

Significance Of Precipitation In The Pamba Basin On Kerala Flood 2018 –An Overview

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Abstract- Being the most predominant form of precipitation causing stream flow, the term precipitation is used for rainfall in India, unless otherwise stated. The magnitude of precipitation of a place varies with season and it varies from place to place. It is this variation that causes many hydrological problems, such as droughts and floods. Usually very high rainfall and the consequent runoff results in floods. In August 2018, Kerala faced a devastating flood mainly on the banks of the Holy river Pamba and Periyar. In this paper the rainfall data in various raingauge stations of the Pamba Basin is analysed.

Keywords- Precipitation, Raingauge Station, Runoff, Flood, Pamba Basin.

I. INTRODUCTION

A flood is an unusually high stage in a river that causes the overtopping of the river banks and inundates the adjoining banks. This leads to mishaps- loss of life, property, and other economic losses. At a given section of a river, flood peaks vary from year to year and their magnitude constitutes a hydrologic series which enable one to assign a frequency to a given flood peak value. In design of hydraulic structures the peak flow that can be expected with an assigned frequency of say 1 in 100 years is of primary importance to adequately proportion the structure to accommodate its effect. The design of bridges, culverts, waterways, and spillways for dams are on the basis of this flood peak value. From the rainfall value, area of catchment and type of terrain the flood discharge can be arrived at.

As reservoirs contribute major water storage system, they can mitigate the effect of rains to some extent. But in Kerala State, there exists no such large dams intended only for flood control. So flood mitigation by dams could not be taken into account. The application of mathematical tools for flood prediction is of most importance in water resources engineering.

II. SYSTEM DESCRIPTION- PAMBA RIVER ORIGIN, TRAVEL AND TRIBUTARIES

The river Pamba is the second longest and Holy river of Kerala State and its basin spreads mainly over two districts Pathanamthitta and Alappuzha (Kuttanadu area) of Kerala state. It is formed by the confluence of Pamba Aar, the Kakki Aar, the Azhuthai Air, the Kakkad Aar and the Kallar. Pamba flows west through places namely, Sabarimala, Ranni-Perunadu, Vadasserikkara, Ranni, Kozhencherry, Aranmula, Chengannur and then Achenkovil and Manimala rivers merges with, before it falls in Vembanadu lake. Finally at Thottappally spillway it reaches to Arabian Sea. It has a length of 176 Km from origin to Sea and has got a Catchment of around 2235 Square Kilometers.

In the last flood August 2018, the banks of the same were overflowed, inundating adjoining areas and caused in loss of lives, property, and other economic losses. The river banks were overtopped between 15th – 19th Aug. 2018, even before the mid way of its course at Vadasserikkara. This caused a major devastation in Vadasserikkara and its downstream reaches namely Ranni, Cherukole, Kozhencherry, Aranmula, Chengannur Municipality, Pandanad Panchayaths etc. The present study analyses the rainfall of Aug 2018 at the three Dam locations in the Pamba basin namely Kochupamba, Kakki and Moozhiyar in Pathanamthitta district, Kerala State.

III. RAINFALL CLASSIFICATION

Rainfall classification of Indian Meteorology Department is given in the table I below.

Table 1. IMD Rainfall Classification

| Rainfall classification of IMD | |
|--------------------------------|---------------|
| Very light | 0.1-2.4mm |
| light | 2.5-15.5mm |
| Moderate | 15.6-64.4mm |
| Heavy | 64.5-115.5mm |
| Very heavy | 115.6-204.4mm |
| Extremely heavy | > 204.4mm |

IV. COMPARISON OF RAINFALL AT THE THREE DAM STATIONS

The rainfall for August 2013 to 2018 at the three dam stations namely Kochupamba, Kakki and Moozhiyar are given in Table 2. Rainfall of Aug. 2018 and the average of rainfall for Aug. 2013-17 are plotted below in Fig 1 a, b & c.

Table 2 Rainfall at Kochupamba, Kakki and Moozhiyar stations [2]

| August | Kochupamba | | | | | Kakki | | | | | moozhiyar | | | | | | | |
|--------|------------|-----|-----|-----|-----|-------|-----|-----|-----|-----|-----------|------|------|------|------|------|------|------|
| | 2013 | 14 | 15 | 16 | 17 | 2013 | 14 | 15 | 16 | 17 | 2013 | 14 | 15 | 16 | 17 | | | |
| 1 | 10 | 52 | 0 | 9 | 11 | 15 | 4 | 73 | 0 | 12 | 19 | 24 | 0 | 49.5 | 0 | 5.8 | 9.6 | 9.7 |
| 2 | 73 | 34 | 0 | 9 | 33 | 5 | 51 | 44 | 0 | 19 | 42 | 5 | 17.4 | 56.8 | 0 | 0 | 7.4 | 1.2 |
| 3 | 40 | 30 | 10 | 1 | 12 | 2 | 33 | 23 | 9 | 0 | 6 | 8 | 31.2 | 62.6 | 0 | 0 | 18.2 | 2.6 |
| 4 | 11 | 57 | 5 | 6 | 12 | 5 | 17 | 73 | 6 | 10 | 19 | 13 | 32.8 | 83.4 | 16.2 | 4.4 | 47.6 | 0 |
| 5 | 90 | 27 | 12 | 11 | 2 | 0 | 133 | 38 | 17 | 13 | 24 | 0 | 49.2 | 78.2 | 35.6 | 0 | 72.4 | 0 |
| 6 | 37 | 27 | 16 | 6 | 8 | 3 | 61 | 30 | 11 | 5 | 49 | 7 | 55.4 | 37.5 | 28.4 | 0 | 84.2 | 4.8 |
| 7 | 9 | 6 | 9 | 2 | 6 | 22 | 16 | 15 | 6 | 2 | 7 | 26 | 20.2 | 32.4 | 4.6 | 9.2 | 73.6 | 6.5 |
| 8 | 9 | 1 | 4 | 5 | 8 | 73 | 26 | 2 | 4 | 3 | 17 | 59 | 29.2 | 17.6 | 0 | 0 | 52.8 | 54.2 |
| 9 | 6 | 16 | 9 | 3 | 5 | 195 | 3 | 23 | 14 | 3 | 7 | 143 | 8.4 | 64.2 | 14.2 | 0 | 0 | 92.4 |
| 10 | 3 | 4 | 5 | 3 | 9 | 119 | 11 | 7 | 10 | 10 | 19 | 83 | 17.8 | 12.4 | 9.8 | 24.6 | 48.4 | 68.6 |
| 11 | 5 | 5 | 18 | 3 | 18 | 37 | 4 | 4 | 33 | 3 | 22 | 155 | 4.8 | 9.8 | 16.6 | 0 | 19.2 | 51.4 |
| 12 | 7 | 14 | 56 | 6 | 16 | 5 | 15 | 21 | 33 | 5 | 17 | 6 | 2.8 | 41.5 | 53.4 | 0 | 13.4 | 2.9 |
| 13 | 8 | 0 | 25 | 5 | 0 | 77 | 6 | 0 | 24 | 12 | 3 | 194 | 9.2 | 0 | 35.2 | 14.8 | 0 | 72.6 |
| 14 | 7 | 14 | 5 | 0 | 0 | 72 | 6 | 10 | 6 | 10 | 2 | 69 | 11.8 | 23.6 | 32.6 | 9.8 | 0 | 47.4 |
| 15 | 5 | 0 | 11 | 8 | 0 | 283 | 6 | 0 | 25 | 13 | 4 | 156 | 0 | 16.7 | 0 | 34.6 | 0 | 122 |
| 16 | 5 | 4 | 7 | 4 | 3 | 147 | 7 | 0 | 14 | 16 | 14 | 194 | 19.2 | 5.8 | 27.4 | 5.8 | 12.5 | 175 |
| 17 | 24 | 2 | 4 | 13 | 3 | 89 | 38 | 0 | 4 | 8 | 6 | 333 | 31.4 | 0 | 8.6 | 0 | 0 | 113 |
| 18 | 0 | 2 | 9 | 16 | 23 | 77 | 6 | 20 | 5 | 3 | 371 | 6.2 | 0 | 34.8 | 43.4 | 7.8 | 0 | 87.5 |
| 19 | 9 | 0 | 11 | 13 | 12 | 33 | 9 | 0 | 23 | 25 | 18 | 70 | 17.1 | 48.2 | 21.4 | 23.6 | 26.6 | 34.2 |
| 20 | 2 | 7 | 16 | 5 | 25 | 37 | 4 | 4 | 0 | 2 | 41 | 70 | 16.8 | 0 | 0 | 0 | 58.2 | 12.8 |
| 21 | 12 | 3 | 2 | 4 | 37 | 38 | 19 | 10 | 0 | 7 | 40 | 27 | 21.4 | 24.2 | 0 | 3.6 | 86.4 | 14.7 |
| 22 | 4 | 10 | 9 | 0 | 35 | 5 | 9 | 3 | 7 | 14 | 50 | 13 | 12.2 | 0 | 0 | 0 | 73.7 | 3.8 |
| 23 | 0 | 3 | 1 | 0 | 3 | 3 | 2 | 11 | 11 | 3 | 3 | 4 | 0 | 82.4 | 0 | 0 | 14.9 | 0 |
| 24 | 0 | 25 | 8 | 0 | 6 | 1 | 3 | 17 | 16 | 9 | 6 | 0 | 0 | 25.8 | 0 | 45.2 | 5.4 | 0 |
| 25 | 0 | 1 | 5 | 4 | 5 | 0 | 2 | 0 | 4 | 3 | 5 | 0 | 4.4 | 0 | 0 | 26.4 | 0 | 0 |
| 26 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 18.8 | 0 | 0 |
| 27 | 0 | 0 | 1 | 15 | 0 | 0 | 5 | 0 | 0 | 65 | 16 | 3 | 6.2 | 0 | 0 | 19.4 | 19.6 | 0 |
| 28 | 0 | 2 | 0 | 6 | 42 | 8 | 8 | 9 | 0 | 14 | 33 | 12 | 0 | 0 | 0 | 35.4 | 33.4 | 7.6 |
| 29 | 68 | 12 | 0 | 2 | 43 | 17 | 17 | 23 | 0 | 0 | 42 | 34 | 5.2 | 34.2 | 0 | 24.4 | 84.8 | 11.4 |
| 30 | 5 | 31 | 0 | 5 | 18 | 0 | 4 | 47 | 0 | 8 | 22 | 2 | 9 | 48.6 | 0 | 22.6 | 67.5 | 0 |
| 31 | 18 | 53 | 0 | 9 | 4 | 7 | 5 | 73 | 0 | 10 | 14 | 0 | 17.8 | 63.4 | 0 | 17.4 | 17.6 | 0 |
| | 467 | 447 | 240 | 177 | 404 | 1195 | 815 | 594 | 324 | 316 | 561 | 1953 | 459 | 919 | 339 | 389 | 965 | 997 |

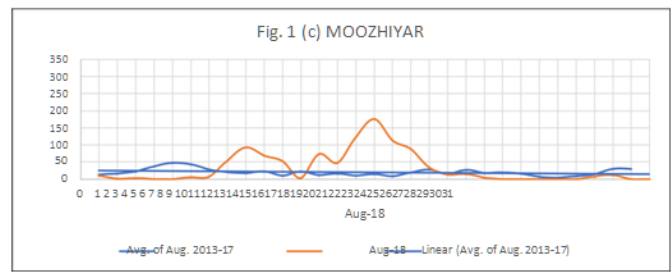


Fig. 1 (c) MOOZHIYAR

Table 3 (a) Descriptive Statistics

| RAINFALL AT | N | Range | Minimum | Maximum | Mean | | Std. Deviation | Variance |
|--------------------|-----------|-----------|-----------|-----------|-----------|------------|----------------|-----------|
| PAMBA | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| | | AUG2013 | 31 | 90.00 | .00 | 90.00 | 15.0645 | 4.12465 |
| AUG2014 | 31 | 58.00 | .00 | 58.00 | 14.4194 | 3.11734 | 17.35660 | 301.252 |
| AUG2015 | 31 | 36.00 | .00 | 36.00 | 7.7419 | 1.45319 | 8.09101 | 65.465 |
| AUG2016 | 31 | 16.00 | .00 | 16.00 | 5.7097 | .78998 | 4.3644 | 19.346 |
| AUG2017 | 31 | 43.00 | .00 | 43.00 | 13.0323 | 2.40407 | 13.38528 | 179.166 |
| AUG2018 | 31 | 203.00 | .00 | 203.00 | 38.5806 | 9.07540 | 50.52971 | 2553.252 |
| Valid N (listwise) | 31 | | | | | | | |

Table 3 (b) Descriptive Statistics

| RAINFALL AT | N | Range | Minimum | Maximum | Mean | | Std. Deviation | Variance |
|--------------------|-----------|-----------|-----------|-----------|-----------|------------|----------------|-----------|
| KAKKI | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| | | AUG2013 | 28 | 121.00 | 2.00 | 123.00 | 18.3929 | 4.82315 |
| AUG2014 | 31 | 78.00 | .00 | 78.00 | 19.0645 | 4.06903 | 22.82241 | 520.862 |
| AUG2015 | 31 | 38.00 | .00 | 38.00 | 10.4516 | 1.97339 | 10.98738 | 120.723 |
| AUG2016 | 31 | 66.00 | .00 | 66.00 | 10.1935 | 2.14848 | 11.96222 | 143.095 |
| AUG2017 | 31 | 50.00 | .00 | 50.00 | 18.0968 | 2.67258 | 14.88031 | 221.424 |
| AUG2018 | 31 | 296.00 | .00 | 296.00 | 63.0000 | 15.75887 | 87.74167 | 7698.600 |
| Valid N (listwise) | 28 | | | | | | | |

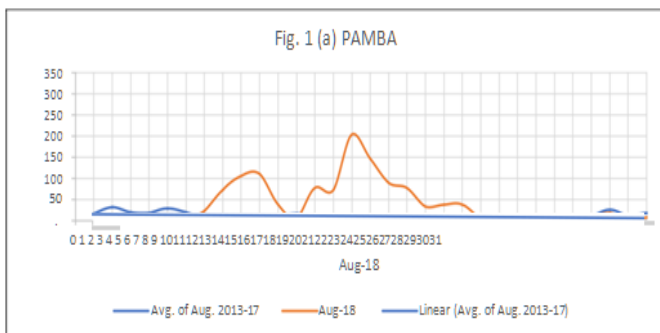


Fig. 1 (a) PAMBA

Table 3 (c) Descriptive Statistics

| RAINFALL AT | N | Range | Minimum | Maximum | Mean | | Std. Deviation | Variance |
|--------------------|-----------|-----------|-----------|-----------|-----------|------------|----------------|-----------|
| MOOZHIYAR | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| | | AUG2013 | 31 | 55.40 | .00 | 55.40 | 14.8097 | 2.54143 |
| AUG2014 | 31 | 83.40 | .00 | 83.40 | 28.6387 | 4.98161 | 27.73589 | 769.280 |
| AUG2015 | 31 | 53.40 | .00 | 53.40 | 10.9290 | 2.71693 | 15.13834 | 229.169 |
| AUG2016 | 31 | 45.20 | .00 | 45.20 | 12.5548 | 2.53739 | 14.12758 | 199.589 |
| AUG2017 | 31 | 94.20 | .00 | 94.20 | 31.1355 | 5.57639 | 31.04802 | 963.980 |
| AUG2018 | 31 | 175.00 | .00 | 175.00 | 32.1387 | 8.17701 | 45.52765 | 2072.767 |
| Valid N (listwise) | 31 | | | | | | | |

Table 4. Comparison of statistical measures for the years 2013 to 2017 and 2018

| | 2013-2017 | | | 2018 | | |
|----------------|-----------|----------|-----------|----------|----------|-----------|
| Max. values | Pamba | Kakki | Moozhiyar | Pamba | Kakki | Moozhiyar |
| Range | 90 | 121 | 94.2 | 203 | 296 | 175 |
| Maximum | 90 | 123 | 94.2 | 203 | 296 | 175 |
| Mean (static) | 15.0645 | 18.3929 | 31.1355 | 38.5806 | 63 | 32.1387 |
| Std. deviation | 22.96510 | 25.52173 | 31.04802 | 50.52971 | 87.74167 | 45.52765 |
| Variance | 527.396 | 651.358 | 963.980 | 2553.252 | 7698.6 | 2072.767 |

V. COMPARISON OF RAINFALL AT THE NEIGHBOURING STATIONS IN THE BASIN

The only available rainfall data for Aug. 2018 at the five neighbouring stations in Pamba basin are given in Table 5

Table 5. Rainfall data for Aug. 2018 [1], [2]

| Rain gauge Stations | Koruthodu | Nilackal | Moozhayar | Punnamedu Ridge | Vadasserikkara |
|---------------------|----------------|----------|-----------|-----------------|----------------|
| Aug. 2018 | Rainfall in mm | | | | |
| 1 | 4 | 0 | 9.7 | 13.2 | 16 |
| 2 | 0 | 0 | 1.2 | 0 | 0 |
| 3 | 0 | 13.2 | 2.6 | 12.5 | 12 |
| 4 | 3.8 | 12.4 | 0 | 5 | 0 |
| 5 | 2.6 | 0 | 0 | 0 | 0 |
| 6 | 2.8 | 6 | 4.8 | 0 | 5 |
| 7 | 4 | 17.4 | 6.5 | 9.7 | 10.6 |
| 8 | 50.4 | 62.4 | 54.2 | 79.4 | 59.4 |
| 9 | 73.2 | 74.8 | 92.4 | 79.5 | 65 |
| 10 | 76 | 80.2 | 68.6 | 81.1 | 71 |
| 11 | 73 | 31.2 | 51.4 | 25.3 | 16 |
| 12 | 4.8 | 17.2 | 2.9 | 11 | 7 |
| 13 | 49.8 | 76.8 | 72.6 | 25.1 | 24 |
| 14 | 56 | 62.8 | 47.4 | 33.5 | 19 |
| 15 | 125.2 | 148.4 | 122 | 146.5 | 162 |
| 16 | 144.6 | 210.2 | 175 | 89.4 | 142.6 |
| 17 | 96.2 | 148.4 | 113 | 131.4 | 137 |
| 18 | 96 | 162.4 | 87.5 | 106.1 | 102 |
| 19 | 35.2 | 34.6 | 34.2 | 9.1 | 7.6 |
| 20 | 32.6 | 22.2 | 12.8 | 23.2 | 5.6 |
| 21 | 13.6 | 22.4 | 14.7 | 3 | 0 |
| 22 | 9.6 | 12.8 | 3.8 | 5.1 | 7.6 |
| 23 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 0 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 |
| 27 | 0 | 2.8 | 0 | 0 | 0 |
| 28 | 15.2 | 13.8 | 7.6 | 14.5 | 12.6 |
| 29 | 16.4 | 28.2 | 11.4 | 0 | 10.4 |
| 30 | 0 | 0 | 0 | 13.3 | 0 |
| 31 | 1.2 | 0 | 0 | 0 | 5.4 |
| | 985.2 | 1261 | 997 | 918 | 897.8 |

The rainfall for the month of August 2018 at these five stations are plotted in Fig. 2 a, b, c, d & e below.

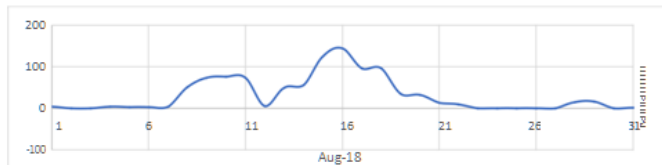


Fig. 2.a- Aug/2018 Rainfall -Koruthodu Station



Fig. 2.b- Aug/2018 Rainfall- Nilackal Station

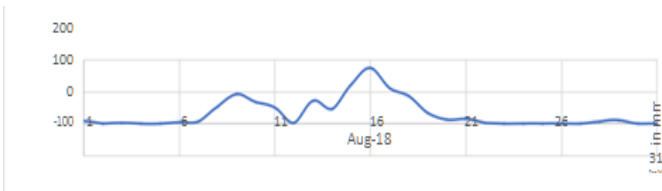


Fig 2.c- Aug/2018 Rainfall-Moozhayar Station

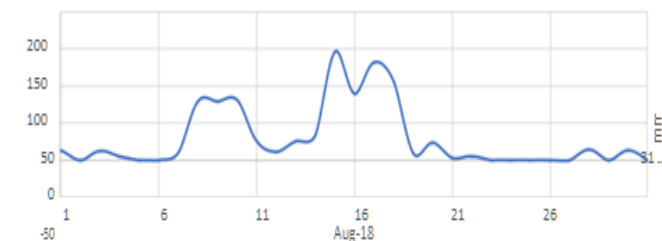


Fig 2.d- Aug/2018 Rainfall- Punnamedu Ridge Station



Fig 2. e- Aug/2018 Rainfall- Vadasserikkara Station

Fig. 2 a, b, c, d & e plots of rainfall for Aug. 2018

These plots are similar and shows two ups in the rainfall with a peak between 14th and 19th as in Fig 1 a., b & c.

VI. RESULTS AND CONCLUSIONS

- From the rainfall plot Fig. x, y, z in Aug/2018, it is clear that the rain has two ups between Aug 08th to Aug. 11th and between Aug 14th and Aug. 19th. By 11th itself, the infiltration requirement has already met and then the 2nd peak occurs between 14th and 19th. This resulted in a sudden and heavy runoff resulted in heavy flood.
- The statistical measures such as Range, Maximum values, Static Mean, Std deviation and Variance have its maximum values in Aug. 2018 compared to that from 2013 to 2017.
- The maximum rainfall at all the three dam locations and the other five in the basin come in ‘very heavy’ and ‘extremely heavy’ category, which gave rise to the flood 2018.

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