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Comparative Study of Rainfall at various Rain Gauge Stations of the Pamba River Basin

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Abstract: ***The aim of this paper is to establish a mathematical relationshipbetween the monthly period of a water year and the cumulative rainfall at the three Rain Gauge Stations of the Pamba basin. The data considered for calibration in the monthly rainfall for five years from 2009-10 to 2013-14 and the three rain gauge station considered are namely Moozhiyar, Ullumkal and CUMI-Maniyar. As the basin consists of a cascade power generation system with an Irrigation project at its tail end, the study contributes much in the scheduling of these projects' operations.***

Keywords: Rainfall, Rain gauge station, Hydrologic cycle, Runoff, Reservoir, River basin

1. Introduction

Hydrology is the science of water deals with the occurrence, circulation and distribution of water of the earth and its atmosphere. Water occurs on earth in all its three states, viz. liquid, solid and gaseous. Hydrologic cycle explains the movement of water from one state to the other. The portion of the rainfall which reaches the stream channel is called runoff and once it enters a stream channel, runoff becomes strem flow. As far as the contribution to reservoirs are concerned, the runoff plays the major role and its computation is of vital importance. Reservoirs form a major water resources system and their optimal operation is a very important area of water resource planning and management, as the interrelationship between some of the variables is nonlinear in nature. Conflicting and complementary uses of reservoir storage have to be scientifically addressed and managed for the efficient and effective water resources management. With the growing pressure on available resources, the problem of water conservation has assumed importance in recent days.

The runoff from a catchment is usually worked out by multiplying the coefficient of runoff with the product of the area of the catchment and the intensity of rain fall on it. The area of catchment which contributes to a reservoir or a river is known and the coefficient of runoff is also known based on the nature of the earth surface whether it is covered with forest/ lawn/ rocky and its general topography. Moreover, every part of the catchment may not be accessible and judgement is unavoidable due to the lack of any real time data.The variable deciding the runoff is the intensity of rainfall and that is to be scientifically judged for better results. There lies the importance of accessing rainfall intensity.

2. Literature Review

[1]Asatil S.R. (2012) analysed Rainfall data of 10 years of Brahmapuri for drought investigation, which may be used for long term planning of irrigation system in the area. During 10 years period, one drought year was experienced which occurred in 1972 in which the total rainfall was 801.9 mm. A comprehensive knowledge of the trend and persistence in rainfall of the area is of great importance because of economic implications of the rain sensitive operations and since it plays vital role of any agricultural and non agricultural programme. If proper and comprehensive study of various rainfall data was analysed, the severity and reoccurrence of drought can be known before hand thus various measures can be taken to cope up with the problems and drought.[2] Malik S.C. et al. describes the statistical tools for data analysis.[3] Mallika Roy (2013) has measured the correlation coefficients between rainfall and time for Sylhet, where correlation coefficient for Sylhet is negative. In order to check the strength of linear relationship between rainfall and time, P-value has been measured. Due to various factors of Sylhet region of Bangladesh, there is a growing need to study the rainfall pattern, and also frequency of the heavy rainfall events. This study was checked annual average rainfall of 30 years for this region.[4]Rafa H A-Suhili et al. (2014) fitted Different frequency distributions models to the monthly rainfall data in Sulaimania region, north Iraq. The distributions models fitted are of Normal, Log-normal, Wiebull, Exponential and Two parameters Gamma type. The Kolmogorov-Smirnov test was used to evaluate the goodness of fit. The fittings were done for the overall data and for each month separately.. The t-test, F-test and Kolmogorov-Smirnov test indicate the capability of these models to produce data that has the same frequency distribution of the observed one. Comparison between the performances of the overall and periodic models reveals that there no distinguishable improvement of the monthly model over the overall one. [5] Sabyasachi Swain et al. (2015) presented a trend analysis of monthly rainfall data for Raipur district, Chhattisgarh for the period of 102 years that is from 1901 to 2002. The results reveal a significant decrease for the months of Southwest monsoon i.e. June, July, August and September, thereby inferring for a consequent decrease in annual rainfall. [6] Sabyasachi Swain et al. (2015)presented an analysis of variation in annual rainfall for Raipur district, Chhattisgarh by checking the percentage change with respect to that of previous year and also by comparing with the mean annual rainfall for the whole period under investigation. The monthly precipitation data is collected from the website of Indian Meteorological Department (IMD) for the period of

1901-2002. Further, the rainfall in various decades is compared. The results reveal that the last decade of the 20th century witnesses maximum decrease in rainfall in the whole duration. [7]Subramanya K explains the measurement of rainfall at rain gauge stations and calculating the runoff from a catchment.

3. Aim and objectives of the study

It is hypothesized that there exists a relationship between the period of the year and the intensity of rain fall. Also the intensity of rain fall in adjacent rain gauges of a basin are related. In this paper a relationship between the rainfall of adjacent rain gauge stations of the Pamba basin is evolved.

4. System Description and Methodology

There exists only three rain gauge stations in the upper reach of pamba basin which contributes for the cascade power projects and for the downstream Pamba Irrigation Project. The details of the stations are shown in table 1. The locations are shown in fig. 1

Table 1: Details of rain gauge stations

Sl no.	Name of the rain gauge station	Distance in km
1	Moozhiyar	00.00
2	Ullumkal	16.00
3	CUMI-Maniyar	26.50

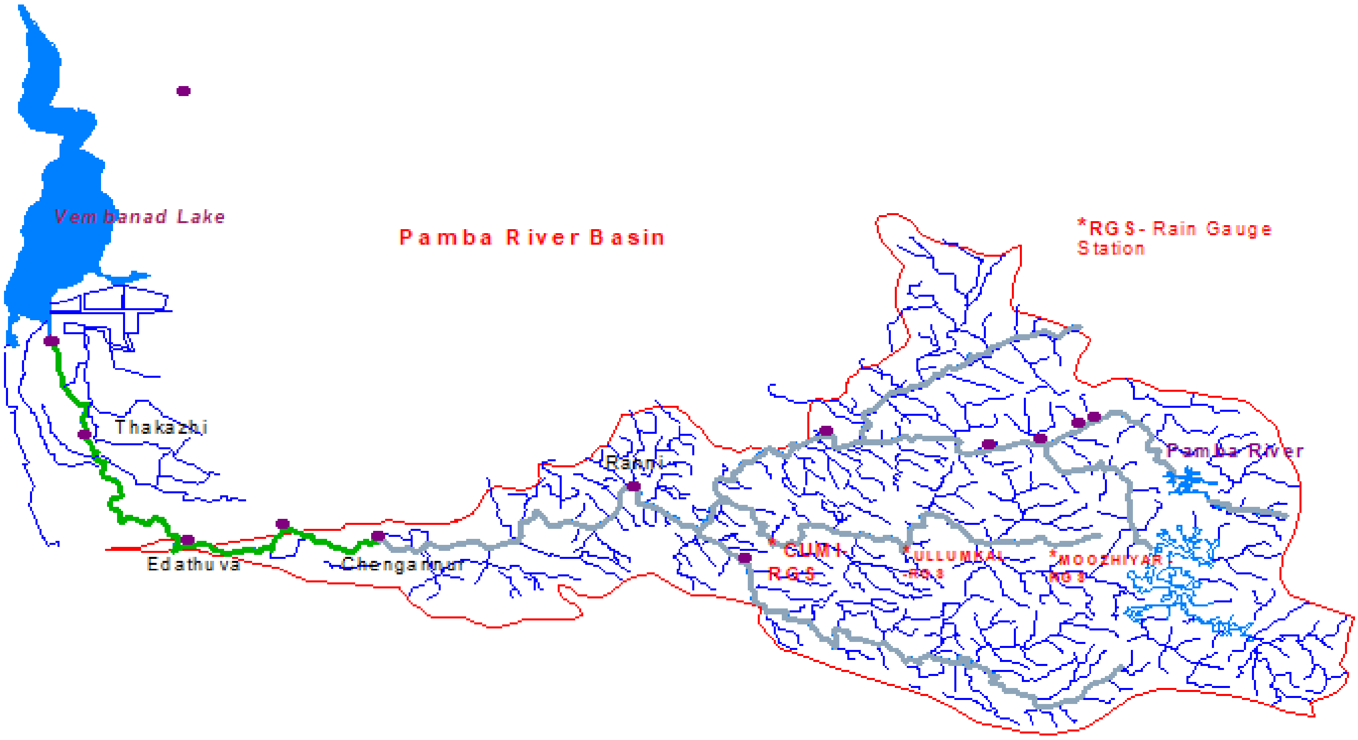

Figure 1: Showing the locations of the three rain gauge stations

Cumulative values of the monthly rainfall data for the years 2009 to 2014 is taken for the study. As a water year starts in June and ends by May, the values are tabulated accordingly for all these three stations. The cumulative values for the stations Moozhiyar, Ullumkal and CUMI-Maniyar are shown in Fig. 2,3 &4 respectively. The graph showing the variation of the cumulative rainfall at these stations are plotted against the monthly periods in Fig. 2,3 &4.

Table 2: Cumulative rainfall data of Moozhiyar Rain Gauge Station for the years 2009 to 2014

Moozhiar rain gauge station – Cumulative rain fall 2009-14						
months	2009-10	2010-11	2011-12	2012-13	2013-14	average
June- 1	437.7	705.7	812.5	729.7	1102.8	757.68
July-2	1318.2	1384.1	1601.1	1516.7	1968	1557.62
August-3	1586.3	2013.4	2425.1	2533.3	2427.1	2197.04
September-4	2170.6	2279.6	2970.5	2950.8	2904.9	2655.28
October-5	2448.4	2857.3	3265.1	3219.1	3214.9	3000.96
November-6	2771.2	3326	3735.5	3389.7	3449.4	3334.36
December-7	2792.1	3443.4	3980.3	3389.7	3493.7	3419.84
January-8	2802.3	3487.4	3996.6	3389.7	3493.7	3433.94
February-9	2802.3	3552.6	4022	3468.1	3546.1	3478.22
March-10	2938.5	3688	4067.9	3683.6	3606.1	3596.82
April-11	3201.2	4007.8	4428.6	4025.7	3708.1	3874.28
May-12	3693.6	4324.1	4647.9	4304.6	4230.8	4240.2

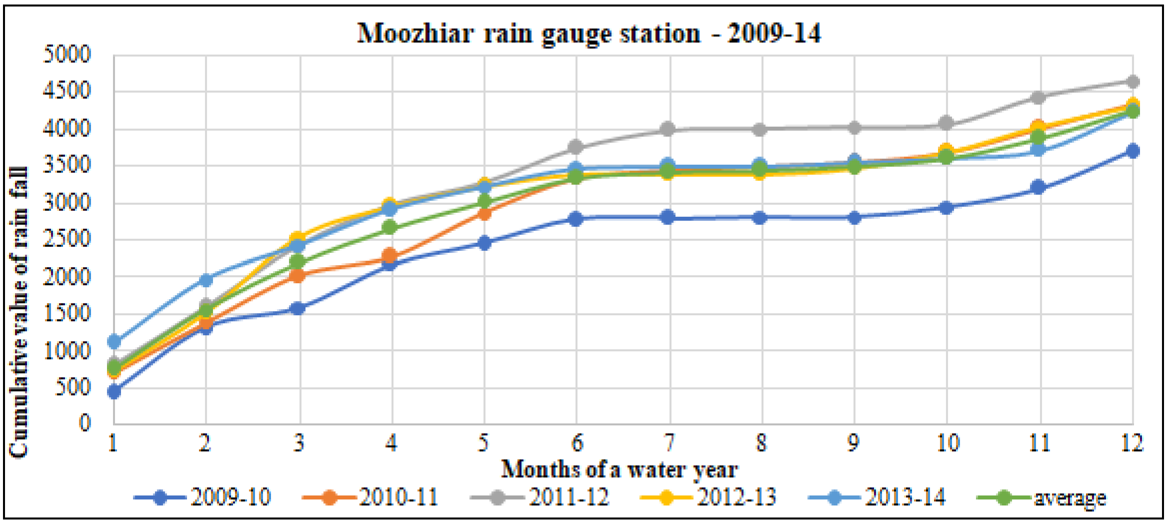

Figure 2: Graph showing the Cumulative rainfall data MoozhiyarRain Gauge Station for 2009-14

Table 3: Cumulative rainfall data of Ullumkal Rain Gauge Station for the years 2009 to 2014

Ullumkal rain gauge station – Cumulative rain fall 2009-14						
months	2009-10	2010-11	2011-12	2012-13	2013-14	average
June- 1	278.2	538	344.25	243	690	418.69
July-2	746.45	1007.25	705.75	507.75	1289.25	851.29
August-3	995.7	1462.75	1169.75	931.75	1683.75	1248.74
September-4	1351.7	1779.25	1425.5	1055.5	2039.5	1530.29
October-5	1578.95	2066.25	1590.5	1405	2431.5	1814.44
November-6	1773.7	2301.25	1769.2	1551	2804.5	2039.93
December-7	1832.7	2351.75	1836.2	1557.75	2824.25	2080.53
January-8	1891.2	2402.75	1854.7	1559	2825	2106.53
February-9	1891.2	2541	1858.95	1572.5	2849.5	2142.63
March-10	1989.95	2599.75	1947.95	1699	2895.25	2226.38
April-11	2231.45	2882	2216.2	1884.75	3104.03	2463.686
May-12	2527.45	3050	2359.95	2131.5	3523.78	2718.536

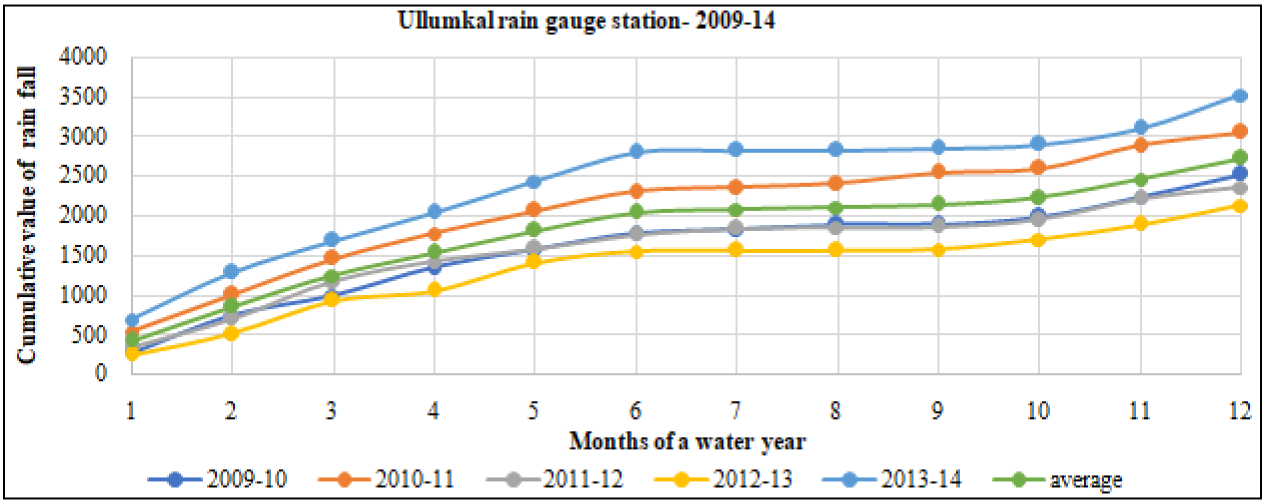

Figure 3: Graph showing the Cumulative rainfall data Ullumkal Rain Gauge Station for 2009 -14

Table 4: Cumulative rainfall data of CUMI-Maniyar Rain Gauge Station for the years 2009 to 2014

CUMI-Maniyar rain gauge station - Cumulative rain fall 2009-14						
months	2009-10	2010-11	2011-12	2012-13	2013-14	average
June-1	329.3	260.2	504.1	260.1	679.6	406.66
July-2	711	801.8	1003.6	612.9	1156.6	857.18
August-3	964.6	1430.2	1565.3	1080.5	1566.1	1321.34
September-4	1251.5	1944.8	1817.6	1217.9	1920.7	1630.5
October-5	1512.5	2430.9	2007.2	1415.5	2518.3	1976.88
November-6	1659.1	3022.9	2270.4	1522	3002.9	2295.46
December-7	1745.7	3127.2	2373.6	1526	3021.1	2358.72
January-8	1790.9	3188.9	2374.6	1526	3026.7	2381.42

February-9	1790.9	3460.7	2386.6	1526	3122.7	2457.38
March-10	1834.1	3700.9	2553.8	1526	3206.9	2564.34
April-11	2028.35	4131.3	3012.5	1704.2	3449	2865.07
May-12	2399.15	4473.5	3114.5	1977.7	4031.2	3199.21

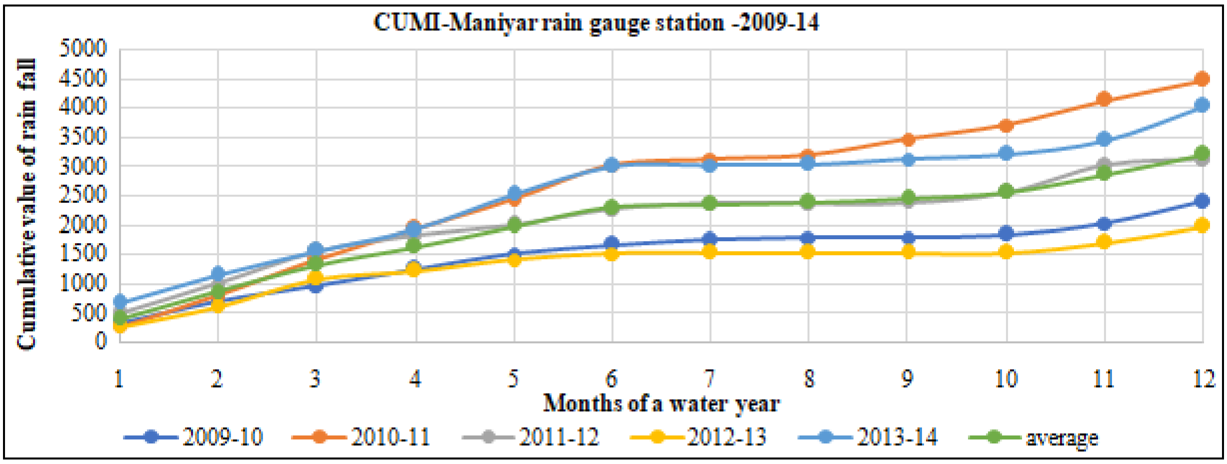

Figure 4: Graph showing the Cumulative rainfall data CUMI-ManiyarRain Gauge Station for 2009-14

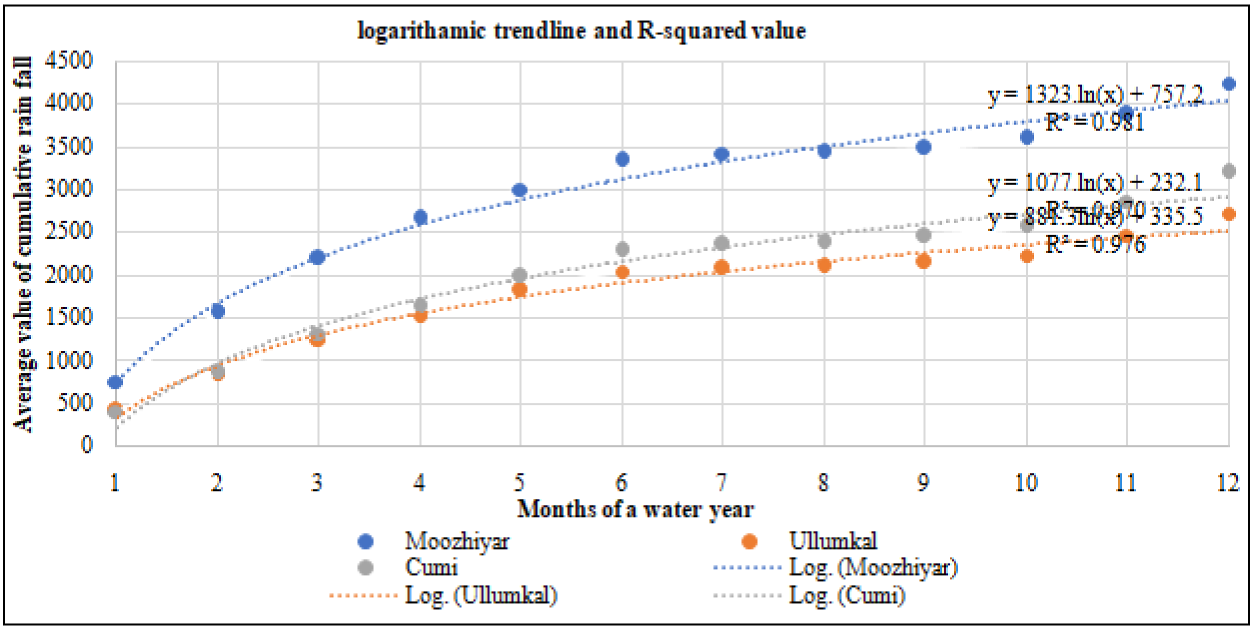

Figure 4: Graph showing the logarithmic trendlines of the Rain Gauge Stations

Averaged cumulative data and its trendlines for the three stations are plotted against the monthly periods in Fig. 5. The variation is vivid from the trendline equations and R^2 values.

3. Results and Conclusion

The present study shows clearly that though the rainfall data differs from station to station, each set follows a general trend and adheres to it. The R^2 value varies between 0.9708 and 0.9817 which is very close to 1in this study. So the trendlines fits perfectly. Rainfall data for the five consecutive years from 2009-10 to 2013-14 are taken for this calibration study. Further validation can be done for the next consecutive years from 2014-15 to 2017-18.

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