Occurrence of dry and wet weeks over Maharashtra

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सार - मार्कोव चेन निर्देश का प्रयोग करते हुए दक्षिणी पश्चिमी मानसून ऋतु के दौरान महाराष्ट्र के सभी जिलों की सामान्य और परिस्थितियों पर आधारित सम्भावित एक सप्ताह की वर्षा, दो सप्ताहों की वर्षा और लगातार तीन सप्ताहों की वर्षा का पिछले 90 वर्षों (1901- 90) के दैनिक वर्षा आँकड़ों के आधार पर आकलन किया गया है। सम्भावनाओं के कालिक और स्थानिक संदर्भ में भी वर्षा वाले सप्ताहों के वितरण का इसमें विस्तार से अध्ययन किया गया है। अधिकांश जिलों में जुलाई के महीने में वर्षा वाले सप्ताहों की अधिकतम संभावनाएं पाई गई है। कुछ जिलों में वर्षा वाले सप्ताहों की अगस्त के महीने में भी अधिकतम संभावनाएं पाई गई हैं। राज्य के पश्चिमी और उत्तरपूर्वी भागों में वर्षा की अधिकतम संभावना वाले सप्ताहों की संख्या 10-16 तक रही है। पश्चिमी तट पर अधिक वर्षा वाले जिलों में वर्षा ऋतु की अधिकांश अवधि के दौरान वर्षा वाले अधिक सप्ताहों की संभावना रही है। साधारण वर्षा वाले क्षेत्रों के कुछ जिलों में जुलाई और अगस्त में वर्षा वाले सप्ताह की अधिक संभावना रही है। राज्य के केवल सूदूर पश्चिमी भागों में ही निरन्तर वर्षा होती रही है। 19 अंश उत्तर में पूर्व से पश्चिम तक वर्षा की अधिकतम संभावना वाले सप्ताहों में भिन्नता की पद्धति रोमन लिपि के "एल" अक्षर के आकार की पाई गई है। जबकि उत्तर से दक्षिण तक वर्षा की अधिकतम संभावना वाले सप्ताहों में भिन्नता की पद्धति सिनुसाइडल वक्र की तरह पाई गई है।

ABSTRACT. Based on the daily rainfall data of the past 90 years (1901–90), the initial and conditional probabilities of a wet week and the probabilities of 2 and 3 consecutive wet weeks have been computed for all the districts of Maharashtra during the southwest monsoon season by using Markov Chain model. A temporal and spatial distribution of probabilities of wet weeks have been studied in detail. Most of the districts show the highest probability of wet weeks during July. A few nember of the districts show the second highest probability during August. The western and northeastern parts of the state show 10-16 wet weeks with high probability. The high rainfall districts along the west coast show high wet week probabilities during most of the period of the season. A few number of the districts from moderate rainfall zone, show high probability of a wet week during, July and August. A persistency in rainfall is noticed in only extreme western parts of the state. The east-west variation along 19° N shows 'L' shaped pattern for the high probability wet weeks. While, the north - south variation of the wet weeks with high probability shows a sinusoidal curve from north to south.

Key words – Markov Chain model, Dry and wet week, Threshold rainfall, Monsoon, Sinusoidal, Initial and conditional probabilities.

1. Introduction

A large number of agricultural operations are sensitive to weather parameters particularly the rainfall. Spatial and temporal distributions of rainfall play a dominant role in different stages of a crop and control the yield. Rainfall distribution alongwith its quantity is an essential factor. Mean rainfall gives the general picture and can be used for monitoring purposes while the probability of occurrence of a certain amount of rainfall within a week can be used for ideal planning particularly when the rainfall forecast for coming week is not available, probability of weekly rainfall can be computed

based on past data. These probabilities can be used in planning of agricultural operations like land preparations, sowing, crop planning and irrigation etc.

In literature, two types of probabilities for weekly rainfall namely simple and conditional have been computed by using Markov Chain model of order one. These probabilities have been found very useful in describing the characteristics of rainfall patterns. A number of workers have applied Markov Chain technique and have computed probabilities of weekly rainfall [Khambete and Biswas (1984) and Pandharinath (1991)]. A few studies are also available which deal with the study

of daily rainfall probabilities [Gabriel and Neumann (1962), Victor and Sastry (1979), Chowdhury (1981)].

2. Data used

In this study, daily rainfall data for past 90 years (1901–90) for all the stations of Maharashtra have been used. Considering a district as a unit, data of all the available stations in a district are used for computing daily district rainfall. By using the daily district data, weekly district rainfall for all the standard weeks of southwest monsoon season (22nd to 39th) have been computed. The 22nd standard week covers the period 27 May to 3 June while the 39th standard week covers period from 24 September to 30 September.

3. Methodology

In this paper, an attempt has been made to compute initial and conditional probabilities for wet and dry weeks for all the 30 districts of Maharashtra and use these probabilities in further computation of probabilities of 2 and 3 consecutive wet or dry weeks by using Markov Chain model of order one. For different agricultural operations certain minimum amount of rainfall is needed. This minimum amount of rainfall is denoted by threshold value. This is necessary as the user may be interested to know the probability of having a threshold rainfall in the next week if the present week is wet or dry.

3.1. *Threshold rainfall values of a district*

If the amount of rainfall in a week is more than the threshold amount, it is considered as a wet week. Threshold rainfall has been defined based on the coefficient of variation (C.V.) of the rainfall. In literature, detailed analysis of C.V. of seasonal monsoon rainfall over India is available. Utilising this information, threshold rainfall value for a district as a function of C.V. has been determined. The details of criteria used for this purpose are given in Table 1.

By using the criteria, given in Table 1, the weekly threshold rainfall values for all the districts of Maharashtra State have been computed and are given in Table 2.

It is seen from the table that the weekly threshold rainfall value for different districts vary from 30 mm to 40 mm. These values have been utilised for deciding a wet or dry week of a district.

TABLE 1

Criteria for Determining Threshold Rainfall Values for a District

Co-efficient of variation of seasonal rain (%) (June – September)	Threshold rainfall for a district (mm)
0 – 19	50
20 – 29	40
30 – 39	30
40 – 49	20
50 – 100	10

3.2. *Formulation of model*

The Markov Chain probability method makes use of the fact that the atmosphere is persistent on many occasions. On all these occasions atmospheric events are dependent on the preceding events. Thus Markov Chain model can be utilized for estimating the probabilities of a wet or dry week with reference to the rainfall of previous week. The two types of probabilities, initial and conditional, can be computed from Markov Chain model. The initial probability is denoted by $p(w)$ and is computed by using long series of data for the same week. The conditional probability of wet/dry week is computed by utilizing the long series of rainfall data of current as well as previous week. By following this procedure of the conditional probability for a wet week, if a previous week is wet, is denoted by $p(w/w)$. If the previous week is dry the conditional probability for a week to be wet is denoted by $p(d/w)$. With the help of initial and conditional probabilities, the probabilities of 2 and 3 consecutive wet weeks can also be computed by Markov Chain model.

Using the formulae given by Robertson (1982), probabilities of dry/wet weeks, and of consecutive two or three dry/wet weeks can be computed.

In this study as mentioned above district and week have been considered as units of area and time. For 90 years (1901-90) daily rainfall for all the 30 districts of Maharashtra have been computed. These daily district rainfall (1901-90) have been used for computing the normal seasonal rainfall for different districts of the State and are given in Table 2. In the same table, the number of stations used for computing district statistics, coefficient of variation (C.V.) and threshold rainfall are also given.

3.3. *Determination of rainfall threshold values*

For identifying the threshold rainfall the normal rainfall values for all the districts are presented in Fig. 1. It

TABLE 2

State : Maharashtra   Period : 1901-1990

S No	Name of Districts	No of Stns. used under a district	Normal R/F for season Jun-Sep (mm)	C.V. (%) for season Jun-Sep	Threshold rainfall value (mm)
			Konkan		
1.	Bombay	8	2239	20-30	40
2.	Colaba	20	3200	20	40
3.	Ratnagiri	21	3155	20	40
4.	Thane	14	2373	20	40
5.	Sindhudurg	8	2773	20	40
			Madhya Maharashtra		
6.	Ahmednagar	14	440	30-40	30
7.	Dhulia	14	694	30	30
8.	Jalgaon	13	652	30	30
9.	Nasik	21	871	30	30
10.	Kolhapur	19	1548	20-30	30
11.	Sangli	16	441	30-40	30
12.	Satara	17	626	30-40	30
13.	Pune	24	1005	30	30
14.	Sholapur	12	453	30-40	30
			Marathwada		
15.	Aurangabad	14	611	30	30
16.	Parbhani	11	778	30	30
17.	Osmanabad	11	664	30-40	30
18.	Nanded	11	838	30	30
19.	Bhir	10	592	30-40	30
20.	Jalna	5	651	30	30
21.	Latur	6	831	30-40	30
			Vidarbha		
22.	Akola	14	724	20-30	40
23.	Amroati	16	752	20-30	40
24.	Bhandara	14	1281	20-30	40
25.	Buldhana	14	686	20-30	40
26.	Nagpur	11	1004	20	40
27.	Wardha	7	934	20-30	40
28.	Yeotmal	11	870	20-30	40
29.	Chandrapur	23	1230	20-30	40
30.	Gadchiroli	8	1308	20	40

Fig. 1.   Mean seasonal rainfall (cm) for districts of Maharashtra state

is seen from the figure that based on district normals, the State can be divided into 3 zones of rainfall *i.e.*, high (>1600 mm), medium (600-1600 mm) and low (<600 mm). The high rainfall zone occupies the western portion of the state while other two rainfall zones occupy central and eastern portion of the state (Fig. 1). The normal seasonal rainfall for the different districts of western Maharashtra (Konkan) ranges from 2000 to 3000 mm and the C.V. varies from 20-30%. Thus, the threshold value of rainfall is found above 40 mm. Normal seasonal rainfall for Madhya Maharashtra is 400 to 800 mm for about 80% of the districts and 1000 to 1500 mm for 20% districts. Except Kolhapur, all the districts have C.V. around 30-40% and corresponding threshold value is 30 mm, while only Kolhapur district has threshold of 40 mm. Marathwada districts have seasonal rainfall varying between 600-800 mm. The C.V. values for most of the districts ranged about 30-40 % and corresponding threshold value of rainfall is 30 mm. The districts from Vidardha have seasonal normal rainfall varying about 700 to 900 mm for more than 50% of the districts and about 45 % of the districts have 1000 to 1300 mm seasonal normal rainfall. The C.V. for all district range 20-30% and corresponding threshold amount of rainfall is 40 mm.

4.   Results and discussion

For understanding the characteristics of wet and dry weeks, analysis of results for the 3 rainfall zones has been presented below. For all the districts falling in each zone, the probabilities of wet weeks were computed and analysis for 3 categories of probabilities *viz.* high (>70%), moderate (51-70%) and low (30-50%) has been discussed in detail. The temporal and spatial variation of probabilities of wet weeks are discussed monthwise and seasonwise. Distribution of number of wet weeks is also analysed. The nature of persistent rainfall for 2 to 3 consecutive wet weeks is also discussed in this section.

4.1. *Temporal variations of wet week probabilities during monsoon season*

The probabilities of rainfall by Markov Chain model, respectively for high, moderate and low rainfall zones are shown in Figs. 2 (a-c).

As seen from Fig.1, the high rainfall region occupies western parts of Maharashtra and consists of five districts
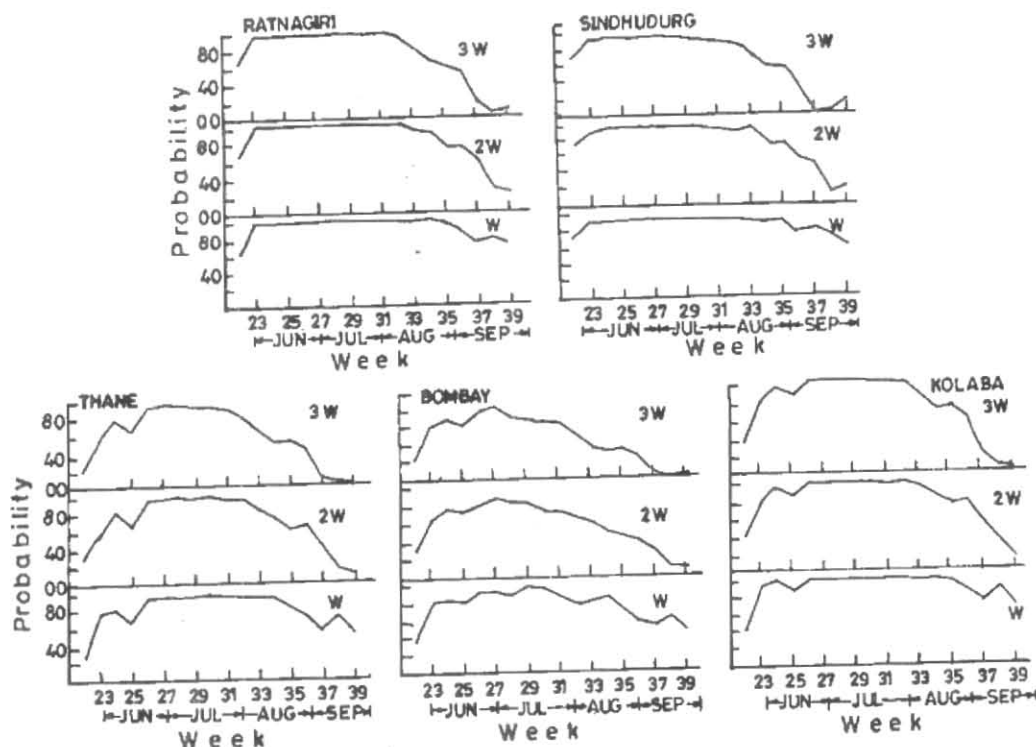
Fig. 2(a).   Probability of rainfall by Markov Chain model for high rainfall zone

viz. Mumbai (earlier Bombay), Ratnagiri, Sindhudurg, Raigarh and Thane. It is seen from Fig.2 (a) that in all these districts, high probabilities (>70%) for wet weeks are found throughout the season, generally from 23rd (4-10 June) to 36th (3-9 September) week. Thus, the high rainfall districts which are situated along the west coast show high probability for wet weeks during most of the period of the season.

The moderate rainfall region of the state consists of 21 districts (Fig.1). This region is sub-divided into two sub-groups based on the probabilities of wet weeks. The first sub-region shows some weeks of high probability while the second sub-region does not show any week with high probability. Thus, the brief description is presented here for first sub-group region, which consists of twelve districts out of which the 8 districts (Dhule, Jalgaon, Nagpur, Yeotmal, Nasik, Kolhapur, Pune and Amraoti) show high probabilities (Fig.2b) during the period 27th to 31st week. In addition, Pune alone shows second peak of high probabilities around 34th week. The remaining 4 districts of the first sub-region (Satara, Bhandara, Chandrapur and Gadchiroli) show high probabilities during the period 27th to 35th week. The second sub-region lies in the central parts of Maharashtra and consists 9 districts *viz*. Aurangabad, Parbhani, Osmanabad, Nanded, Jalna, Latur, Akola, Buldhana and Wardha.

The low rainfall (<600 mm) region of the State consists of four districts *viz*. Ahmednagar, Sangli, Sholapur and Bhir. These districts do not show high probability even for a single week in a season as can be noted from Fig.2(c). They have low (30-50%) or very low (<30%) probabilities during the season.

Considering the entire State, some special features are noted. It is seen from Fig.2 that more than 50% of the districts of the State show an increase in probability on 24th week with the onset of the monsoon and subsequently sudden fall on 25th week. The districts Thane and Kolhapur show a marked fall on 25th week. Most of the districts show a peak value during the weeks 27th to 31st and a decreasing trend thereafter. A second peak on 34th week is observed in case of Yeotmal, Nanded, Buldhana, Bhandara, Satara, Pune and Akola. The district Pune shows a marked increase in probability on 34th week, being wet.

4.2. *Spatial variation of wet weeks probabilities during monsoon season*

An analysis for number of wet weeks with different probabilities has been carried out and isopleths for wet weeks period with high probabilities have been shown in Figs.3 (a-d) respectively for months June (sowing month),
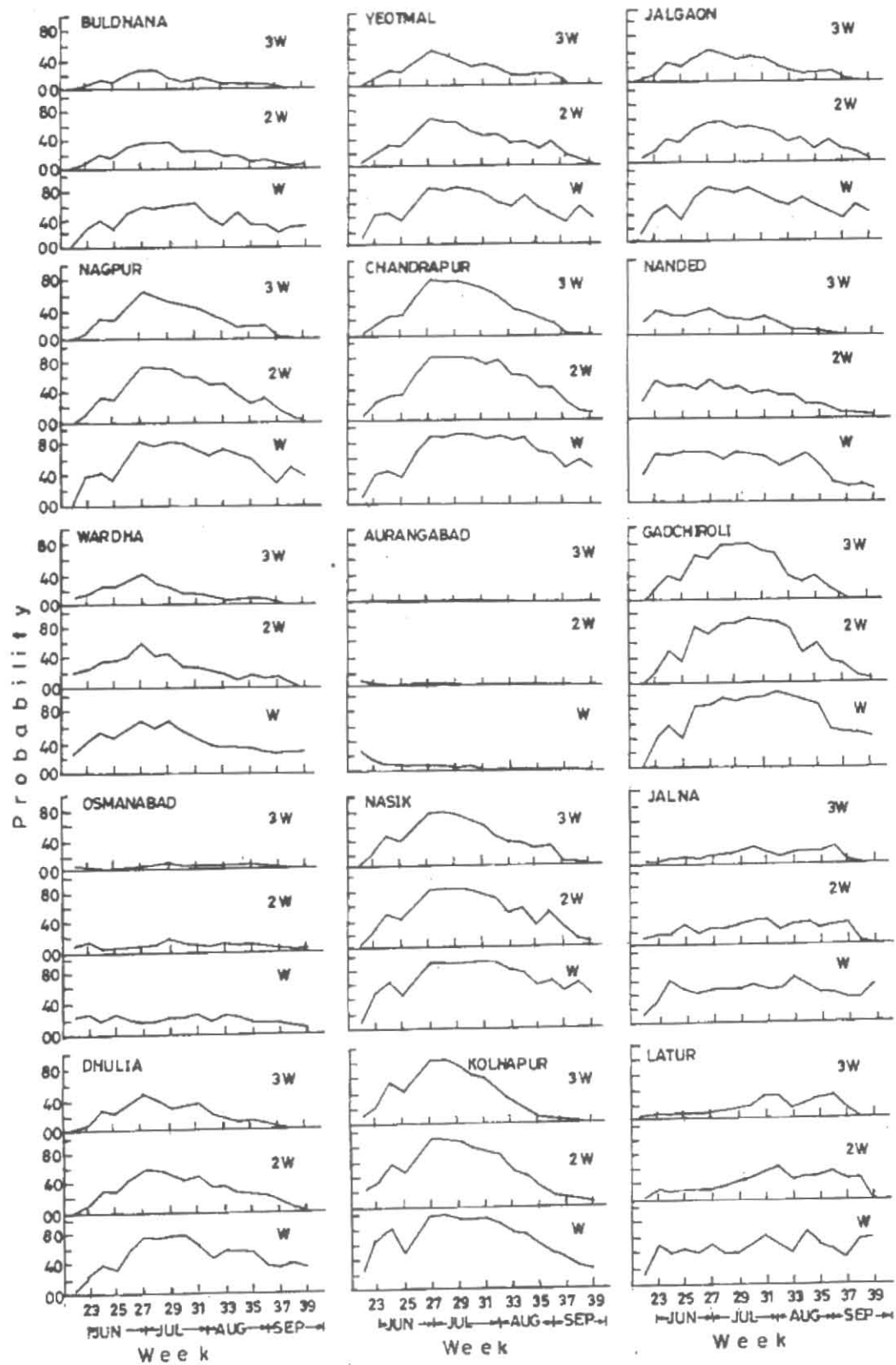
Fig. 2 (b). Probability of rainfall by Markov Chain model for moderate rainfall zone
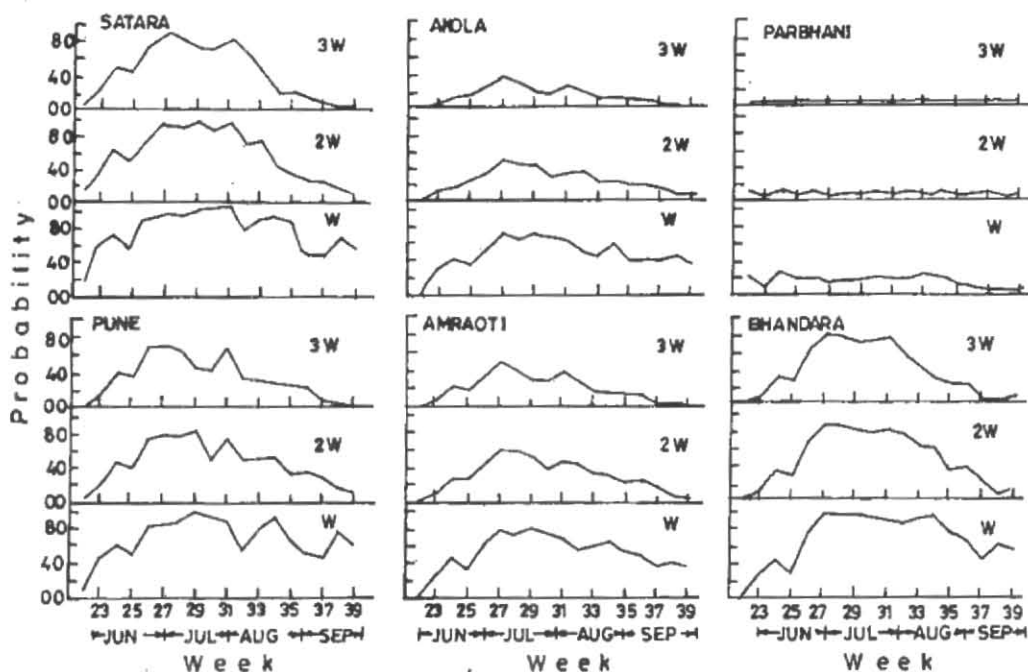
Fig. 2 (b). Probability of rainfall by Markov Chain model for moderate rainfall zone

July and August (a cumulative growth period), for the month of September and for the season as a whole.

Fig.3(a) represents the isopleths for the month of June. It is seen from the figure that major parts of Maharashtra are not prone to high probabilities for wet week in June. Except the high rainfall zone districts of western Maharashtra which show high probabilities for a period about 2 to 4 weeks and the districts of northeast Maharashtra which show high probability for one week.

Fig. 3(b) shows the high probability weeks during July and August. The districts from western parts and northeastern parts show 8-9 wet weeks having high probability. The central parts and a few southeastern parts of the State (low rainfall districts) have no wet weeks with high probability. A few districts, which fall in moderate rainfall zone show high probability for 2 to 7 wet weeks.

During the month September major parts of the State have no wet weeks with high probabilities as can be seen from Fig. 3(c). Few districts in western parts have 1 to 4 wet weeks with high probabilities.

A seasonal pattern for wet weeks is given in Fig. 3(d). In extreme western parts 13-16 wet weeks with high probability are observed. A belt beyond this area from Nasik to Kolhapur and few districts from northeastern

parts show 8-10 wet weeks. The central parts have no wet weeks.

The details of monthwise distribution of number of wet weeks for various districts are given in Table 3. It is seen from the table that the districts of Aurangabad, Parbhani, Osmanabad and Sangli show no wet weeks with at least 50% probability throughout the season. For planning agricultural operations in each month or in growing season, the detailed information given in the table can be used. The information can help to prepare contingency irrigation plans and such other activities.

4.3. *Temporal variation of 2 consecutive wet weeks during monsoon season*

Fig. 2(a) also gives the probabilities for two consecutive wet weeks. The districts from western parts of Maharashtra from high rainfall region, show high probability for two consecutive wet weeks during the weeks 23rd to 35th. Considering all the districts of high rainfall region, Bombay shows high probability for shorter period (24-31 weeks).

The districts from medium rainfall region are divided into two sub-regions for the sake of presentation of results. It is seen from Fig. 2 (b) that eight districts from one sub - region *viz.* Kolhapur, Pune, Nagpur, Nasik,
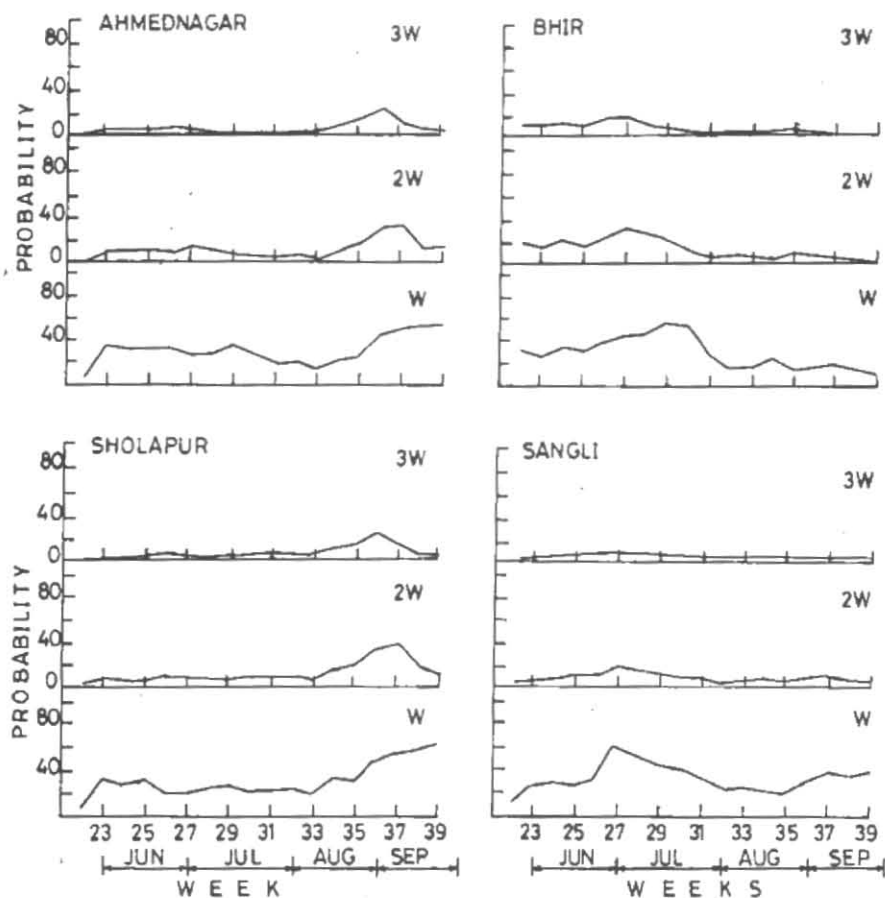
Fig. 2 (c).   Probability of rainfall by Markov Chain model for low rainfall zone

Satara, Bhandara, Chandrapur, Gadchiroli show high probabilities during 27th –$31/32^{nd}$ weeks. The remaining 4 districts (Dhule, Jalgaon, Yeotmal & Amraoti) from first sub-region and nine districts (Aurangabad, Parbhani, Osmanabad, Nanded, Jalna, Latur, Akola, Buldhana & Wardha) from second sub-region show low (30-50%) or very low (<30%) probabilities.

The districts from low rainfall region show very low (<30%) probabilities during the season for two consecutive wet weeks.

4.4. *Spatial variation for two consecutive wet weeks during monsoon season*

Analysis shows that during June, districts of high rainfall region, which lie in western parts of Maharashtra exhibit a high probability for two to four weeks. In the months of July and August (cumulative period) districts of western and northeastern parts show high probabilities. For the month of September no district shows high probability except Raigarh which shows high probability for two weeks. Seasonal pattern resembles July and August pattern. During the whole monsoon season, high probability of wet week is found for 10-14 weeks over extreme western parts, 4-8 weeks over eastern neighbouring parts and 6-7 weeks over northeastern parts.

4.5. *Temporal variation of 3 consecutive wet weeks during the monsoon season*

The probabilities for 3 consecutive wet weeks situated in high, medium and low rainfall regions are respectively, shown in Figs. 2(a-c). It is seen from Fig. 2(a) that Ratnagiri and Raigarh districts which are from higher rainfall region exhibit high probability for maximum period (23rd-33rd week). Thane shows high probabilities mostly in July (26th-32nd weeks), while Sindhudurg shows high probabilities mostly in June (23rd-27th weeks). Bombay has very short period (26th-28th weeks) for high probabilities for 3 consecutive wet weeks.

TABLE 3
Number of wet weeks with at least 70%, 60% and 50% probabilities

S. No.	District	Wet weeks > 70%						Wet weeks > 60%						Wet weeks > 50%					
		Jun	Jul	Aug	Sept	Jul-Aug	Seas-onal	Jun	Jul	Aug	Sept	Jul-Aug	Seas-onal	Jun	Jul	Aug	Sept	Jul-Aug	Seas-onal
1	Ahmednagar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
2.	Dhule	0	4	0	0	4	4	1	5	0	0	5	6	1	5	3	0	8	9
3.	Jalgaon	0	3	0	0	3	3	1	5	1	0	6	7	2	5	4	1	9	12
4.	Nasik	0	5	3	0	8	8	2	5	3	2	8	12	2	5	4	2	9	13
5.	Kolhapur	2	5	2	0	7	9	3	5	3	0	8	11	3	5	4	0	9	12
6.	Sangli	0	0	0	0	0	0	0	1	0	0	1	1	0	2	0	0	2	2
7.	Satara	1	5	4	1	9	11	2	5	4	2	9	13	4	5	4	2	9	15
8.	Pune	1	5	2	1	7	9	1	5	3	1	8	10	2	5	4	2	9	13
9.	Sholapur	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3	0	3
10.	Aurangabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.	Jalna	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	1	2
12.	Parbhani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.	Latur	0	0	0	0	0	0	0		1	1	0	2	0	1	1	2	2	4
14.	Osmanabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.	Nanded	0	0	0	0	0	0	3	3	1	0	4	7	4	5	2	0	7	11
16.	Bhir	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
17.	Akola	0	0	0	0	0	0	0	4	0	0	4	4	1	5	1	0	6	7
18.	Amraoti	0	4	0	0	4	4	0	5	1	0	5	6	1	5	4	0	9	10
19.	Bhandara	1	5	4	0	9	10	1	5	4	1	9	11	1	5	4	3	9	13
20.	Buldana	0	0	0	0	0	0	0	2	0	0	2	2	1	5	1	0	6	7
21.	Nagpur	0	5	2	0	7	7	1	5	4	0	9	10	1	5	4	2	9	12
22.	Wardha	0	2	0	0	2	2	0	3	0	0	3	3	2	4	0	0	4	6
23.	Yeotmal	0	5	0	0	5	5	0	5	1	0	6	6	1	5	4	1	9	11
24.	Chandrapur	0	5	4	0	9	9	1	5	4	1	9	11	1	5	4	2	9	12
25.	Gadchiroli	1	5	4	0	9	10	1	5	4	0	9	10	2	5	4	0	9	11
26.	Bombay	4	5	4	0	9	13	4	5	4	1	9	14	4	5	4	3	9	16
27.	Ratnagiri	4	5	4	4	9	17	4	5	4	4	9	17	4	5	4	4	9	17
28.	Sindhudurg	4	5	4	3	9	16	4	5	4	4	9	17	4	5	4	4	9	17
29.	Colaba	4	5	4	4	9	16	4	5	4	4	9	16	4	5	4	4	9	16
30.	Thane	3	5	4	2	9	14	4	5	4	2	9	15	4	5	4	4	9	17

Fig. 2(b) shows that districts from moderate rainfall region *viz.* Bhandara, Gadchiroli and Chandrapur in northeastern parts and Nasik, Satara and Kolhapur from western parts show 2-3 weeks with high probability during July. The remaining districts from moderate rainfall region show mainly low or very low probabilities.

The districts from low rainfall region Fig. 2(c) show very low (<30%) probabilities.

4.6. *Spatial variation of 3 consecutive wet weeks during monsoon season*

The analysis shows that in the month of June only extreme western parts show high probabilities for 2-4 weeks. In addition, in July extreme northeastern parts also exhibit high probability. In September, no week with high probability is observed. A pattern for cumulative period of July and August resembles seasonal pattern. In extreme western parts, high probability for consecutive 3 wet weeks is noticed for 8-11 weeks. However, the high

probability for district Bombay is noticed for 4 weeks. In northeastern parts, only 3 weeks with high probabilities are noticed in the entire monsoon season.

For 2 and 3 consecutive wet weeks, the frequencies of high, medium and low probabilities are given in Table 4. The table contains frequencies for all the districts for the middle part of the season (July-August) and for entire monsoon season.

4.7. *East-west variation of number of wet weeks along latitude 19° N*

A east-west variation of number of wet weeks during the season, along 19°N is shown in Figs.4 (a-c) respectively for high, moderate and low probabilities. It reveals interesting results as it crosses different types of rainfall regions *viz.* high rainfall region of Bombay, moderate rainfall region of Pune, low rainfall region of Ahmednagar & Bhir and again moderate rainfall region of Parbhani & Nanded. The curve for number of wet weeks
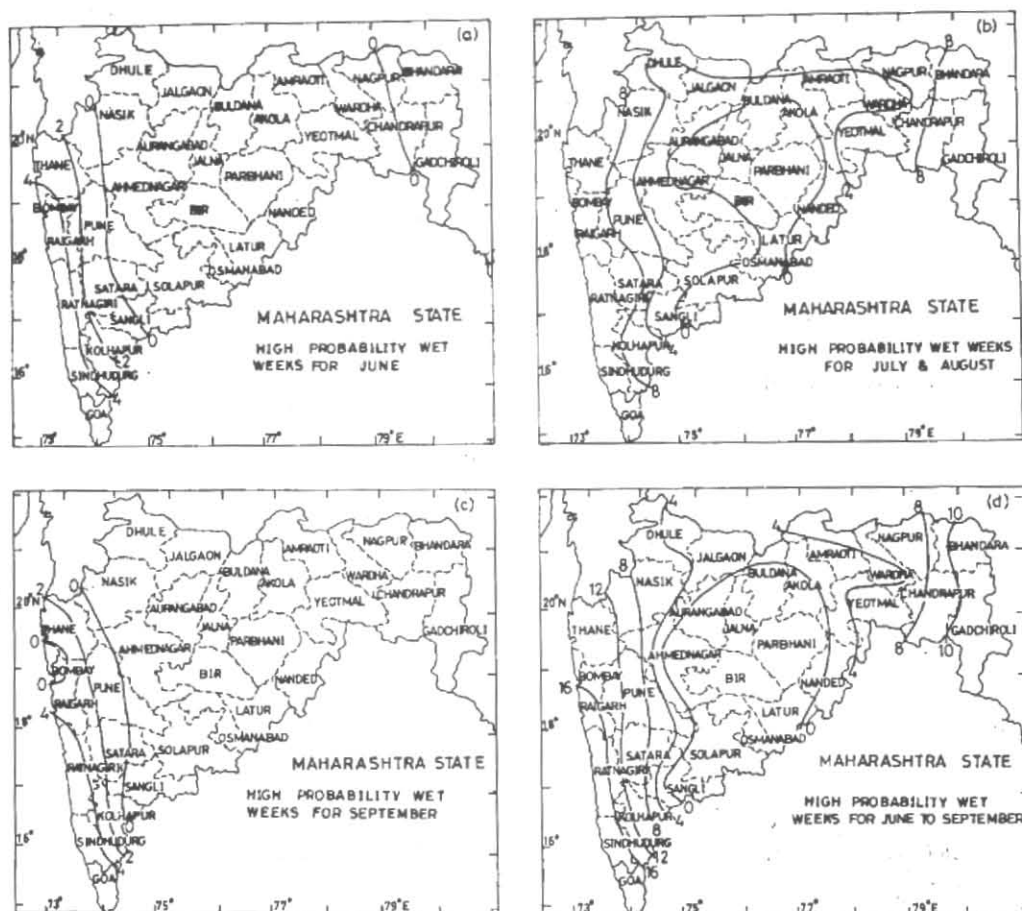
Figs. 3 (a-d).   Isopleths of high probability of wet weeks for (a) June ,(b) July-August, (c) September
and (d) June-September

with high probability shows 13 to 10 wet weeks as it
crosses from high to moderate rainfall region of Bombay
to Pune. Then the curve drops down to zero as it passes
through low rainfall region of Ahmednagar & Bhir to
moderate rainfall region of Parbhani. High probability
shows variation resembling 'L' and low probability shows
considerable longitudinal variation, which is dependent on
seasonal rainfall amounts.

Moderate probability wet weeks show a variation of
wet weeks in range 0 to 11 for moderate rainfall region.
Similarly low probability wet weeks show a peak (6
weeks) near Ahmednagar and minimum (0 weeks) near
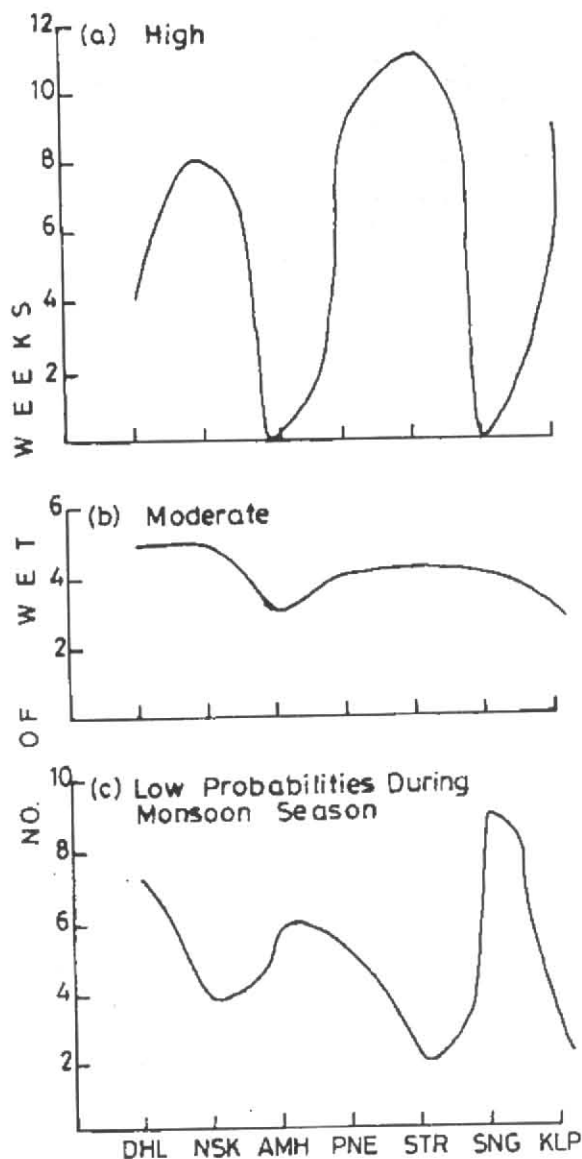Parbhani which are moderate rainfall regions.

4.8. *North-south variation of number of wet weeks
along longitude 74.5° E*

A north-south variation of number of wet weeks
during the season, along 74.5°E is shown in Figs,5(a-c)
respectively for high, moderate and low probabilities. It
shows a large variation for high probabilities as one
moves from north to south. While moving southward
along this line, we come across northern moderate rainfall
districts (Dhule and Nasik), low rainfall district
(Ahmednagar), moderate rainfall districts of (Pune and
Satara) and again low rainfall district (Sangli) and
moderate rainfall district (Kolhapur). In north-south
profile, three peaks are observed in north - south
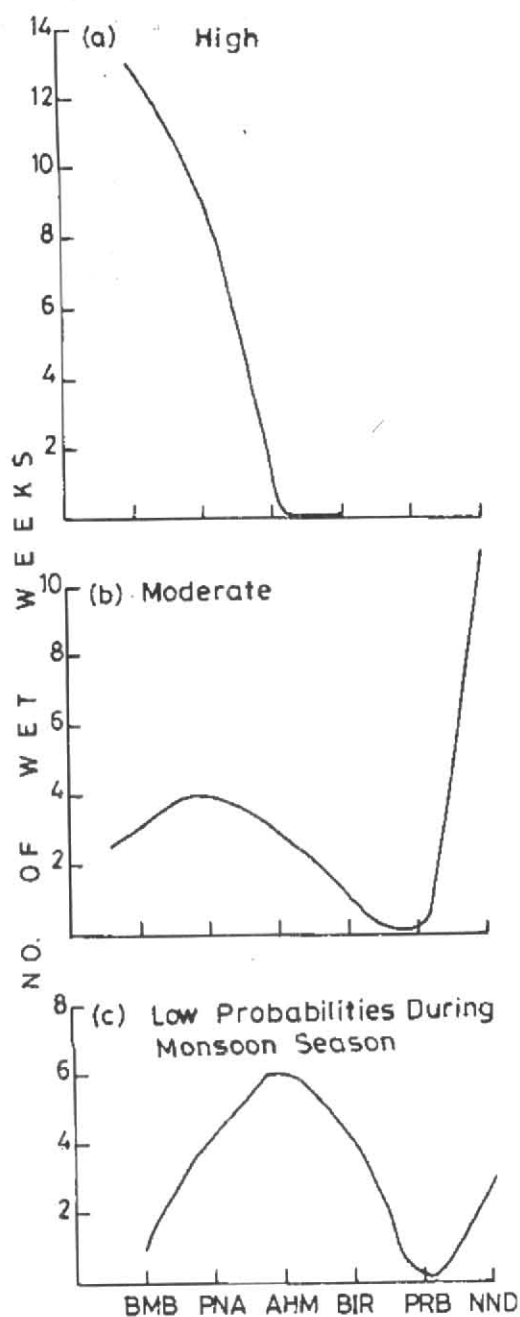
Figs.4 (a-c).   East- west variation of wet weeks along 19°N for (a) high, (b) moderate and (c) low probabilities during monsoon season

Figs. 5 (a-c).   North- south variation of wet weeks along 74.5°E for (a) high, (b) moderate and (c) low probabilities during monsoon season

probability, one each near Nasik, Pune, Satara and Kolhapur. These district have 8-10 wet weeks with high probabilities. Ahmednagar and Sangli, which are low rainfall regions, do not show weeks with high probabilities. There is not much variation for period of wet weeks with moderate probabilities. However, period of wet weeks with low probabilities show peak (9 weeks) near Sangli.

5.   Conclusions

5.1.   *General features of the probabilities of wet weeks during monsoon season indicate the following*

(*i*)   With the onset of monsoon (24th week) more than 50% of the districts show increase in probabilities. A maximum probability is noted

TABLE 4

Number of wet weeks with high, moderate and low probabilities for 2 & 3 consecutive wet weeks

S. No	District	2 Consecutive wet weeks						3 Consecutive wet weeks					
		Jul-Aug (%)			Seasonal (%)			Jul-Aug (%)			Seasonal (%)		
		>70	51-70	30-50	>70	51-70	30-50	>70	51-70	30-50	>70	51-70	30-50
1.	Ahmednagar	0	0	0	0	0	2	0	0	0	0	0	0
2.	Dhulia	0	3	4	0	3	6	0	0	4	0	0	5
3.	Jalgaon	0	2	5	0	2	7	0	0	5	0	0	6
4.	Nasik	5	2	2	5	3	5	3	2	3	3	3	5
5.	Kolhapur	5	1	2	6	2	4	3	2	1	3	4	2
6.	Sangli	0	0	0	0	0	0	0	0	0	0	0	0
7.	Satara	6	2	0	6	4	5	4	2	1	5	3	2
8.	Pune	4	2	3	5	2	6	1	2	3	1	3	5
9.	Sholapur	0	0	0	0	0	2	0	0	0	0	0	0
10.	Aurangabad	0	0	0	0	0	0	0	0	0	0	0	0
11.	Jalna	0	0	2	0	0	2	0	0	0	0	0	0
12.	Parbhani	0	0	0	0	0	0	0	0	0	0	0	0
13.	Latur	0	0	4	0	0	5	0	0	0	0	0	1
14.	Osmanabad	0	0	0	0	0	0	0	0	0	0	0	0
15.	Nanded	0	1	6	0	1	10	0	0	1	0	0	3
16.	Bhir	0	0	0	0	0	0	0	0	0	0	0	0
17.	Akola	0	0	5	0	0	6	0	0	1	0	0	1
18.	Amraoti	0	3	5	0	3	6	0	0	3	0	0	4
19.	Bhandara	6	2	1	6	3	3	3	3	1	3	4	1
20.	Buldana	0	0	3	0	0	4	0	0	0	0	0	0
21.	Nagpur	3	3	2	3	4	5	0	3	3	0	3	4
22.	Wardha	0	1	2	0	1	5	0	0	1	0	0	2
23.	Yeotmal	0	3	4	0	3	6	0	0	3	0	0	4
24.	Chandrapur	6	2	1	6	3	4	3	3	2	3	4	2
25.	Gadchiroli	6	2	1	7	2	3	3	3	2	3	4	3
26.	Mumbai	6	3	1	8	4	3	3	4	3	4	5	3
27.	Ratnagiri	9	0	0	12	3	0	7	2	0	11	3	1
28.	Sindhudurg	8	1	0	12	3	0	7	2	0	11	2	1
29.	Colaba	9	0	0	14	1	0	8	3	0	11	3	0
30.	Thane	8	1	0	10	4	1	7	2	1	8	3	2

.during July (27ᵗʰ-31ˢᵗ week) for most of the districts and a second maximum is noted in case of few districts *viz.* Yeotmal, Buldhana,Bhandara, Satara, Pune and Akola. Out of these stations Pune shows marked second maximum probability.

(*ii*) The isopleth analysis for a high probability wet week period shows that during the entire monsoon season western parts of the state show high probability for 13-16 wet weeks while a belt beyond this area from Nasik to Kolhapur shows 8-10 wet weeks. During later June, July and August some northeastern parts show 8-10 wet weeks with high probability.

(*iii*) The districts Parbhani, Aurangabad and Osmanabad show no wet weeks with at least 30% probability throughout the season.

5.2. *The probabilities of wet weeks in different rainfall zones indicate*

(*i*) High rainfall districts situated along west coast show high wet week probabilities during most of the period of the season.

(*ii*) Moderate rainfall districts occupy major parts of the state which include mainly northern and northeastern regions. Based on the period of occurrence of high probability of wet weeks, this zone has been subdivided into two sub-groups. The first sub-group containing 12 districts shows high probability during July and August. The second sub-group containing 9 districts shows very low to moderate probabilities.

(*iii*) Districts situated in low rainfall region show very low probabilities of wet weeks.

5.3. *Persistent rainfall features of probabilities for 2 and 3 consecutive wet weeks*

Western parts, characterised by high rainfall zone, show high probabilities for two and three consecutive wet weeks during June to August. Northeastern parts in

moderate rainfall zone show high probabilities for two consecutive wet weeks during July and August and high probabilities for three consecutive wet weeks during July only.

5.4. *Analysis of wet week probabilities along 19° N and 74.5° E*

(*i*) East-west variation of high probability wet weeks are analysed for all districts which are situated along 19°N latitude. While moving from western to eastern region, one comes across the high rain zone (Bombay), moderate rainfall zone (Pune), low rainfall zone (Ahmednagar & Bhir) and again moderate rainfall zone (Nanded). It shows 'L' shaped curve while passing from west to east where number of wet weeks vary from 13 to 0. Moderate probability wet week curve shows a peak at Nanded for 11 weeks and other regions show only 0-4 weeks. Low probability week curve shows a peak (6 weeks) near Ahmednagar.

(*ii*) The study of north-south variation of the period of wet weeks during the season along 74.5°E shows a sinusoidal variation of high probability wet weeks.

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