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# A study of the spacial and frequency distribution of rainfall in the Ratnagiri district

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## 1. Introduction

Studies of the spacial and frequency distribution of rainfall in small areas, such as districts, are of considerable importance from the point of view of issuing forecasts and warnings to interests such as Community Development Blocks and in assessing their accuracy. In a previous paper (Hariharan 1956a) the results of a study in spacial and frequency distribution of daily rainfall in relation to network of rain-recording stations in south Hyderabad have been described. The author has discussed there the relationship between the rainfall distribution as indicated by the limited number of synoptic stations and that shown by the more extensive network of State rain-recording stations. In two earlier papers (Rai Sircar and Hariharan 1954, Hariharan 1956b) it was shown how the assessment of spacial distribution of rainfall in an area can be affected considerably by the density of network of rain-recording stations used for the assessment. As the ideas gained from these studies were found useful in forecasting rainfall for small areas such as those covered by Community Development Blocks, it was considered desirable to extend the studies to some other areas.

## 2. Area under study and data

The area chosen for the present study is the Ratnagiri district of the Konkan on the west coast of Bombay State. There are four observatory stations (Vengurla, Devgad, Ratnagiri and Harnai) and 14 rain-recording stations (Malwan, Rajapur, Sangameshwar, Chiplun, Guhagar, Khed, Dapoli, Mandangad, Lanja, Kankavali, Savantwadi, Banda, Amboli and Kudal) in this district. A map of the district showing the locations of these stations is given in Fig. 1. The shaded portion in the map shows the area under community development scheme, for which forecasts and warnings are issued by the Regional Meteorological Centre, Bombay. The rainfall data examined refer to the monsoon season (June-September) for the five-year period 1946-50 and comprise of rainfall records of State raingauge stations published by the Bombay Government. For describing the spacial distribution of rainfall, the gradations used in the India Meteorological Department have been adopted. These are indicated in Table 1. The criteria for describing the rainfall distribution in the Ratnagiri district as 'widespread', 'fairly widespread', etc in terms of the actual number of observatories and rain-recording stations in the district, which should have rainfall, are given in Table 2.

## 3. Spacial distribution of rainfall

The rainfall distribution on each of the 610 days of the five-year period has been graded as 'widespread', 'fairly widespread', 'local' and 'scattered', first taking into account the rainfall recorded at the four observatory stations only and then by considering the total number of rain-recording stations including the observatories, *viz.*, 18. These occasions have been reduced to a frequency table, given in Table 3. The last column of Table 3 gives the classification considering only the rainfall reported by the observatory stations and remaining columns show the

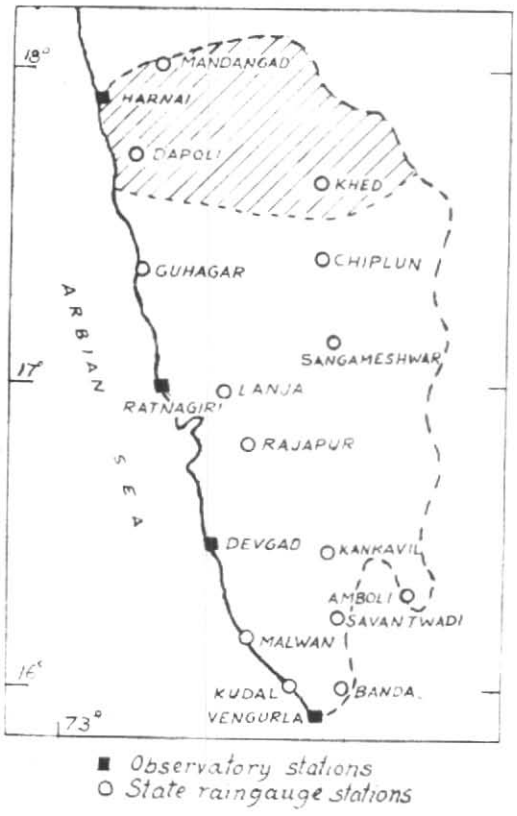


**Fig. 1. Map of Ratnagiri district showing the network of rain-recording stations**

Shaded portion shows the area under Community Development Projects, for which warnings are issued

changes in gradation when we consider the network of all rain-recording stations. For example, there have been 321 occasions when all the observatories in the district received rain; but when we consider all the rain-recording stations, it is seen that out of 321 occasions, rainfall was really widespread on 75 per cent of the occasions only. On about 23 per cent occasions there was 'fairly widespread' rain and on 1 to 2 per cent of the days only 'local' rain. A very significant fact which the table brings out is that there were 72 occasions when none of the observatory stations reported any rain, so that going by the data of synoptic stations only, the weather on these days would have been described as 'dry'. But when we examine the reports from all the rain-recording stations, it is seen that the number of dry days (*viz.*, when none of the rain-recording stations had received any rain) is reduced to 20 per cent of the days. Of the remaining days, the area had 'local' rain on 21 per cent of the days and 'scattered' rain on 60 per cent of the days. Similarly there were 54 occasions when the rainfall distribution according to the observatory stations alone, was 'scattered'. But reports from the network of the 18 stations indicate that the area had 'scattered' rain only on 24 per cent of the days. On 2 per cent of the days there was 'no rain'; on 54 per cent of the days there was 'local' rain and on 20 per cent of the days there was 'fairly widespread' rain. It is thus seen that our assessment of weather based on the reports of synoptic stations can be very different from the actuals. This difference is most marked in the case of the classes 'local', 'scattered' and 'no rain'. The fact that none of the observatory stations has reported any rain does not necessarily mean that there has been no precipitation in the area. This fact should always have to be taken note of while verifying forecasts issued for small areas.

#### 4. Frequency distribution of mean rainfall of the district

The mean rainfall of the district on each of the 610 days has been determined first by taking the data of the four observatory stations and secondly by considering the data of all the 18 rain-recording stations, including the observatories. Then both the series of means have been reduced to a frequency distribution by classifying them according to the following limits—less than 10 cents, 10-24 cents, 25-49 cents, 50-74 cents, 75-99 cents and 1 inch or more. The results are shown in Table 4. Some of the points that may be noticed from this table are—

(*i*) On 148 days, the mean rainfall of the district according to the full network of rain-recording stations was less than 25 cents,

**TABLE 1**

| Gradation of rainfall distribution | Criteria for grading |
|---|---|
| Widespread (W) | Rainfall at all stations in the area |
| Fairly widespread (FW) | Rainfall at 2/3 or more but not at all the stations |
| Local (L) | Rainfall at 1/3 or more but less than 2/3 of the stations |
| Scattered (SC) | Rainfall at less than 1/3 of the stations |
| No rain (NR) | No rain at any station |

**TABLE 2**

| Gradation of rainfall distribution | No. of stations which should have had rainfall | |
|---|---|---|
| | Observatory stations | All the rain recording stations, including observatories |
| Widespread | 4 | 18 |
| Fairly widespread | 3 | 12—17 |
| Local | 2 | 6—11 |
| Scattered | 1 | 1—5 |
| No rain | 0 | 0 |

Out of these, on 136 days, the mean rainfall of the observatory stations was also less than 25 cents. On the other hand, out of the 195 occasions when the mean rainfall of the observatory stations was less than 25 cents, on 59 (30 per cent) occasions mean rainfall according to the network of rain-recording stations was higher.

(*ii*) There were 111 occasions when the mean rainfall of the observatory stations was 25-49 cents. The number of such occasions considering all rain-recording stations is only 33 (about 30 per cent of the occasions).

(*iii*) Out of 73 occasions when the mean rainfall of the observatory stations was 50-74 cents, the mean rainfall considering the full network exceeded 74 cents on 44 (60 per cent) occasions. Similarly, out of 46 occasions when the mean rainfall of observatory stations was 75-99 cents, the mean rainfall of all the rain-recording stations was 1″ and more on 32 occasions. It would thus appear that on occasions of moderate or perhaps heavy rain, the mean rainfall of the district is generally higher than what is indicated by observatory stations.

**5. Frequency of heavy rain**

Rainfall figures recorded at the various raingauge stations in Ratnagiri district (including observatories) on occasions when the mean rainfall of the district as a whole was 3 inches or more were collected. These occasions were further classified according to the mean rainfall of the observatory stations. The results of this classification are given in Table 5. It will be seen that out of 52 occasions, when the mean rainfall of the district, according to the full network, was 3″ or more , the mean rainfall according to the observatory stations was less than 3″ on 21 (40 per cent) of the occasions.

**TABLE 3**

| Rainfall gradation according to the four observatory stations | Rainfall gradation as per 18 rain-recording stations | | | | | Total |
|---|---|---|---|---|---|---|
| | W | FW | L | SC | NR | |
| Widespread (W) | 241 | 75 | 5 | 0 | 0 | 321 |
| Fairly widespread (FW) | 0 | 97 | 11 | 0 | 0 | 108 |
| Local (L) | 0 | 23 | 24 | 8 | 0 | 55 |
| Scattered (SC) | 0 | 11 | 29 | 13 | 0 | 53 |
| No rain (NR) | 0 | 0 | 15 | 44 | 14 | 73 |
| Total | 241 | 206 | 84 | 65 | 14 | 610 |

**TABLE 4**

**Frequency distribution**

| Mean rainfall of the four observatories | Mean rainfall of the district based on all 18 rain-recording stations | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Less than 10 cents | 10—24 cents | 25—49 cents | 50—74 cents | 75—99 cents | 1 inch or more | |
| Less than 10 cents | 56 | 41 | 14 | 0 | 1 | 3 | 115 |
| 10—24 cents | 7 | 32 | 30 | 6 | 4 | 1 | 80 |
| 25—49 cents | 1 | 8 | 33 | 33 | 25 | 11 | 111 |
| 50—74 cents | 0 | 0 | 10 | 19 | 16 | 28 | 73 |
| 75—99 cents | 0 | 1 | 0 | 9 | 4 | 32 | 46 |
| 1 inch or more | 2 | 0 | 1 | 3 | 20 | 159 | 185 |
| Total | 66 | 82 | 88 | 70 | 70 | 234 | 610 |

**TABLE 5**

**No. of days when (a) the mean rainfall of 18 rain-recording stations was 3 inches or more and (b) the mean rainfall of four observatories was within specified limits**

| (a) | (b) | | | |
|---|---|---|---|---|
| | 3″ or more | 2·00″ to 2·99″ | 1·00″ to 1·99″ | Less than 1″ |
| 52 | 31 | 16 | 5 | 0 |

**TABLE 6**

**No. of days when (a) the mean rainfall of observatories/ rain-recording stations was 3 inches and more, and (b) the mean rainfall of raingauge stations in the Community Project area was within specified limits**

| | (a) | (b) | | | |
|---|---|---|---|---|---|
| | | 3″ or more | 2·00″ to 2·99″ | 1·00″ to 1·99″ | Less than 1″ |
| Observatories | 34 | 20 | 9 | 3 | 2 |
| Rain-recording stations | 52 | 35 | 13 | 4 | 0 |

**TABLE 7**

**No. of days when (a) the mean rainfall of raingauge stations in the Community Project area was 3 inches and more and (b) the mean rainfall of the observatories was within specified limits**

| (a) | (b) | | | |
|---|---|---|---|---|
| | 3″ or more | 2·00″ to 2·99″ | 1·00″ to 1·99″ | Less than 1″ |
| 56 | 21 | 15 | 16 | 4 |

**TABLE 8**

**Frequency distribution of the number of days when rainfall at each of the Community Project raingauge stations was of different orders corresponding to the days when the rainfall at Harnai was 3″ or more**

| Community Project raingauge station | 3″ or more | 2·00″ to 2·99″ | 1·00″ to 1·99″ | Less than 1″ |
|---|---|---|---|---|
| Khed | 25 | 6 | 3 | 4 |
| Dapoli | 31 | 5 | 2 | 0 |
| Mandangad | 28 | 5 | 3 | 2 |

**TABLE 9**

**Frequency distribution of the number of days when rainfall at Harnai was of different orders corresponding to the days when rainfall at each of the Community Project raingauge stations was 3″ or more**

| | | Community Project raingauge stations which recorded rainfall of 3″ or more | | |
|---|---|---|---|---|
| | | Khed | Dapoli | Mandangad |
| Rainfall at Harnai | 3″ or more | 25 | 31 | 28 |
| | 2·00—2·99″ | 11 | 11 | 14 |
| | 1·00—1·99″ | 15 | 8 | 16 |
| | Less than 1″ | 8 | 2 | 13 |
| | Total | 59 | 52 | 71 |

**6. Rainfall distribution in Community Project area**

Tables 6 to 9 show the relationship between the rainfall pattern in the Community Project area *vis-a-vis* the observatory stations and the rain-recording stations. From Table 6 it will be seen that on 34 occasions the mean rainfall of the observatory stations was 3″ or more. Out of these, on 20 (59 per cent) occasions, the mean rainfall of the Community Project area was also 3″ or more. Considering the full network of rain-recording stations, there were 52 occasions when mean rainfall of the district was 3″ and more. Out of these on 35 (67 per cent) occasions the mean rainfall of the Community Project area was also 3″ or more. From Table 7 it is seen that out of 56 occasions when the average rainfall of the Community Project area was 3″ and more, there were only 21 (37 per cent) occasions when the mean rainfall of the observatory stations was also of the same order. On 15 (27 per cent) occasions it was between 2 and 3 inches, on 16 (29 per cent) occasions between 1 and 2 inches and on 4 (7 per cent) occasions less than 1 inch.

Incidentally it may also be noted that out of 610 days for which the rainfall figures have been examined, the number of occasions when the mean rainfall of the rain-recording stations, the observatory stations and the Community Project raingauge stations respectively was 3″ or more, was only 52, 34 and 56, *i.e.*, less than 10 per cent.

From Fig. 1 it would be seen that out of the four India Meteorological Department observatories, *viz.*, Harnai, Ratnagiri, Devgad and Vengurla, Harnai is situated nearest to the Community Project area shown by the shaded portion. There are 3 rain-recording stations in this area, *viz.*, Khed, Dapoli and Mandangad. These are at distances of 20, 6 and 6 miles respectively from Harnai. The relationship between rainfall recorded at Harnai and that recorded at each one of the 3 Community Project raingauge stations is given in Tables 8 and 9. From Table 8, it will be seen that out of the 38 occasions when Harnai recorded 3″ or more of rain, the number of occasions when Khed, Dapoli and Mandangad recorded similar amounts was 25 (65 per cent), 31 (81 per cent) and 28 (73 per cent) respectively. Similarly Table 9 shows that (*i*) out of 59 occasions when Khed recorded 3″ or more, there were 25 occasions when Harnai also recorded 3″ or more, and only 8 occasions when Harnai had less than 1″; (*ii*) out of 52 occasions when Dapoli recorded 3″ and more, there were 31 occasions when Harnai recorded similar amounts. On 2 occasions only Harnai received less than 1″; and (*iii*) out of 71 occasions when Mandangad received 3″ or more, there were 28 occasions, when Harnai had 3″ or more. There were 13 occasions when Harnai had less than 1″.

The present brief study emphasizes some of the limitations in assessing the probable amount of rain recorded at the Community Project areas from the data of reporting stations even in an area like Ratnagiri district which is a very good monsoon area and where there is some rain practically on every day in the months of *July* and *August*.

*REFERENCES*


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