried out on the regression slopes for the cases studied. Study revealed that month of August is very critical for *kharif* crop point of view in this region and rainfall of this particular month is decreasing significantly, hence there is need to harvest more rainfall of July month through construction of different in-situ and ex-situ water conservation and storage structures. This stored water can be useful for providing lifesaving irrigations during long dry spells because the numbers of rainy days were also found to be reduced significantly during monsoon season. Moreover, farmers need to make some changes in their cropping pattern to cope with changing rainfall pattern like switching over to less water demanding crops, such as pulse, millets etc. The trend at monsoon temperature showed that most of the districts have no trend but Rayagada, phulbani, Koraput, Malkangiri, Nayagarh and Puri are showing rising trend at 5% and 10% significant level. The reservoirs show a delayed and decreased inflow during the month of June, which compels for starting of cropping season, may be shifted to late June or early July. Creation of irrigation potentials is highly essential in order face the varying rainfall scenario.

REFERENCES

1. Aggarwal, P. K. (2007). Climate change: implications for Indian agriculture. Jalvigyan Sameeksha, 22(1), 37-46.
2. Amien, I., Rejekiningrum, P., Pramudia, A., & Susanti, E. (1996). Effects of interannual climate variability and climate change on rice yield in Java, Indonesia. Water, Air, and Soil Pollution, 92(1-2), 29-39.
3. Arora M., Goel NK. & Singh P. (2005). Evaluation of temperature trends over India. Hydrol. Sci. J. **50**(1), pp. 81-93.
4. Wu, S., Bates, B., Zbigniew Kundzewicz, A. W., & Palutikof, J. (2008). Climate change and water. Technical Paper of the Intergovernmental Panel on Climate Change. Geneva.

5. Brekke, L. D., Miller, N. L., Bashford, K. E., Quinn, N. W., & Dracup, J. A. (2004). Climate change impacts uncertainty for water resources in the san joaquin river basin, california 1. JAWRA Journal of the American Water Resources Association, 40(1), 149-164.
6. Brown, R. A., & Rosenberg, N. J. (1999). Climate change impacts on the potential productivity of corn and winter wheat in their primary United States growing regions. Climatic Change, 41(1), 73-107.
7. Brumbelow, K., & Georgakakos, A. (2007). Consideration of climate variability and change in agricultural water resources planning. Journal of Water Resources Planning and Management, 133(3), 275-285.
8. Burn, D. H. (1994). Hydrologic effects of climatic change in west-central Canada. Journal of Hydrology, 160(1-4), 53-70.
9. GLEICK, P., CAIN, N., HAASZ, D., HENGES-JECK, C., & HUNT, C. (2005). M., MOENCH, M., PALANIAPPAN, M. SRINIVASAN, V., WOLFF, G. The World's Water 2004–2005: The Biennial Report on Freshwater.
10. Christensen, J. H., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., ... & Whetton, P. (2007). Regional climate projections. Chapter 11.
11. Bates, B. (2009). Climate change and water: IPCC Technical Paper VI.
12. DANDODIA, A., & SASTRI, A. (2015). Impact of rainfall variability on water resources of chhattisgarh state with special reference of Mann-Kendall test statistics on the context of climate change: Impact of rainfall variability on water resources of Chhattisgarh state with special reference. Ecology, Environment and Conservation, 21(4), 125-132.
13. Dash, S. K., Kumar, J. R., & Shekhar, M. S. (2004). On the decreasing frequency of monsoon depressions over the Indian region. Current Science, 1404-1411.
14. Gosain, A. K., Rao, S., & Basuray, D. (2006). Climate change impact assessment on hydrology of Indian river basins. Current science, 346-353.
15. Lal, M. (2000). Climatic change-implications for India's water resources. Journal of Social and Economic Development, 3, 57-87.