Rainfall Analysis-A Review

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Abstract : *This article aims to review studies for rainfall trend all over India. Non-parametric tests such as Sen's Slope were used as estimator of trend magnitude which was supported by Mann-Kendall test. Regarding rainfall trend results of different studies shows variation which leads to an unclear picture of rainfall trend. In the study of monsoon of different locations in India some places showed increasing trends however there is signifying decrease in trend allover India. It was also mentioned that analysis can vary from for a location if done using different source or types of collection of data.*

Key Words: Rainfall, trends, analysis, intensity, monsoon.

Introduction

Rainfall is a significant meteorological parameter, which has direct application in fields like agriculture and other related divisions in India. These parts are exceptionally reliant on the accessibility of water just as satisfactory climatic conditions. The measure of precipitation in a region satisfies different needs including farming, industry, and local and pressure-driven power age.

Rainfall is estimated in units of length per unit time. The standard method for estimating precipitation is the standard rain gauge, which can be found in 100 mm (4 in) plastic and 200 mm (8 in) metal. Rainfall intensity is classified by the pace of precipitation, which relies upon the time. Intensity and duration are typically inversely related.

In water resource engineering there are several applications and requirements of adequate data analysis of rainfall, for example, rainfall depth, its return period, rainfall trend, etc. Rainfall helps in designing and modeling water management studies, rainwater harvesting, estimation of the flood, pond design, groundwater recharge techniques, irrigation plans, evapotranspiration estimation, etc.

Rainfall data can be analyzed in different forms in the context of different requirements. These requirements may include trend analysis, frequency analysis, rainfall intensity, extreme events analysis, future prediction, etc. Trend analysis is a method that helps in determining the spatial variations and temporal changes for different parameters of climate.

In view of the above, numerous studies have attempted to investigate the trend of variable climate in our country. These studies have looked at the trends on the country scale, regional scale and at the individual stations. The earliest of all studies was by Walker (1910) which indicated no significant trend in rainfall in the monsoon season during the second half of the 19th century. Later studies have been confined to trends and periodicities over specific regions of India using different periods of data depending on the data availability.

Methodology

The methodology for rainfall analysis generally follows the statistical approach. The statistical methods used included the mean, standard deviation, coefficient of variation, coefficient of Skewness, Kurtosis, Chi-Square, Anderson Darling Test, Kolmogorov - Simornov Test, and Mann-Kendall Test.

Numbers of studies have been done on rainfall data at national as well as international levels. These studies helped in creating a baseline for the new generation and gave ideas for different aspects and angel of research. A few of the studies are listed below:

Pant and Hingane[17] studied geographic areas of Punjab, Haryana, Rajasthan, and west Madhya Pradesh between 1901–1982 in the year 1988 and located an increasing trend in mean annual and southwest monsoon. Kumar et al.[8] performed a study in 1999 and located that the relation between the Indian monsoon and ENSO weakened in recent decades. Sen Roy and Balling[24] analyzed daily rain for 1910 – 2000 in 2004 that showed an increasing trend during a contiguous region from the northwestern range of mountains in Kashmir through most of the Deccan Plateau within the south and decreasing values within the eastern part of the Gangetic Plains and some areas of Uttarakhand. Trend detection of rain for 1901–1984 at 11 stations in Himachal Pradesh indicated an increase in annual rain at 8 stations declared by Kumar et al.[11] in 2005, 8 stations showed a decreasing trend in the monsoon. The decreasing trend of annual and

monsoon rain in Shimla was statistically vital at a 95% confidence level. Singh et al.[29] found in 2005 that annual rain over major basins in Middle India (Sabarmati, Mahi, Narmada, Tapi, Godavari, and Mahanadi) showed a decreasing trend since the Sixties, whereas Indus, Ganga, Brahmaputra, Krishna and Cauvery basins showed an increase. Trends in extreme rain indices for 1901 – 2000 were examined using 100 stations over India by Joshi and Rajeevan[6] in 2006. Most of the intense rain indices for the southwest monsoon season and annual amount showed vital positive trends over the west coast and north-western peninsula. However, 2 hill stations (Shimla and Mahabaleshwar) showed a decrease in the number of intense rainfall. By high resolution daily gridded rainfall for 1951–2003, Goswami et al.[4] in 2006 showed that there have been vital rising trends within the frequency and magnitude of utmost rain events over central India in monsoon. They additionally found a decreasing trend within the frequency of moderate events throughout an equivalent amount, so resulting in no vital trend within the mean rain. Ramesh et al.[21] analyzed daily gridded determined rainfall for 1951–2003 in 2007 and located decreasing trends in early as well as late monsoon and a decrease in rainy days in India. Analysis of rain quantity in 2007 for different seasons by Dash et al.[3] indicated decreasing tendency within the summer monsoon over India and the trend was increasing throughout pre-monsoon and post-monsoon months. Pattanaik and D. R.[18] conducted a study in 2007 during which a decreasing trend in monsoon over northwest and central India from 1941–2002 was stated. Basistha et al.[1] analyzed 80 years'(1901–1980) rain from 30 stations within the Indian range of the Himalayas in 2007 and located an associated increase in trend between 1901 and 1964, and a decreasing trend between 1965 and 1980. Ranade et al.[22] found no trend within the beginning or ending date, length and total rain of the hydrological wet season over different basins of India in 2008 by the info of 316 rain gauges. Singh et al.[30] studied the changes in the rain over the last century in 9 basins of northwest and Central India in 2008. Change in the rain for every 43 stations was determined by line slope and these values were interpolated to induce the spatial distribution of rain over the study space. They found increasing trends in annual rain over 8 basins within the 2–19% vary of the mean per a hundred years. Variability and long trends of utmost rain events over central India were examined by Rajeevanet al.[20] by 104 years (1901–2004) of high-resolution daily gridded rain in 2008. They found a statistically vital long trend of 6% decade within the frequency of utmost rain events. As per them, the increasing trend of utmost rain events within the last 5 decades can be related to the increasing trend of ocean surface temperatures and surface heat of transformation flux over the tropical ocean. In 2009 studies of temporal variation in monthly, seasonal and annual rain over Kerala for 1871–2005 were done by Kumar et al.[7] discovered a big decrease in southwest monsoon rain and a rise within the post-monsoon season. rain throughout winter and summer seasons showed an insignificant increasing trend. Pal and Al-Tabbaa[14] studied the trends in seasonal rain extremes in Kerala in 2009, by daily rain data for 1954–2003. They found winter and post-monsoon extreme rain having an increasing tendency with statistically vital changes in some regions and decreasing trends in spring seasonal extreme rain. within the same year, Pal and Al-Tabbaa[15] additionally studied the changes in frequency and magnitudes of utmost monsoon rain deficiency and excess from 1871 to 2005 over 5 regions in India. the intense monsoon seasonal precipitation exhibited a negative tendency resulting in increasing frequency and magnitude of monsoon rain deficit and decreasing frequency and magnitude of monsoon rain excess. analysis of rain knowledge in 2010 by Kumar et al.[9] of a hundred thirty-five years (1871– 2005) indicated no vital trend for annual, seasonal associated monthly rain on an all-India basis. Annual and monsoon rain weakened, and pre-monsoon, post-monsoon and winter rain inflated over the years, with the most increase within the pre-monsoon season. Monsoon months of June, July and Sep witnessed decreasing rain, whereas August showed associate increasing trend on associate all-India basis. An analysis on the sub-divisional basis (30 sub-divisions) indicated that an increasing trend in annual rain was showed by half of them, however solely 3 sub-divisions, particularly Haryana, Punjab, and coastal Karnataka, this trend was statistically vital. the Chhattisgarh sub-division had a decreasing trend out of the 15 sub-divisions showing a decreasing trend in annual rain. All the 5 regions showed a non- vital trend in annual, seasonal and monthly rain for many of the months. Analysis of rain information at 5 stations (Srinagar, Kulgam, Handwara, Qazigund, and Kukarnag) within the Kashmir Valley during 1903–1982 studied by Kumar et al.[10] in 2010 showed that the primary 3 stations practiced a decreasing trend in annual rainfall; the most important decrease was for Kulgam (–20.16% of mean/100 yrs) and also the smallest for Srinagar. The decreasing trend in winter rain was statistically vital (95% confidence level) at Kulgam and Handwara, whereas none of the increasing trends within the pre-monsoon and also the post-monsoon season was vital. Srinagar and Handwara witnessed a decreasing (non- significant) trend in annual rainy days, whereas Kulgam had an alternative trend. All the stations showed a decreasing trend in monsoon and winter rainy days. Qazigund and Kukarnag decreasing annual rain, whereas Srinagar showed increasing annual rain from 1962–2002. Annual, pre-monsoon, post-monsoon and winter rain increased (non- significant), whereas monsoon rain decreased (non- significant) at Srinagar throughout the last century. Pal and Al-Tabbaa[16] conjointly performed a study in 2010 and located decreasing trends within the spring and monsoon rain, and increasing trends within the fall and winter rain over India throughout 1954–2003. meantime a study of monthly, seasonal and annual rain of 5 meteorologic sub-divisions of Central North East India done by Subash et al.[31] in 2010 showed a big decreasing trend of 4.6 mm/yr for Jharkhand and 3.2 mm/day for Central North East India throughout 1889–2008. all the meteorologic sub-divisions, except Jharkhand, have shown a big decreasing trend of rain within the recent past in

December. The long trend in monsoon season extreme rain events for 1951–2005 was analyzed by Pattanaik and Rajeevan[19]. The typical frequency of maximum rain events at the side of the contribution of maximum rain events to the seasonal rain showed a big increasing trend (above the 98% confidence level) over India throughout monsoon season and conjointly throughout June and July. it was indicated that the increasing trend of contribution from extreme rain events is balanced by a decreasing trend in low rain events. C. M. Pradeep et al.[2] in 2011 analyzed and said that in 1987-2008 February was driest and Sept was the wettest month having a mean rain of 2.3 mm and 175.9mm respectively. Their analysis disclosed that Kharif was the wettest season whereas Rabi was the driest with average seasonal rain 537.4mm and 30.8. In 2014 Nyatuame M. et al.[12] performed a study that showed that the linear regression analysis was a statistically insignificant increase in the trend of annual mean rain. The mean monthly information showed an associate upward trend in some months and downwardly in others. it was conjointly indicated that there was a really weak correlation between rain and monthly rain. Swain et al.[32] performed analytic tests for Raipur District of Chhattisgarh in 2015 for monthly data of rain for 1901-2002 i.e. Mann-Kendall and Sen Slope. They found a downward trend for many of the years for that amount. Rao G. Sreenivasa et al.[23] in 2016 analyzed of Godavari sub-Basin for the time span of 14 years i.e. from 2001 -2014 from that it was disclosed that there are traces of negative trends within the future. In 2017 Shekhar M.S. et al.[28] found a negative trend all told ranges of Western Himalaya apart from Shamshawari. The positive tendency rate was found within the western and middle components of Western the Himalaya whereas negative tendency dominated Japanese and southern components of Western the Himalaya. In 2017 Sharma Manu Raj[25] results of rectilinear regression analysis showed a statistically vital decreasing trend in annual mean rain however monthly rain information conjointly showed decreasing trends all told months. In 2018 by H. Li et al.[5] investigated the abstraction and temporal pattern of rain in reason of the Himalayas that was supported by 4 sets namely interpolated gridded data based on gauge observations, reanalysis data and high-resolution simulation by a regional climate model. They terminated that though datasets could be similar in terms of abstraction pattern and temporal variation and changes, there's a distinction in absolute values i.e. 497 - 819 mm/year because of source and technique. These variations were notably large in July and August and at the windward slope and high-elevation areas. it was found that summer is wetter and winters were drier, and trends weren't statistically significant.as a result, wetter summer ends up in a lot of and greater floods and hotter and drier winter ends up in fewer glaciers accumulation. Padhiary J. et al.[13] performed a study coping with the variability and long trends and temperature over Jaraikela Catchment in 2018. They found that there was a big increase in each annual rain and temperature at most of the stations, however, found no clear trend within the monthly and seasonal analysis of rain and temperature. it absolutely was found from rainfall between 1992-2012 of Shimla by Sharma N. K. & Sharma S.[26] in 2019 that one-day annual most rain was found to be 98.9mm with variance and constant of variation of 25.06 and 57.19 severally. rain of the Dharamshala region was taken for a study by Sharma N. K. & Sharma S.27 between 1992-2012, it showed that the average of one- day annual most rain was 142.9 mm. it was notified that the quality deviation was 54.8 whereas the constant of variation 51.34. Similarly, the coefficient of skewness is 1.1. for 2 to 7 days consecutive annual most rain varying values for mean, variance, coefficient of variation and coefficient of Skewness are 201 – 393.4 mm, 70.17 – 146.5, 41.65 – 30.47 and 0.726 – 1.593. For a repeat interval of 20 years, the most rain expected in a day as well as 2, 3, 4, 5, 6, and that of 7 is 277.7mm, 373.6mm, 445.11mm, 518.62mm, 589mm, 680.3mm and 753.79mm respectively.

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