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ANALYSIS OF RAINFALL DATA IN THE SOUTH WESTERN PART OF GODAVARI RIVER BASIN, JAGITYAL DISTRICT, TELANGANA STATE INDIA

K. Alekhya* Research Scholar, Department of Geophsyics, Osmania University, Hyderabad
*Corresponding Author

Dr.G.Ramadass Professor (Rtd) Department of Geophsyics, Osmania University, Hyderabad

Dr.G.Udaya Laxmi Assistant Professor, Department of Geophsyics, Osmania University, Hyderabad

ABSTRACT The rainfall is the most important factor of the climate elements as well as hydrological cycle. The amount of rainfall received over an area affects the availability of water resources of an area. The present study deals with the rainfall characteristics of the Southern part of Godavari river basin in the Jagityal district, Telangana State, India. In order to study spatial and temporal variations of rainfall data have been collected during 2010 to 2016 year from 14 rain gauge stations. The data were analyzed for employing the statistical methods i.e., average, standard deviation and Coefficient of variation was determined for the data sets of month and year-wise. The mean rainfall of the area is about 178.06 mm, highest rainfall recorded 2010 - 2011 where as lowest 42.06 mm is recorded in 2015-16.

KEYWORDS : Standard deviation, mean, Co-efficient of variation, Rain fall Data

Introduction

The total amount of rain deposited on a given area during a given time as measured by a rain gauge is called rainfall; this data is utmost importance to hydrologists as it forms the basis of many hydrological studies. The amount of rainfall does not show an equal distribution, either in space or time. It varies from heavy rain to scanty in different parts. Productivity of the agriculture in a particular year depends on the amount of rainfall received, intensity and distribution of the rainfall over a particular area which indicates the growth of the economy of the state (Mahalingam, et. al., 2014). Analysis of rainfall data is important to understand the micro-level variability of the rainfall which in turn useful to planning the agriculture, land and water development activities. Therefore, rainfall is one of the climatic variables that affect both the spatial and temporal patterns on water availability (Umamahewswar Rao et. al., 2015) and its effect on socio-economic and ecological of any region. In India, temporal variation in monthly, seasonally and annually ((Sawant et al., 2015, Joy Rajbanshi 2015 , Rathod and Aruchamy, 2010. Khan , Asim, 2000. Latha, Rajendran and Vasudevan,2014 , Kusre and Singh,.2012, Mohapatra et al 2003) reported that the rain fall over India was increased from 1431 mm to 1960mm.

All the above studies shows the rainfall analysis in different parts of the India. However, the information regarding the rainfall trends and its variability over South-western part of Godavari River is limited. Godavari River is mainly rain fed river and about 80% of the annual discharge occurs during upon the monsoonal rainfall and river water. Understanding the fluctuations of rainfall in this region is very crucially important to study the change of hydrologic and management of their water resources (Mallika Roy,2013). Hence in this paper an attempt has been made to find out the long-term variability of rainfall both temporal and spatial scale over 14 mandals of Jagityal district (Sriramsagar project command) area, of Telangana State is to determine the pattern of rainfall distribution using ArcGIS environment representing spatial distribution of monthly and yearly rainfall.

Study Area

The study are lies between the North latitudes 180 30' N and 190 5'N and east longitudes between 780 30' E and 790 35'E (Figure.1). The Jagityal district is located in the southern part of Godavari river basin, River Godavari occupies largest area in the peninsular India, The rest of the study area located in between Pedda vagu I & II and south Kakatiya canal. The district covers an area of 141934 (ha) hectors. The Godavari basin is characterized by moderate winter and hot and humid summer. The study area experience mainly four seasons namely, winter(January to February), Pre-Monsoon (March-May), Monsoon (June-September) and Post-Monsoon(October-December) due to the influence of seasonal and varying topographic features, some of the areas of Godavari basin receive higher amounts of rainfall and some of areas experiences low rain fall. The geological formations in the district comprise granites, gneisses, sandstones, limestone, shale, quartzite's etc. The occurrence and movement of the groundwater is a consequence of a finite combination of topographical, climatologically, hydrological, geological and structural features. Topographically slope of the study area is gradually decreasing towards north to east.

Methodology

In the study area, the spatial and temporal variability of the rainfall (Joy Rajbanshi,2015) over Godavari basin is examined for the period of (2010-2016). The rainfall data obtained from the Indian meteorological department (IMD) and Indian water portal (www.indiawaterportal,org/met_data). The general characteristics of the rainfall over Godavari River basin are analyzed by computation of mean monthly, seasonal and annual standard deviation and coefficient of variation (Josiah etc., 2014).

Climate Conditions and Rainfall

The climate conditions of the study area in general are semi-arid with dry hot summers and mild winters. The average annual rain fall is during June to September of the year 2015-16 was maximum. In the months of April and May the temperature range between 20.7oC and 44.7oC while during months of December and January lower temperatures from 8oC to 17o C are common.

Daily rainfall data has been collected for a period of 2010 to 2016 from State Groundwater Department of Telangana, Hyderabad. This data has been checked and proceed for finding the missed rainfall data for various rain gauge stations and gaps were accordingly filled. The base map (Figure.1) of study region has been prepared from Survey of India Toposheets 56J/13,56N/1,56I/16,56M/4) in 1:50,000 scale were delineated for 14 rain gauge stations of Jagityal district in GIS environment. Ground positions control points have been collected using Global Positing System (GPS) for ground verification.

Fourteen rain gauge stations are located (Table-I) at Metpalle, Kathlapur, Koratla, Mallapur, Raikal, Medipalle, Jagityal, Mallial, Sarangapur, Gollapalle, Pegadapali, Dharmapuri, Velgtoor and Dharmaram. Six of these stations are outside the study area but quite close by study are shown in Figure 1.

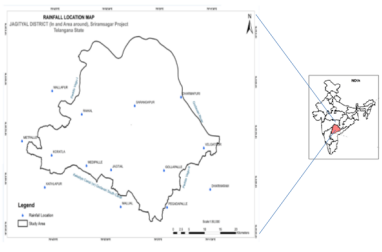

Figure 1 Location map Rainfall gauge stations in Jagityal district.

Table-1 showing geographical coordinates of rain gauge stations

Sl. No.	Latitude (in degrees)	Longitude (in degrees)	Rain gauge stations
1	78.6222	18.8468	Metpalle
2	78.69	18.75	Kathlapur
3	78.7089	18.8111	Koratla
4	78.7111	18.9639	Mallapur
5	78.807	18.9077	Raikal
6	78.8156	18.7983	Medipalle
7	78.9064	18.7846	Jagital
8	78.9506	18.7067	Mallial
9	78.9582	18.9361	Sarangapur
10	79.0667	18.7833	Gollapalle
11	79.075	18.6919	Pegadapalle
12	79.1	18.95	Dharmapuri
13	79.1736	18.8458	Velgatoor
14	79.2028	18.7354	Dharmaram

The analysis of rain gauge station wise (Table-2), spatial variations in rainfall shows that the study area has annual as well as seasonal fluctuations (month wise) in rainfall of 2010 to 16 presented in figure.2, which varies between slight and extreme. The classification of year wise rainfall distribution shows that (Table- 2) during the year 2010-11 and 2013-14 have been received high rainfall at all stations. The years 2011-12, 2012-13, 2014-15 and 2015-16 the study area had received rainfall very low. The recorded data of all stations indicated that during the years 2010-11 and 2013-14 have been covered by high amount of rainfall, which is 102.15mm to 178.066 mm minimum 62.675mm to 89.61mm. The distribution of rainfall over time of six years in fig. clearly shows that high, moderate and low rainfall play a prominent role in the study area.

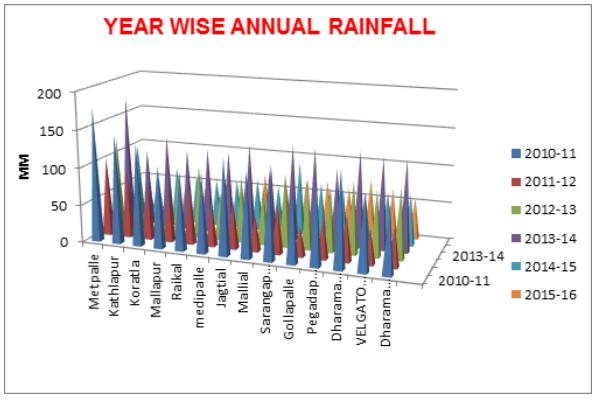

Figure 2. Rain fall distribution of year wise from 2010 to 2016

Table.2 Year wise Average Rainfall data at each Rain gauge station

S. No	Rain gauge station	2010-11 (mm)	2011-12 (mm)	2012-13 (mm)	2013-14 (mm)	2014-15 (mm)	2015-16 (mm)
1	Metpalle	178.0667	105.1667	123.9667	176	100.7333	42.86667
2	Kathlapur	145.1833	90.98333	90.25	104.2	70.78333	43.08333
3	Koratla	136.35	73.3	73.066	125.29	74.75	46.83
4	Mallapur	108.4	71.575	83.05	109.425	65.90833	42.16667
5	Raikal	104.1	72.68333	96.88333	113.175	62.86667	57.48333
6	Medipalle	105.325	57.98333	62.75833	111.2083	64.86667	47.58333
7	Jagtial	128.0167	63.66667	87.43333	124.0333	68.95	68.875
8	Mallial	114.2583	47.45	76.01667	99.16667	62.675	65.46667
9	Sarangapur	116.9833	66.68333	97.76667	128.5917	98.21667	66.26667
10	Gollapalle	92.86667	39.13333	93.55	126.8667	72.45	66.71667
11	Pegadapalli	102.15	54.34167	86.26667	102.0417	68.15	60.84167
12	Dharamapuri	127.3	60.26667	97.29167	128.4083	67.39167	74.95
13	Velgatoor	99.50833	46.9	88.7	122.8917	69.11667	64.53333
14	Dharamaram	89.61667	52.91667	93.78333	122.35	69.375	56.64167

The Seasonal Pattern of Rainfall (month wise) 2010-16

For each year (Figure 2) of the cone at each station is proportional to the total annual at that station. The areas of different sector marked by different months correspond to the proportionate monthly rainfall. Monitoring the rainfall data is an important aspect from the point of groundwater studies. Since the main source of recharge to the aquifer system in the area is infiltration, it is essential to record precisely the inflow factor. For this purpose the rainfall data was collected at monthly intervals from 2010-16 (Table 3.). The rain fall data prepared in sector diagrams of each year month (average) for six years shown in Figure 2.

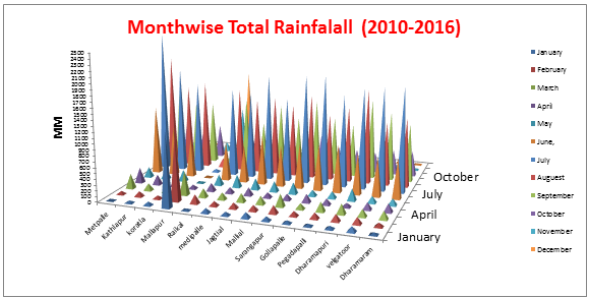

Figure 2.(a) Month wise total rain fall data from 2010-16 at each Rain gauage station

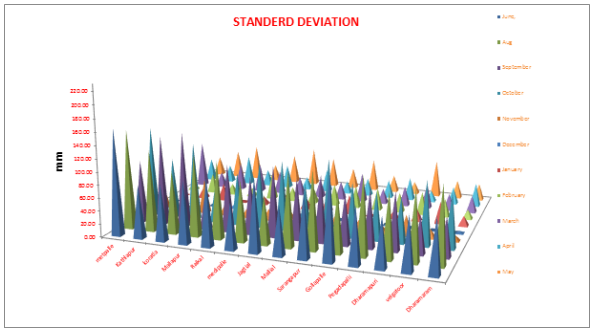

Figure 2(b) Month wise Standard deviation of rain fall data from 2010-16 at each Rain gauge station

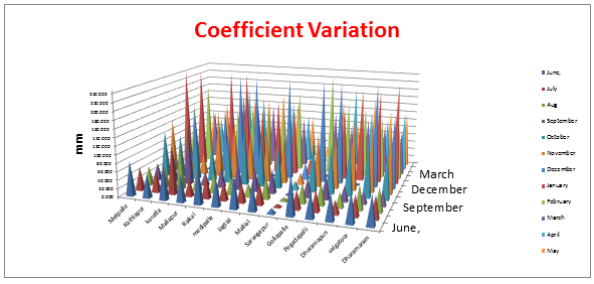

Figure 2 c) Month wise Coefficient of variation of rain fall data from 2010-16 at each Rain Gauge station

Daily rainfall has been converted into monthly, the spatial variations in rainfall (Table 4) have been classified into four season wise i.e. winter (January-February) , Pre-monsoon(March to May), Monsoon(June to September) and Post Monsoon (October to December). The corresponding maps Standard deviation and Coefficient of variation maps for study areas have been prepared in GIS environment (Rathdo and Aruchamy, 2010) Microsoft Excel is used for preparation

of temporal and seasonal variations of the rainfall. Table 4 shown the mean monthly, seasonal annual rainfall statistics over the Study area.

Table 3: Total rainfall data (mm) month wise from 2010-16 at rain gauge stations

Mandals	Jan	Feb	Mar	April	May	June	July	August	Sep	Oct	Nov	Dec	Total	Avg
Metpalle	4	56.3	257.8	266.6	175.5	1197.2	2491.4	1982.8	1382.4	747.2	160.4	0	8721.6	1453.6
Kathlapur	43.4	92.4	123.8	174.8	210.8	880.8	1856.4	1456.2	1062.8	524	104	4.4	6533.8	1088.967
koratla	65	58.6	146.9	174.2	196.2	691.8	1610.4	1561	1102	585	162.8	1.2	6355.1	1059.183
Mallapur	1327.9	1143.3	417.4	72.3	23.8	5.4	52.4	156.4	85.4	105.8	871.2	1505	5766.3	961.05
Raikal	30	156.8	153.2	140	185.1	681.4	1557.2	1478.8	1231.8	412	58.8	1.2	6086.3	1014.383
Medipalle	81	84	120.8	103.6	219.2	649.4	1525.5	1321.2	810.7	400.9	78	2.4	5396.7	899.45
Jagtial	62.6	102	147	138.4	194.4	863.6	1859.2	1387.1	1165	485.8	86.6	0	6491.7	1081.95
Mallial	101.2	103.1	141.6	94.1	179.8	729.2	1476.6	1279.4	965	433.4	74	3	5580.4	930.0667
Sarangapur	72.6	140.4	220.3	106.4	198.6	786.8	1913.8	1492.1	1306.8	580.7	74.2	1.4	6894.1	1149.017
Gollapalle	51.6	84.4	98.8	147.6	106.6	812	1938	1164.2	1023.8	398.6	70.2	3.2	5899	983.1667
Pegadapalli	42.4	103.4	167	106.3	121.2	838.6	1613.7	1327.5	929.4	376.6	52.2	7.2	5685.5	947.5833
Dharamapuri	50.6	123.2	178.8	74.2	208.9	715.2	1762.6	1664.9	1412.7	363.2	113	0	6667.3	1111.217
Velgatoor	92.2	118.4	130.4	127.4	121.2	688	1798	1117.5	1216	434.9	53.4	2.4	5899.8	983.3
Dharmaram	39.2	69.8	144.4	149.8	118.7	712.6	1840.3	1224	1030	443.2	33.2	11	5816.2	969.3667
Total	2063.7	2436.1	2448.2	1875.7	2260	10252	23295.5	18613.1	14723.8	6291.3	1992	1542.4	87793.8	

Table-4 Mean monthly, seasonal annual rainfall statistics over the Study areas

Month/Season (2010 to 2016)	Rainfall (mm)	Standard Deviation	Coefficient of Variation	Contribution to annual rainfall (%)
June	179.18	95.683	68.440	12.354
July	408.53	140.96	50.410	28.029
August	324.34	110.87	48.990	22.284
September	265.66	93.86	52.870	18.252
October	113.17	93.79	112.260	7.775
November	18.62	21.27	126.860	1.279
December	0.81	1.41	143.049	0.055
January	13.14	16.99	171.580	0.9027
February	24.37	26.72	147.110	1.674
March	39.15	35.90	119.990	2.689
April	28.81	29.91	121.790	1.979
May	39.71	39.52	122.51	2.728
Total	1455.49	706.88	1288.859	100
Average	121.29	58.90	107.40	
Winter (Jan-Feb)	37.05	43.71	318.69	2.57
Pre-Monsoon (March-May)	107.08	105.33	364.20	7.356
Monsoon (June-Sept)	1177.68	441.37	220.71	80.913
Post –Monsoon (Oct-Dec)	131.89	116.47	382.69	9.161
Total (Annual)	1455.49	706.88	1288.859	100

The mean annual rainfall of the Godavari river basin is 121.29 mm with standard deviation of 1.41mm based on 6 years consequent data from Jagityal district. The analysis of mean monthly rainfall of Godavari River basin shows the rain fall during July is the highest (408.53 mm) which contributes 28 % to the annual rainfall followed by August (324.34 mm), September (265.66 mm) and June (179.18 mm). Least amount of rainfall is observed during December (0.81mm), January (13.14 mm) and November (18.62 mm). From table - 4 standard deviation is more during the monsoon period and low coefficient of variation are observed, low standard deviation and high coefficient of variations is seen during the months of December to April..

The Seasonal Pattern of (Rain gauge stations) Rainfall

The seasonal pattern of rainfall in the study region (six years) all the 14 rain gauge stations of the study area Jagityal district of Telangana region have experiences four distinct seasons namely Winter (January-February), Pre-Monsoon (March-May), Monsoon (June-September) and Post –Monsoon (October-December) is shown in figure 3. Mean rainfall in winter varies from 9.63mm in Mallapur to a maximum of 2013 in Sarangapur mandals. The total winter rainfall of the study area is 437.73mm; winter rainfall contributes only 2.57% to the annual rainfall. The spatial distribution of the winter rainfall shows that the rainfall is less than 10.mm in all thirteen mandals. Pre-monsoon season, mean rainfall varies from 57.933 in Mallapur to 525.3mmin Sarangapur rainguage station, The average annual rainfall pre-monsoon season is 1507.42mm with the standard deviation is105.33 mm which contribute 7.35% to the annual rainfall.

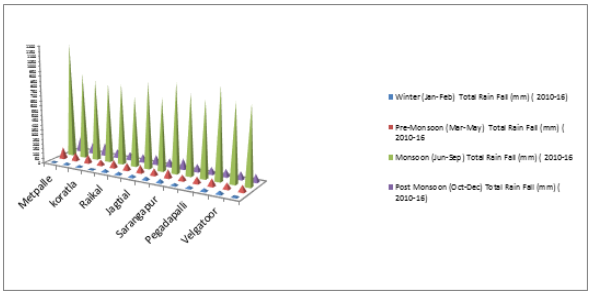

Figure 3. Seasonal wise rainfall data (2010-16) each rain gauge station

The North western part of Godavari River in the study region receives maximum rainfall during monsoon season June to September from 717.8mm in Medipalli to 5499, 5mm in Sarangapur rainguage stations. This season has the maximum number rainy days with standard deviation is 441.47mm which contribute 80.92% to the annual rain fall. During the Post-monsoon low rainfall recorded 72.66mm in Pegadapally to 656.3mm in Sarangapur rain guage stations with the standard deviation is 382.69m contribute 9.161% to the annual rain fall (Table-5).

Table-5 Rain-gauge stations, seasonal annual rainfall statistics over the Study area

Rain gauge stations	Winter (Jan-Feb) Total Rain Fall (mm) (2010-16)	Pre-Monsoon (Mar-May) Total Rain fall (mm) (2010-16	Monsoon (Jun-Sep) Total Rain fall (mm) (2010-16	Post Monsoon (Oct-Dec) Total Rain Fall (mm) (2010-16)	Total Annual (Rainfall (201016) (mm)	Contribution to annual rainfall (%)
Metpalle	10.05	116.65	1175.63	151.26	1453.6	9.93
Kathlapur	22.63	84.9 84.90	876.03	105.40	1088.96	7.44
Koratla	20.6 2020.60 20.60	86.22 886.2286.22 86.21	827.53	124.83	1059.18	7.24
Mallapur	9.63	57.93	807.90	85.58	**961.05**	6.56
Raikal	31.13	79.72	824.86	78.66	**1014.38**	6.93
Medipalle	27.50	73.93	717.80	80.22	**899.45**	6.15

Jagtial	27.43	79.96	879.15	95.40	**1081.95**	7.39
Mallial	34.05	69.25	741.70	85.06	**930.06**	6.35
Sarangapur	35.	87.5	916.58	109.38	**1149.02**	7.85
Gollapalle	22.66	58.83	823.00	78.66	**983.16**	6.72
Pegadapalli	24.30	65.75	784.86	72.66	**947.58**	6.47
Dharamapuri	28.96	76.98	925.90	79.36	**1111.22**	7.59
Velgatoor	35.10	63.16	803.25	81.78	**983.3**	6.72
Dharmaram	18.16	68.81	801.15	81.23	**969.36**	6.63
Total	347.73	1069.66	11905.36	1309.53	**14632.3**	100.000

Coefficient of Variations

The rainfall coefficient (Vijay Kumar et al.2010) of variation has been computed using selected 10 years data to measure the spatial variations in rainfall in the study area. The coefficient of variation (CV) is defined as the ratio of the standard deviation to the average, so each rain gauge stations values has been found using the results of standard deviation and the means values. The results of CV have been plotted on its locations to prepare the spatial variation of rainfall (Figure 4.). Spatial variability of the rainfall in South of the Godavari river Basin, coefficient of variation (CV) has been calculated using mean monthly and annual rain fall. It is observed that the co-efficient of variation during winter seasons receives from 147.11 % in February to 171.58% in January months receives rain falls from 1.67% to 2.689%in the month of February. Pre –monsoon period the study region has the higher variability of the rainfall as the CV varies from (March to May) 119.9% in March to 122.51%in May, which contribute the annual rainfall of 1.979% to 2.689%(Table-4).

During the monsoon periods C.V varies from 48.99% in August to 68.440% June ,which contribute the annual rain fall is 12.354% to 28.029% similarly during the Post monsoon period C.V varies from112.26% to 143.05%,is effect on change of annual rain fall of 0.055% to 7.775%. From the annual spatial variability figures is seen that annual rainfall variability is highest in the Monsoon months of June to September.

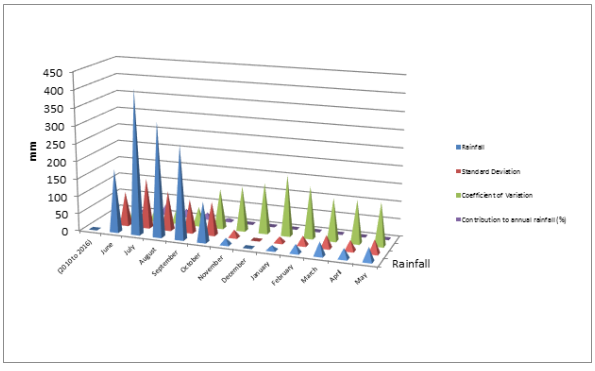

Figure 4(a). Coefficient of variation of each month (2010-16) study region

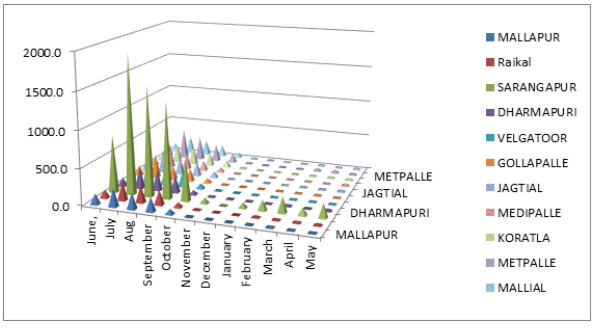

Figure 4(b). Coefficient of variation of each rain gauge staion (2010-16)

Conclusions

The spatial and temporal variability of the rainfall has been studied for the period of six years (2010-2016) with the help of the different statistical methods in all areas of the rain gauge stations in the Jagityal district of Telangana state, India..Rainfall over the study area is not uniformly distributed in all season. It varies from place to place. The highest rainfall variability is seen at Sarangapur Rain gauge station.

The collected data have been used to analyzed year-wise spatial variations of rainfall in ArcGIS, average, standard deviation and Coefficient of variation has also been compute to assess the area, which has mean rainfall about 178 mm, highest rainfall recorded 2010-11, where as lowest 42.86mm mm is recorded in 2015-16 (Table.4). The coefficient of variation is varying low over monsoon, standard deviation is high.

Acknowledgements

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