

Assessing Probabilistic Rainfall Scenario over the Vidarbha Region, India for Proper Risk Evaluation and Management of Water Resources

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Abstract: In a tropical country like India, instability in agricultural production stems from vagaries of rainfall. A complete and quantitative understanding of spatial and temporal variation of this resource is, therefore, required to increase and stabilize food production. The use of average seasonal or monthly rainfall does not seem to be appropriate for planning purposes as it does not cover the risk factor. A detailed probability analysis can bring out the amount of rainfall expected at different probability levels which in turn can give the number of years of adequate, deficient and excess rainfall.

Keeping in mind the above aspects, the present paper studies probabilistic rainfall scenario over the Vidarbha region which, despite having tremendous agricultural potential, could not develop to its full potential.

The study reveals that dynamic influence (mainly lows and depressions moving over the area) is the main cause of rainfall over Vidarbha. Accumulated Assured Rainfall (AAR) analysis, by fitting incomplete Gamma Distribution Model at different probability levels, indicates that it is maximum in the eastern part of Bhandara and northern part of Gadchiroli districts while it is minimum over western Vidarbha covering northern parts of Buldhana, Akola and adjoining Amravati districts. Weekly assured rainfall analysis reveals that in seventy per cent of the years, the eastern most districts of the region get at least 25 mm of rainfall per week continuously for 13 weeks during mid—June to first half of September. Based on AAR analysis at 70% probability level the entire study region has been divided into five homogeneous rainfall zones (namely A, B, C, D and E). The region to the west of 79°E (A, B, and C zones) receives lower rainfall compared to that to the east of 79°E (D and E zones). This could be attributed to the fact that Vidarbha mainly gets rainfall from lows/depressions formed over Bay of Bengal and move in a westerly/northwesterly direction and sheds much of its rainwater over the eastern D and E zones, while A, B and C zones get rainfall when these systems pass their heyday. In each of these zones the amount of peak rainfall and when the peak is received has also been found out. This type of rainfall information at different probability levels could serve as basic input of planning for agriculture, land use, drainage requirements and water resources development. Coupled with soil information these will help deciding crop types that could be raised to increase and stabilize production.

Key words: Vidarbha region, gamma distribution, probabilistic rainfall, risk evaluation, water resources.

Introduction

In a tropical country like India, instability in agricultural production mainly stems from vagaries of rainfall which is the basic input in agriculture. A complete and quantitative understanding of spatial and temporal

variation of this resource is, therefore, required to increase and stabilize food production. Climatic information on rainfall is generally available in the form of long-term monthly or seasonal averages. In some cases weekly averages are also available. Normally, these averages are widely used in agricultural/resource planning. A difficulty

in using monthly or seasonal rainfall as average is that it has a skew type of frequency distribution. At many places, in particular in the low rainfall regions, the monthly or even seasonal average is made up by a few intense spells of rain, while rest of the season goes more or less rain-free. Therefore, the use of average seasonal or monthly rainfall does not seem to be appropriate for planning purposes. Another difficulty in using average rainfall, whether weekly, monthly, or seasonal is that it does not cover the risk factor.

A farmer or a planner is more interested in knowing the various amounts of rainfall, which are likely to occur during different periods of crop growth and at various probability levels. This enables him to select the risk level he could afford to take, after having considered other related factors like soil management, agronomic practices etc. This type of analysis is also handy in determining the likely water stress at the different crop growth phases and hence on deciding about the supplementary irrigation needs. A detailed probability analysis can bring out the amount of rainfall expected at different probability levels which in turn can give the number of years of adequate, deficient and excess rainfall.

Mooley and Appa Rao (1971) showed that if the data series is quite long, normal distribution gives a tolerably good fit to seasonal and annual rainfall over major parts of India. But the same is not true for monthly rainfall. Normal distribution, however, may be fitted to monthly rainfall with certain transformation only in about 70% cases (Mooley, 1973). Thom (1958) suggested fitting of Gamma distribution to skew data like short period rainfall having lower limit zero. Davy et al. (1976) used the same distribution to obtain dekad (10 day) probabilities in the Sudano-Sahelian zone of Africa. By fitting incomplete Gamma distribution model to the weekly rainfall totals, Biswas and Basarkar (1982) had computed weekly

assured rainfall at different probability levels (10-90%) in the dry farming tract of Gujarat. The analysis reveals that there are four homogeneous rainfall zones over Gujarat consisting of four distinct rainfall patterns. Sarker et al. (1982) made probability analysis of short period rainfall in the dry farming tract of India and divided the entire tract into seven homogeneous rainfall zones. Their study also brought out the important features of assured rainfall over the tract. Using the same methodology, homogeneous rainfall zones were brought out by several scientists (Biswas and Khambete, 1979 for Maharashtra; Biswas et al., 1982 for Rajasthan; Khambete and Kanade, 1980 for Karnataka).

Sarkar (1994) and Sarkar (1996) found out the core rainfall period when the drought hazard was less at different probability levels over coastal Orissa and eastern Ganga plains ecozone of West Bengal respectively. Sarkar and Kale (1995) assessed the rainfall environment of the scarcity zone of Maharashtra based on probabilistic rainfall. Biswas and Sarkar (1995), in a detailed analysis of probabilistic rainfall over West Bengal, has brought out the important rainfall features of the state during monsoon season and also divided the entire state into four homogeneous rainfall zones based on accumulated assured rainfall (AAR) at 70% probability level. In a follow up study, Sarkar (2001) brought out further details of the rainfall environment in the heavy rainfall tract of West Bengal through probabilistic approach. The above mentioned studies on probabilistic rainfall distribution, therefore, could be very useful for developing water resources for hydrological purposes, land use planning, irrigation scheduling, determining drainage requirements and setting up industries.

Keeping the above aspects in mind, the present paper attempts to (i) quantify weekly rainfall in the Vidarbha region (Figure 1) at different probability levels using

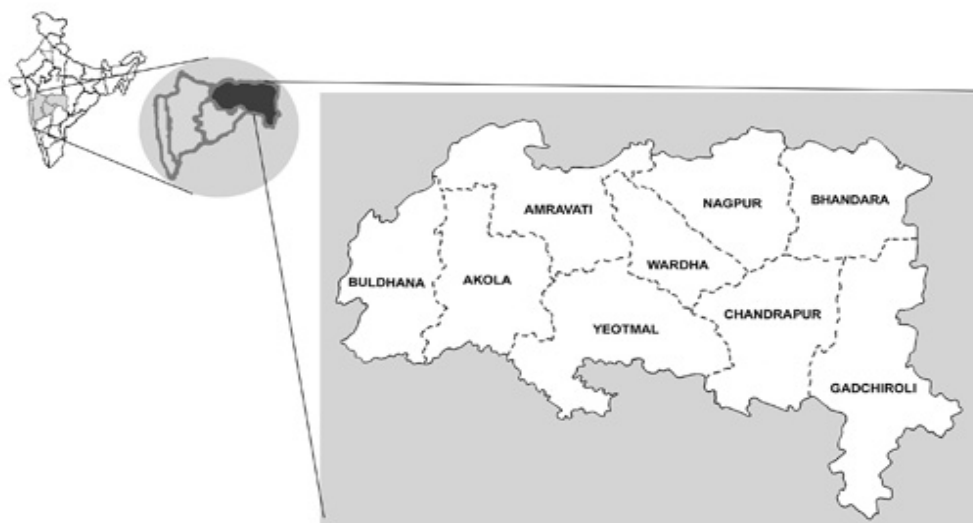


Figure 1: Location map of Vidarbha.

Weekly Assured Rainfall

Isohyetal analyses of AR values has been carried out for all the weeks (23rd–39th mw) of the monsoon season for 70% probability level and presented in Figures 3(a–q). Prominent features of the spatial distribution of AR at 70% have been discussed below:

- (i) Rainfall is very meagre during mw 23. It slowly increases in mw 24; some pockets of rainfall of more than 10 mm can be observed in this week (Figure 3b). In June, during 25th and 26th mw some good amount of rainfall is received in the region. On 25th mw four pockets of maximum rainfall of 25 mm or more are noticed—one over northern part of Gadchiroli district and adjoining southeastern part of Bhandara; another over the small area in the northwestern part of Bhandara district near Chandpur station, the 3rd one over the central part of Chandrapur district and adjoining southwest and southeastern parts of Bhandara and Nagpur districts respectively and the 4th one at Pusad in Yeotmal district. In this week peak amount of 29 mm is received at Chimur (Chandrapur district) and Chandpur (Bhandara district) stations; whereas minimum (<10 mm) lies over northwestern part of the region, covering northern parts of Buldhana, Akola and adjoining western part of Amraoti district.
- (ii) In 26th mw (25 June–1 July) eastern part of the region (east of 79°E) gets rainfall of at least 35 mm or more. Rainfall even exceeds 40 mm at some sporadic pockets in this eastern part. In this week minimum rainfall of less than 15 mm is received at Nandura in the western part of Buldhana district (Figure 3d).
- (iii) During mw 27 (2-8 July) there is substantial increase in rainfall amount all over the region; it

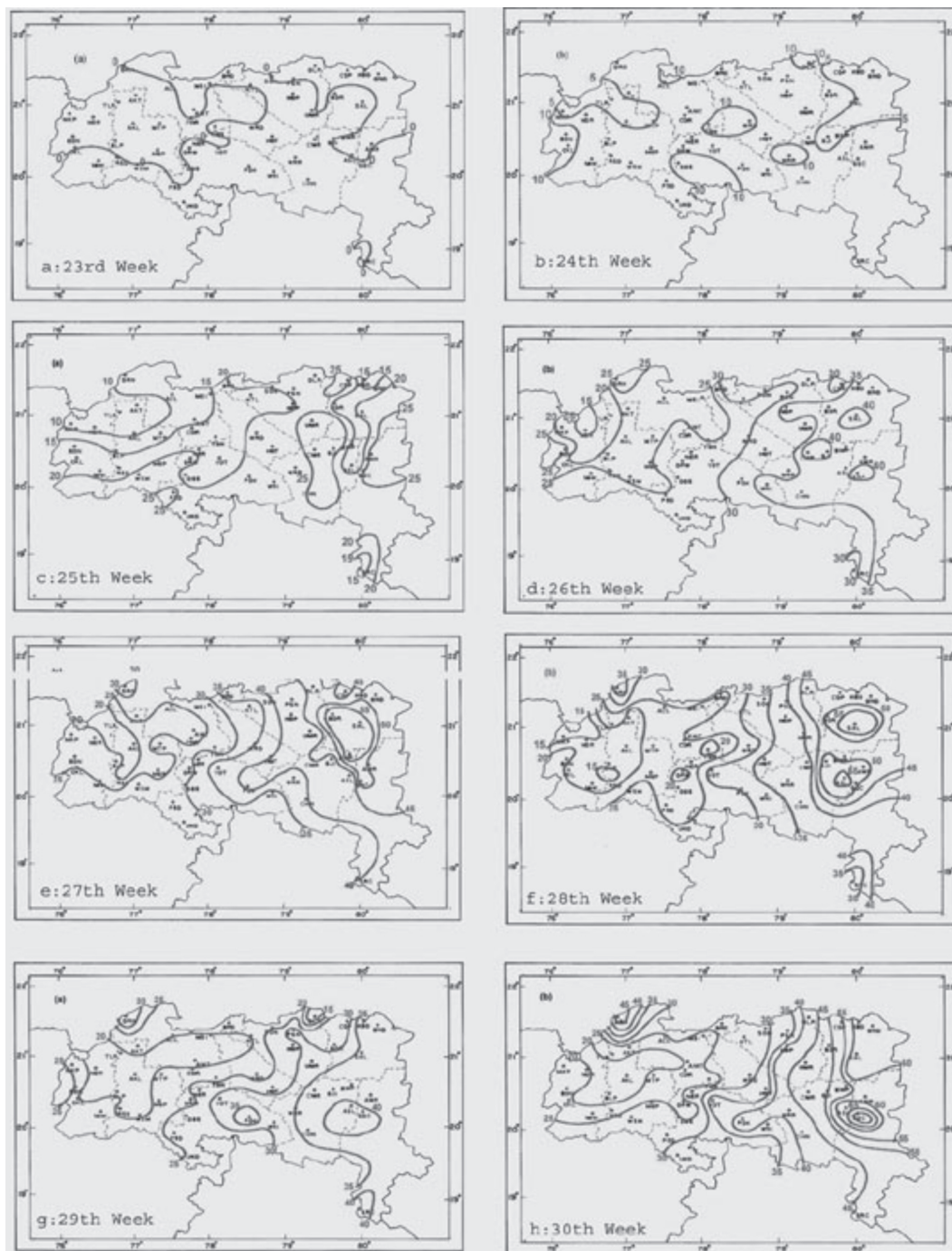
varies from 20 to more than 55 mm. The maximum amount of rainfall of 59 mm is observed over Bhandara at Bhandara district while Risod and Telhara at Akola district witnessed minimum rainfall of 20 mm each (Table 5).

The area bounded by 25 mm isohyete further increases towards the east during mw 28(9-15 July). The area east of 79 °E longitude continue to receive high rainfall (Figure 3f).

- (iv) There is a striking decrease in rainfall in the entire region in the 29 mw (16-22 July); despite this the eastern part (east of 79°E) continues to get rainfall of 35 mm or more. In the subsequent week i.e. 30 mw (23-29 July) increase in rainfall is very much conspicuous—entire eastern half of the Bhandara district and central part of Gadchiroli and adjoining Asola station of Chandrapur district receives rainfall of 60 mm or more. The maximum amount of 70 mm is observed at Gadchiroli station. During mw 31 (30 July-5 August) the same pattern continues over the eastern Vidarbha; however, there is decrease in rainfall over the western Vidarbha region (Figure 3i).
- (v) During mw 32 (6–12 August) there is decrease in the rainfall amount. The decrease is more pronounced over the western part. In the eastern part F Vidarbha the area bounded by 40 mm isohyte further reduces (Figure 3j).
- (vi) The rainfall continues to decrease in mw 33 (13-19 Aug.). During this period rainfall varies from less than 5 to 40 mm. Northern part of Akola and Buldhana districts receive less than 5mm of rain (Figure 3k). Rainfall slightly increases all over the region during mw 34 (20-26 Aug.); after that it goes on decreasing in the succeeding weeks.

Table 1: Intercorrelation study of daily normal rainfall for 10 meteorological stations in Vidarbha for a period of 1 June to 30 September

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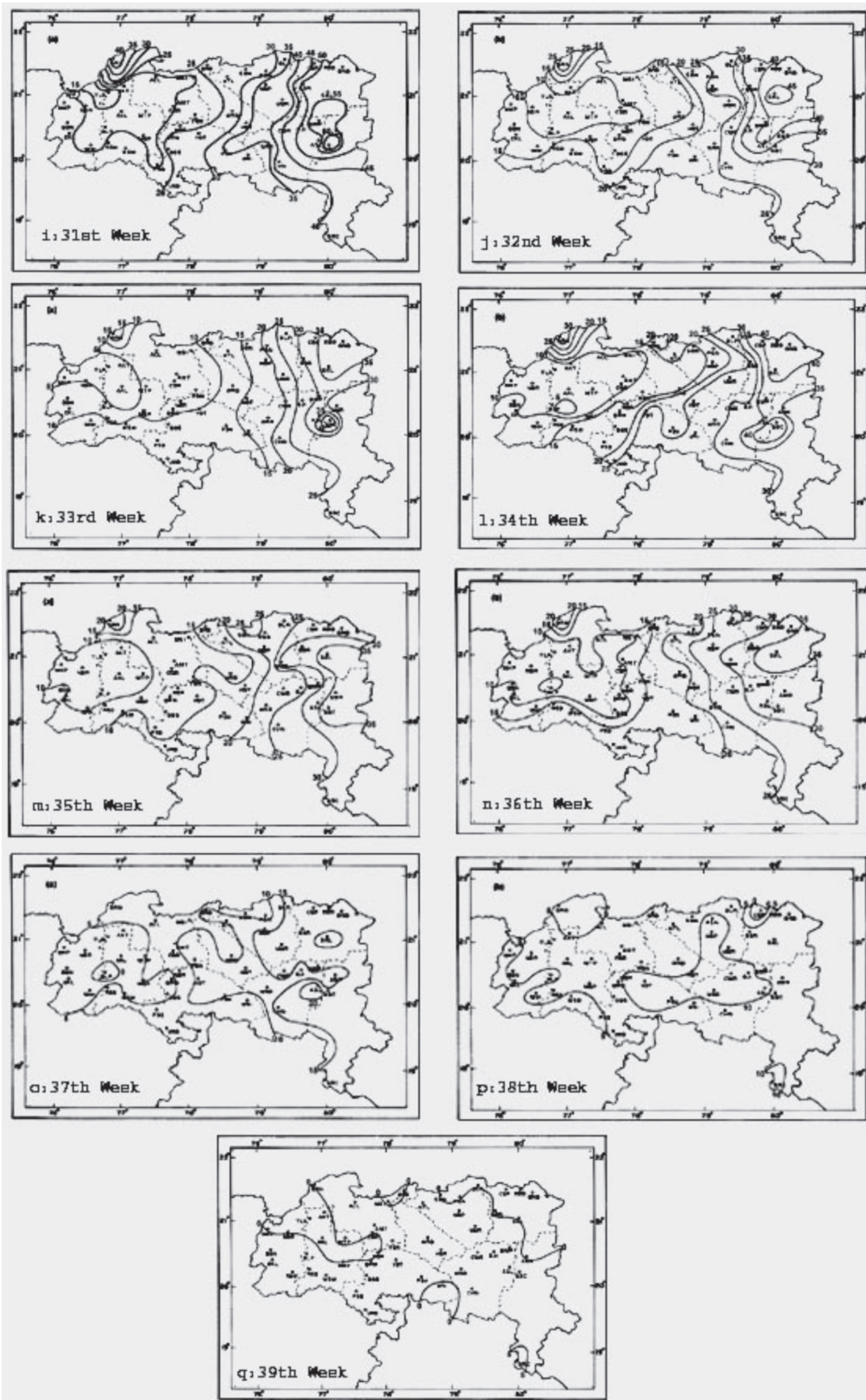


Figures 3(a-h): Spatial distribution of weekly Assured Rainfall (AR) in mm at 70% probability level.

From the above discussion, it is clear that in Vidarbha assured rainfall increases considerably as one moves from west to east. The eastern most districts—Gadchiroli, Bhandara and Chandrapur—get very good amount of rainfall (≥ 25 mm/week) right from mid-June till the 1st dekad of September; whereas the three western most districts—Buldhana, Akola and Amravati—receive comparatively much less rainfall during the same period.

The central part, consisting of Nagpur, Pusad and Wardha gets rainfall in between of these two zones.

Weekly assured rainfall analysis reveals one very important feature of the spatial rainfall distribution over the region. A deeper look in Tables 2-6 and Figures. 3 (a-q) reveal that in August the three western most districts, namely Akola, Amravati and Buldhana, do not contribute as much as they do in July, to the total



Figures 3(i-q): Spatial distribution of weekly Assured Rainfall (AR) in mm at 70% probability level.

Table 2: Weekly AR (mm) at 30 percent level

Stn.	Abr.	Lat.	Long.	← Met. weeks →																	Total
				23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
Akola																					
Akot	AKT	2106	7704	18	33	42	58	66	59	59	59	63	44	45	44	48	49	49	38	22	796
Balapur	BLP	2040	7647	15	34	46	59	64	48	56	56	62	40	39	49	53	37	54	41	28	781
Mangrulpir	MGP	2019	7721	28	36	55	66	66	59	65	63	65	49	45	54	56	50	54	48	38	897
Murtajapur	MTP	2044	7723	18	36	48	73	69	62	60	58	60	36	34	52	53	49	50	39	39	836
Risod	RSD	2020	7648	26	34	52	65	54	51	67	55	61	44	47	49	62	62	58	43	43	873
Telhara	TLR	2102	7650	16	28	43	66	51	57	53	60	50	39	31	36	49	45	43	45	31	743
Washim	WSM	2007	7708	23	38	58	76	80	71	73	73	64	62	48	64	58	62	47	41	30	968
Amravati																					
Achalpur	ACL	2116	7731	19	37	50	59	61	63	56	69	69	50	50	48	53	44	44	39	38	849
Amravati	AMT	2056	7747	17	48	58	70	65	65	51	63	73	56	41	51	53	51	54	45	33	894
Barud	BRD	2128	7816	22	41	61	86	97	98	62	78	85	54	56	58	61	54	61	37	33	1044
Chandur bazar	CDR	2050	7744	20	33	48	78	64	66	67	62	53	48	46	51	59	49	56	35	31	866
Dharni	DRN	2134	7653	11	49	67	85	90	101	85	119	115	89	72	86	88	95	80	40	29	1301
Morsi	MSI	2120	7801	23	32	51	62	74	76	60	68	68	49	48	44	53	41	56	34	32	871
Talegaon	TGN	2041	7806	23	39	62	67	79	64	66	65	78	47	43	53	56	54	67	42	42	947
Bhandara																					
Bhandara	BDR	2110	7940	20	46	70	98	119	123	78	123	121	94	82	85	89	86	69	47	34	1384
Chandpur	CDP	2130	7947	16	57	77	82	103	113	80	139	117	106	78	99	87	76	61	34	23	1348
Khyrbund	KBD	2129	8004	18	52	75	104	138	128	88	162	136	119	104	121	101	93	70	41	26	1576
Sakoli	SKL	2105	8000	23	43	78	112	147	143	101	167	138	118	103	117	102	104	76	49	34	1655
Buldana																					
Buldana	BDN	2032	7611	23	45	64	68	63	61	61	57	71	40	35	60	51	55	61	48	30	893
Chikhli	CKL	2021	7615	30	42	63	78	72	51	55	52	52	29	35	52	42	36	53	40	29	811
Malkapur	MKP	2053	7612	18	38	49	55	50	47	51	52	58	38	38	45	42	55	54	36	16	742
Mehkar	MHK	2010	7633	23	36	53	73	69	53	70	65	55	47	52	49	46	57	43	41	33	865
Nandura	NDR	2050	7628	22	39	55	54	55	52	55	53	58	41	37	40	44	56	52	45	30	788
Chandrapur																					
Asola	ASL	2015	7951	19	63	63	103	106	144	118	139	126	96	86	101	89	91	56	48	40	1488
Brahmapuri	BMP	2036	7952	29	49	71	104	135	135	101	153	152	106	81	92	95	87	68	46	42	1546
Chandrapur	CHN	1958	7918	23	42	71	93	103	106	93	127	119	76	77	86	75	74	62	62	53	1344
Chimur	CMR	2030	7923	21	49	83	120	115	110	91	113	132	73	74	81	86	76	63	50	45	1382
Ghorajheri	GJI	2032	7938	20	38	70	104	119	136	108	129	135	94	86	77	89	89	70	44	38	1446
Warora	WRR	2013	7901	20	47	64	87	103	106	97	102	90	64	71	83	73	67	59	42	33	1208
Gadhchiroli																					
Gadhchiroli	GDC	2011	8000	24	46	87	109	122	133	111	164	148	114	111	111	98	85	74	45	35	1617
Sironcha	SRC	1850	7958	22	49	57	78	97	87	101	113	118	76	79	84	91	66	58	50	47	1273
Armori	AMR	2028	8004	20	48	84	95	123	147	106	139	160	103	96	104	89	93	56	44	35	1542
Nagpur																					
Nagpur	NGP	2109	7907	23	55	72	99	112	107	83	95	99	77	66	73	73	71	58	40	33	1236
Deolapur	DLP	2135	7923	28	43	66	84	111	113	57	93	79	81	71	81	82	80	60	53	48	1230
Katol	KTL	2116	7835	23	46	53	79	79	78	55	68	73	52	57	59	68	58	49	39	36	952
Perseoni	PSN	2122	7909	20	44	67	75	107	112	84	94	84	70	58	61	74	73	51	43	26	1143
Saoner	SON	2123	7855	23	47	59	79	105	84	71	72	75	65	58	55	69	58	51	46	31	1048
Umrer	UMR	2051	7920	24	42	79	90	115	104	92	120	101	76	68	77	83	90	64	49	33	1307
Yeotmal																					
Darwia	DRW	2019	7746	23	46	71	74	81	58	65	66	70	47	47	62	54	63	47	42	34	950
Digras	DGS	2007	7743	23	47	65	73	79	65	77	73	78	47	49	58	53	55	49	43	37	971
Ner	NER	2029	7752	26	40	62	71	88	68	68	64	62	45	41	48	44	49	60	41	34	911
Pandherikawara	PDK	2001	7833	24	48	56	91	97	90	107	108	95	62	65	74	69	68	54	65	34	1207
Pusad	PSD	1955	7735	21	40	72	69	83	64	79	66	68	42	50	60	55	55	45	45	35	949
Umerkhed	UKD	1935	7742	34	40	58	76	62	67	66	73	75	58	55	65	45	67	59	44	35	979
Wani	WNI	2003	7857	22	47	58	94	83	92	92	92	85	66	60	73	71	65	41	55	37	1133
Yeotmal	YOT	2023	7808	25	50	64	76	90	86	85	95	98	55	56	72	63	66	62	55	36	1134
Wardha																					
Wardha	WRD	2047	7835	23	47	63	78	83	76	62	84	98	63	57	57	63	59	60	35	38	1046
Hinganghat	HGT	2033	7850	25	48	69	95	96	98	76	98	99	73	58	74	68	76	55	52	37	1197

Table 3: Weekly AR (mm) at 40 percent level

Stn.	Abr.	Lat.	Long.	← Met. weeks →																Total	
				23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		39
Akola																					
Akot	AKT	2106	7704	10	24	32	45	58	45	44	44	47	33	33	33	34	35	28	28	16	589
Balapur	BLP	2040	7647	8	26	35	46	47	37	41	43	47	30	28	28	38	28	28	23	21	554
Mangrulpir	MGP	2019	7721	15	27	42	51	49	45	48	55	49	37	26	40	42	38	31	36	21	652
Murtajapur	MTP	2044	7723	11	26	36	54	60	48	45	44	46	27	25	38	38	36	38	29	22	623
Risod	RSD	2020	7648	14	25	40	48	41	39	51	42	45	34	35	38	46	47	43	32	24	644
Telhara	TLR	2102	7650	11	21	32	50	40	44	41	45	38	29	23	26	36	32	32	32	23	555
Washim	WSM	2007	7708	17	28	45	58	70	52	55	55	50	47	36	48	43	46	35	30	23	738
Amravati																					
Achalpur	ACL	2116	7731	14	28	38	43	54	48	41	51	51	36	28	36	40	32	34	22	27	623
Amravati	AMT	2056	7747	13	27	43	52	48	50	39	47	56	41	30	37	39	38	39	33	25	657
Barud	BRD	2128	7816	17	30	45	63	83	72	47	58	62	41	42	43	47	41	45	28	25	787
Chandur bazar	CDR	2050	7744	11	25	37	55	48	51	49	45	41	35	33	38	44	36	40	26	23	637
Dharni	DRN	2134	7653	5	28	50	63	67	76	64	89	86	68	54	66	66	71	45	29	15	942
Morsi	MSI	2120	7801	12	24	39	48	55	58	44	50	52	37	36	33	40	31	41	26	23	649
Talegaon	TGN	2041	7806	17	30	47	51	59	49	49	49	60	35	33	40	42	41	50	31	30	713
Bhandara																					
Bhandara	BDR	2110	7940	15	35	53	76	103	108	58	88	106	70	63	65	69	64	52	34	25	1084
Chandpur	CDP	2130	7947	9	41	60	63	90	99	60	98	88	76	69	69	66	57	47	25	13	1030
Khyrbund	KBD	2129	8004	9	39	55	78	99	96	77	115	101	85	78	86	77	67	53	29	20	1164
Sakoli	SKL	2105	8000	16	33	59	84	103	125	74	118	104	104	76	86	79	77	58	37	26	1259
Buldana																					
Buldana	BDN	2032	7611	13	34	49	52	47	46	53	50	52	29	26	44	37	40	35	28	22	657
Chikhli	CKL	2021	7615	15	32	48	59	53	39	42	39	40	22	26	38	31	27	29	29	21	590
Malkapur	MKP	2053	7612	9	28	37	42	44	36	45	45	43	28	22	33	32	39	31	21	9	544
Mehkar	MHK	2010	7633	13	27	41	54	51	39	52	48	41	35	39	37	34	42	32	30	24	639
Nandura	NDR	2050	7628	12	30	40	41	42	40	40	39	44	31	27	29	32	40	29	33	16	565
Chandrapur																					
Asola	ASL	2015	7951	10	36	48	77	93	104	87	120	111	84	67	74	69	67	43	36	29	1155
Brahmapuri	BMP	2036	7952	15	36	54	78	96	100	75	109	104	79	62	81	72	65	51	34	23	1144
Chandrapur	CHN	1958	7918	13	31	52	70	74	78	81	94	88	58	59	66	58	56	46	45	29	998
Chimur	CMR	2030	7923	12	37	61	88	99	82	68	100	97	56	55	62	65	58	48	37	25	1050
Ghorajheri	GJI	2032	7938	14	28	54	91	85	98	80	111	101	83	63	60	67	66	52	34	28	1115
Warora	WRR	2013	7901	11	35	49	67	73	78	72	90	69	49	53	62	56	52	43	32	25	916
Gadhchiroli																					
Gadhchiroli	GDC	2011	8000	12	35	66	84	107	99	86	140	130	85	83	83	75	63	55	33	26	1262
Sironcha	SRC	1850	7958	17	36	43	60	85	65	89	99	87	56	61	63	67	50	43	38	34	993
Armori	AMR	2028	8004	11	34	61	84	87	105	78	122	117	77	73	77	78	69	43	33	18	1167
Nagpur																					
Nagpur	NGP	2109	7907	17	31	55	73	80	79	59	83	73	56	50	55	56	53	44	30	25	919
Deolapur	DLP	2135	7923	21	32	48	72	95	99	43	80	69	60	53	58	63	58	45	39	27	962
Katol	KTL	2116	7835	17	33	41	59	69	59	41	51	56	39	42	44	51	45	36	28	27	738
Perseoni	PSN	2122	7909	9	32	50	56	92	83	72	68	62	54	43	47	57	54	37	33	13	862
Saoner	SON	2123	7855	17	34	44	61	75	63	52	54	58	47	43	41	53	44	38	34	18	776
Umrer	UMR	2051	7920	14	30	59	67	81	78	69	86	78	58	52	60	64	66	48	36	25	971
Yeotmal																					
Darwia	DRW	2019	7746	17	34	52	55	60	44	50	50	53	36	35	47	41	46	35	31	25	711
Digras	DGS	2007	7743	17	36	49	54	59	50	57	52	57	36	37	44	40	31	36	32	27	714
Ner	NER	2029	7752	14	30	47	53	62	50	51	56	48	34	30	36	33	37	43	31	18	673
Pandherikawara	PDK	2001	7833	17	35	43	67	85	66	79	77	73	45	49	56	52	51	40	48	26	909
Pusad	PSD	1955	7735	15	29	53	53	61	48	58	58	52	32	38	45	41	41	34	25	26	709
Umerkhed	UKD	1935	7742	19	29	45	57	54	51	51	65	55	43	41	50	35	50	42	33	26	746
Wani	WNI	2003	7857	16	34	43	73	73	68	67	80	66	49	45	54	54	49	31	40	28	870
Yeotmal	YOT	2023	7808	13	29	49	58	79	64	64	67	74	42	41	53	47	49	46	41	27	843
Wardha																					
Wardha	WRD	2047	7835	11	35	46	58	73	59	48	60	74	47	42	43	46	45	43	26	28	784
Hinganghat	HGT	2033	7850	14	35	53	70	84	73	59	70	73	55	43	54	51	56	41	38	27	896

Table 4: Weekly AR (mm) at 50 percent level

Stn.	Abr.	Lat.	Long.	← Met. weeks →																	Total
				23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
Akola																					
Akot	AKT	2106	7704	5	18	24	35	43	35	35	34	36	25	24	25	20	20	15	21	8	423
Balapur	BLP	2040	7647	3	20	26	36	36	29	32	33	37	22	16	21	22	17	14	17	12	393
Mangrulpir	MGP	2019	7721	8	20	33	40	38	36	37	41	38	29	20	30	32	24	23	27	12	488
Murtajapur	MTP	2044	7723	6	19	28	41	45	38	35	34	35	21	19	23	23	27	22	21	16	453
Risod	RSD	2020	7648	8	19	31	38	33	31	39	33	34	27	21	30	34	36	25	24	18	481
Telhara	TLR	2102	7650	4	12	24	39	32	35	32	35	29	22	17	15	21	19	18	19	12	385
Washim	WSM	2007	7708	9	22	36	45	53	40	43	43	39	36	28	37	33	35	19	22	13	553
Amravati																					
Achalpur	ACL	2116	7731	8	21	29	34	40	38	32	40	39	21	22	27	31	20	21	17	15	455
Amravati	AMT	2056	7747	7	21	33	40	38	40	31	37	43	25	22	23	29	29	23	20	15	476
Barud	BRD	2128	7816	10	23	34	49	61	55	36	46	48	35	31	34	37	32	33	22	13	595
Chandur bazar	CDR	2050	7744	8	18	29	49	37	40	38	35	33	26	20	28	34	22	23	19	12	471
Dharni	DRN	2134	7653	2	21	37	49	53	59	51	70	67	53	41	52	51	54	34	16	7	717
Morsi	MSI	2120	7801	5	18	31	38	43	45	34	38	41	29	27	25	31	24	24	20	13	486
Talegaon	TGN	2041	7806	9	23	36	41	46	38	38	38	47	26	20	31	33	31	37	24	18	536
Bhandara																					
Bhandara	BDR	2110	7940	9	20	42	60	89	81	46	78	80	55	49	51	54	50	40	26	12	842
Chandpur	CDP	2130	7947	4	23	48	50	68	75	47	87	69	59	52	61	52	44	36	19	6	800
Khyrbund	KBD	2129	8004	2	23	41	61	76	75	58	101	80	65	61	66	59	51	41	17	10	887
Sakoli	SKL	2105	8000	9	19	46	66	91	94	57	104	82	78	59	67	62	59	44	27	15	979
Buldana																					
Buldana	BDN	2032	7611	7	26	38	41	37	36	40	38	40	23	20	27	23	24	20	21	12	473
Chikhli	CKL	2021	7615	7	25	37	45	41	31	33	31	32	18	20	28	24	20	17	17	12	438
Malkapur	MKP	2053	7612	4	16	27	33	33	28	34	34	33	21	16	19	24	23	18	15	5	383
Mehkar	MHK	2010	7633	8	21	32	43	40	30	40	37	32	27	30	28	26	31	18	22	14	479
Nandura	NDR	2050	7628	6	22	30	31	34	31	31	31	35	23	16	17	19	24	16	25	8	399
Chandrapur																					
Asola	ASL	2015	7951	4	27	38	61	70	92	67	104	84	64	53	57	55	52	34	27	16	905
Brahmapuri	BMP	2036	7952	8	20	42	61	85	78	59	84	90	62	49	61	56	51	39	26	14	885
Chandrapur	CHN	1958	7918	10	23	40	55	65	61	62	72	68	46	47	53	46	43	35	26	22	774
Chimur	CMR	2030	7923	9	22	47	68	72	63	54	75	75	45	42	49	51	46	38	28	19	803
Ghorajheri	GJI	2032	7938	5	15	42	69	65	87	61	81	79	62	48	47	52	51	39	27	13	843
Warora	WRR	2013	7901	8	27	39	54	56	60	56	68	55	39	41	48	44	41	32	25	14	707
Gadhchiroli																					
Gadhchiroli	GDC	2011	8000	6	21	51	66	81	78	69	102	98	67	65	66	59	50	42	25	16	962
Sironcha	SRC	1850	7958	9	21	34	48	64	51	67	75	67	43	48	49	51	39	33	29	20	748
Armori	AMR	2028	8004	6	20	47	63	77	80	61	92	90	60	56	59	58	54	33	24	8	888
Nagpur																					
Nagpur	NGP	2109	7907	10	24	42	57	71	62	46	63	57	43	38	42	43	42	33	24	14	711
Deolapur	DLP	2135	7923	11	25	37	52	69	75	33	69	52	46	42	44	49	51	35	29	20	739
Katol	KTL	2116	7835	9	20	32	47	52	46	32	40	45	30	25	34	40	35	27	21	14	549
Perseoni	PSN	2122	7909	3	19	38	43	67	65	53	52	48	42	34	37	45	42	22	26	5	641
Saoner	SON	2123	7855	8	20	34	48	67	50	40	42	47	36	33	32	42	34	28	25	10	596
Umrer	UMR	2051	7920	7	17	16	52	72	61	54	76	62	45	41	47	51	51	38	21	14	645
Yeotmal																					
Darwia	DRW	2019	7746	10	20	40	42	46	35	40	39	42	28	26	35	31	27	18	23	14	516
Digras	DGS	2007	7743	9	27	38	43	46	40	44	40	44	28	28	34	31	24	19	24	15	534
Ner	NER	2029	7752	7	22	36	42	48	39	40	43	38	26	22	28	26	29	25	24	9	504
Pandherikawara	PDK	2001	7833	13	21	35	52	64	51	61	68	58	35	37	44	39	40	30	36	15	695
Pusad	PSD	1955	7735	8	22	41	42	47	37	45	43	40	25	29	35	30	30	20	19	15	528
Umerkhed	UKD	1935	7742	15	22	35	44	41	40	40	49	42	33	31	40	28	39	24	25	14	558
Wani	WNI	2003	7857	8	21	34	58	55	53	52	61	52	38	35	42	42	38	19	24	15	647
Yeotmal	YOT	2023	7808	6	22	39	46	60	49	50	59	57	33	24	41	36	37	34	31	15	639
Wardha																					
Wardha	WRD	2047	7835	4	27	36	46	55	46	38	46	57	36	32	33	35	35	25	19	16	586
Hinganghat	HGT	2033	7850	10	20	41	54	64	58	47	62	56	42	33	42	40	43	31	29	15	687

Table 5: Weekly AR (mm) at 60 percent level

Stn.	Abr.	Lat.	Long.	← Met. weeks →																		Total
				23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39		
Akola																						
Akot	AKT	2106	7704	0	11	15	27	34	27	27	27	27	15	14	15	12	12	7	11	3	284	
Balapur	BLP	2040	7647	0	15	20	29	28	23	25	26	28	13	10	12	13	10	4	9	6	271	
Mangrulpir	MGP	2019	7721	3	12	26	32	30	29	29	32	29	23	12	17	19	15	13	15	6	342	
Murtajapur	MTP	2044	7723	2	11	21	32	36	30	28	28	27	16	11	17	18	17	12	12	8	326	
Risod	RSD	2020	7648	3	11	25	31	26	24	30	27	27	21	16	24	20	28	19	15	9	356	
Telhara	TLR	2102	7650	0	7	15	30	25	28	25	28	22	17	10	12	13	11	9	14	4	270	
Washim	WSM	2007	7708	3	13	28	35	42	32	33	35	31	27	17	23	21	27	9	12	8	396	
Amravati																						
Achalpur	ACL	2116	7731	3	13	23	27	32	30	26	32	30	13	13	16	24	15	12	10	9	328	
Amravati	AMT	2056	7747	4	12	20	32	31	32	25	30	34	19	13	17	18	22	18	15	8	350	
Barud	BRD	2128	7816	5	13	27	39	47	43	29	36	38	24	19	27	29	25	19	16	6	342	
Chandur bazar	CDR	2050	7744	4	11	23	37	30	32	29	28	26	15	15	16	25	17	14	11	5	338	
Dharni	DRN	2134	7653	0	12	22	38	42	48	41	57	54	41	32	41	38	41	18	7	0	532	
Morsi	MSI	2120	7801	0	11	24	30	35	35	27	30	32	22	16	15	23	18	18	15	6	357	
Talegaon	TGN	2041	7806	5	18	28	33	37	30	30	31	37	16	12	23	25	20	22	14	10	391	
Bhandara																						
Bhandara	BDR	2110	7940	5	12	32	48	78	64	37	60	63	44	39	40	43	41	30	15	5	656	
Chandpur	CDP	2130	7947	0	12	38	40	53	59	37	66	56	47	41	46	41	36	28	11	1	612	
Khyrbund	KBD	2129	8004	0	13	25	49	61	61	46	77	64	52	49	52	46	41	32	11	5	684	
Sakoli	SKL	2105	8000	5	11	35	53	70	73	45	79	67	61	46	53	49	47	34	16	7	751	
Buldana																						
Buldana	BDN	2032	7611	3	20	29	32	29	29	32	29	31	18	15	21	17	18	11	13	6	353	
Chikhli	CKL	2021	7615	2	20	29	34	33	25	26	25	25	14	12	17	14	13	8	10	6	313	
Malkapur	MKP	2053	7612	0	10	16	26	26	22	27	26	26	16	9	12	14	14	9	8	1	262	
Mehkar	MHK	2010	7633	3	16	25	34	32	23	31	29	25	20	22	22	16	18	10	13	9	348	
Nandura	NDR	2050	7628	2	14	17	24	27	24	25	25	27	14	9	13	14	15	8	14	3	275	
Chandrapur																						
Asola	ASL	2015	7951	0	15	30	49	55	70	53	78	66	50	43	45	44	41	27	20	9	695	
Brahmapuri	BMP	2036	7952	3	11	32	49	65	62	47	67	72	50	39	47	43	41	30	16	7	681	
Chandrapur	CHN	1958	7918	5	13	32	44	50	48	49	57	54	36	37	42	36	34	27	16	11	591	
Chimur	CMR	2030	7923	4	13	37	54	56	50	43	60	59	36	25	39	39	37	29	17	10	609	
Ghorajheri	GJI	2032	7938	0	7	33	54	52	67	48	63	63	49	38	38	39	41	23	21	4	640	
Warora	WRR	2013	7901	4	17	31	43	45	47	44	53	44	31	31	38	34	33	19	19	7	540	
Gadhchiroli																						
Gadhchiroli	GDC	2011	8000	1	13	40	53	64	62	55	91	77	54	51	53	47	40	26	14	9	760	
Sironcha	SRC	1850	7958	5	16	26	38	50	41	53	60	53	34	38	39	40	31	21	22	15	582	
Armor	AMR	2028	8004	2	12	37	49	59	64	48	72	71	49	43	46	46	43	25	14	0	680	
Nagpur																						
Nagpur	NGP	2109	7907	5	14	33	45	55	49	36	50	45	34	29	32	34	33	25	19	8	546	
Deolapur	DLP	2135	7923	5	18	29	41	61	59	25	52	41	36	34	35	38	39	27	17	9	566	
Katol	KTL	2116	7835	4	15	25	38	41	37	26	32	36	23	20	26	31	28	16	12	7	417	
Perseoni	PSN	2122	7909	0	11	30	34	52	51	41	41	37	33	27	28	35	33	13	20	0	486	
Saoner	SON	2123	7855	0	12	27	38	51	40	32	34	37	28	21	24	33	27	17	15	3	439	
Umrer	UMR	2051	7920	2	10	36	41	55	50	43	58	49	35	32	38	40	40	29	16	7	591	
Yeotmal																						
Darwia	DRW	2019	7746	5	15	31	33	37	27	31	32	33	21	15	22	24	17	9	14	7	373	
Digras	DGS	2007	7743	4	21	30	34	37	31	34	32	35	22	17	26	23	14	9	14	8	391	
Ner	NER	2029	7752	3	13	27	34	38	30	32	34	30	20	13	21	20	22	15	18	3	373	
Pandherikawara	PDK	2001	7833	7	16	27	41	51	39	48	52	45	27	23	34	30	31	18	21	9	519	
Pusad	PSD	1955	7735	3	13	32	33	37	30	35	34	31	20	22	27	18	18	12	10	9	384	
Umerkhed	UKD	1935	7742	8	13	27	35	32	32	32	39	33	26	19	32	22	29	15	15	7	416	
Wani	WNI	2003	7857	4	16	27	46	43	42	41	47	41	30	27	33	33	30	12	18	7	497	
Yeotmal	YOT	2023	7808	1	13	30	37	47	39	41	45	44	25	19	32	42	23	19	19	8	454	
Wardha																						
Wardha	WRD	2047	7835	0	20	28	37	44	37	30	37	44	22	19	25	21	27	16	11	8	426	
Hinganghat	HGT	2033	7850	5	13	32	43	50	46	37	47	44	32	21	33	30	34	19	17	9	512	

Table 6: Weekly AR (mm) at 70 percent level

Stn.	Abr.	Lat.	Long.	← Met. weeks →																	Total
				23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
Akola																					
Akot	AKT	2106	7704	0	7	8	21	27	17	21	21	16	12	8	9	7	7	2	5	0	188
Balapur	BLP	2040	7647	0	7	11	22	21	18	19	16	18	8	5	5	6	4	0	4	1	165
Mangrulpir	MGP	2019	7721	0	7	20	25	23	22	22	25	17	14	6	10	11	8	5	8	0	223
Murtajapur	MTP	2044	7723	0	5	12	24	28	23	23	22	16	9	6	9	9	10	5	6	3	210
Risod	RSD	2020	7648	0	6	19	24	20	15	19	21	21	16	9	18	12	17	9	9	4	239
Telhara	TLR	2102	7650	0	3	9	18	20	21	19	23	13	10	5	6	7	6	3	7	0	170
Washim	WSM	2007	7708	0	8	22	23	33	25	20	28	24	16	13	17	15	16	2	4	3	269
Amravati																					
Achalpur	ACL	2116	7731	0	10	13	21	25	23	20	25	18	8	7	10	14	8	6	5	3	216
Amravati	AMT	2056	7747	1	7	13	25	24	25	19	24	21	11	8	10	11	13	10	8	4	234
Barud	BRD	2128	7816	1	8	20	30	38	33	23	29	29	14	12	21	18	15	11	9	0	311
Chandur bazar	CDR	2050	7744	0	6	17	29	24	25	22	21	19	8	8	8	14	8	6	6	0	221
Dharni	DRN	2134	7653	0	7	13	29	33	38	33	46	44	26	19	31	23	24	7	2	0	375
Morsi	MSI	2120	7801	0	6	15	23	28	22	20	23	20	13	9	9	14	10	8	8	0	228
Talegaon	TGN	2041	7806	2	10	17	25	29	19	23	24	23	10	6	14	15	15	12	8	4	256
Bhandara																					
Bhandara	BDR	2110	7940	2	6	20	38	59	51	29	47	50	35	30	25	33	32	18	9	0	484
Chandpur	CDP	2130	7947	0	3	29	30	42	47	29	52	45	38	32	36	26	28	16	0	0	453
Khyrbund	KBD	2129	8004	0	5	15	39	49	48	36	61	51	43	39	42	28	33	19	6	0	514
Sakoli	SKL	2105	8000	1	5	22	42	55	58	35	63	54	48	36	42	38	37	20	9	0	565
Buldana																					
Buldana	BDN	2032	7611	0	12	18	25	23	23	25	23	24	14	9	12	10	10	4	7	2	241
Chikhli	CKL	2021	7615	0	12	17	20	25	19	20	20	20	11	7	10	9	8	3	5	2	208
Malkapur	MKP	2053	7612	0	5	9	16	21	14	21	21	21	12	4	6	7	7	3	3	0	170
Mehkar	MHK	2010	7633	1	9	16	27	25	18	24	22	16	12	13	13	10	11	3	7	4	231
Nandura	NDR	2050	7628	0	8	9	14	21	15	19	20	17	9	4	7	7	8	2	7	0	167
Chandrapur																					
Asola	ASL	2015	7951	0	7	19	39	43	55	41	62	52	40	33	35	34	32	21	11	3	527
Brahmapuri	BMP	2036	7952	0	5	20	39	51	49	38	54	58	39	30	37	27	33	18	9	2	509
Chandrapur	CHN	1958	7918	2	8	25	36	40	38	39	44	43	28	28	33	28	21	16	9	3	441
Chimur	CMR	2030	7923	1	7	29	43	45	39	35	48	45	28	20	30	24	29	18	10	3	454
Ghorajheri	GJI	2032	7938	0	2	25	42	43	53	37	50	50	38	29	30	23	32	14	13	0	481
Warora	WRR	2013	7901	1	13	24	34	37	37	35	43	35	24	19	29	21	25	11	11	2	401
Gadhchiroli																					
Gadhchiroli	GDC	2011	8000	0	7	25	41	51	50	42	70	61	44	40	43	36	32	16	6	3	567
Sironcha	SRC	1850	7958	0	8	15	30	40	33	43	48	42	26	29	31	31	25	16	13	8	438
Armori	AMR	2028	8004	0	6	28	38	48	51	38	57	55	39	27	35	36	34	14	7	0	513
Nagpur																					
Nagpur	NGP	2109	7907	2	8	20	36	44	39	29	40	36	26	18	19	22	27	15	12	3	396
Deolapur	DLP	2135	7923	0	10	22	33	48	47	14	41	32	27	27	28	23	30	15	9	0	406
Katol	KTL	2116	7835	0	8	19	30	33	30	20	26	28	14	11	16	19	22	10	7	2	295
Perseoni	PSN	2122	7909	0	6	23	27	42	40	32	33	29	25	21	17	22	25	7	12	0	361
Saoner	SON	2123	7855	0	7	20	30	40	32	25	27	29	22	16	14	25	17	10	8	0	322
Umrer	UMR	2051	7920	0	6	28	32	44	40	34	46	38	22	24	29	31	31	17	9	2	433
Yeotmal																					
Darwia	DRW	2019	7746	1	8	24	26	29	17	24	25	25	13	9	17	14	9	2	8	0	251
Digras	DGS	2007	7743	0	12	19	27	30	24	26	25	27	14	11	16	14	8	3	8	3	267
Ner	NER	2029	7752	0	8	16	27	31	24	26	27	23	12	8	12	12	13	7	10	0	256
Pandherikawara	PDK	2001	7833	4	9	21	32	40	30	37	42	35	21	14	21	18	19	10	12	4	369
Pusad	PSD	1955	7735	0	8	25	25	28	23	27	27	20	12	13	17	11	11	6	5	4	262
Umerkhed	UKD	1935	7742	4	8	21	28	26	25	25	31	25	20	12	25	17	17	8	9	2	213
Wani	WNI	2003	7857	1	8	21	36	34	33	31	37	32	23	16	26	20	19	6	9	0	352
Yeotmal	YOT	2023	7808	0	7	19	29	38	31	33	36	28	16	10	25	14	15	11	12	3	327
Wardha																					
Wardha	WRD	2047	7835	0	11	21	30	35	28	23	29	26	14	12	15	12	17	9	6	2	290
Hinganghat	HGT	2033	7850	2	8	21	33	40	37	29	37	34	19	16	26	18	26	12	10	3	381

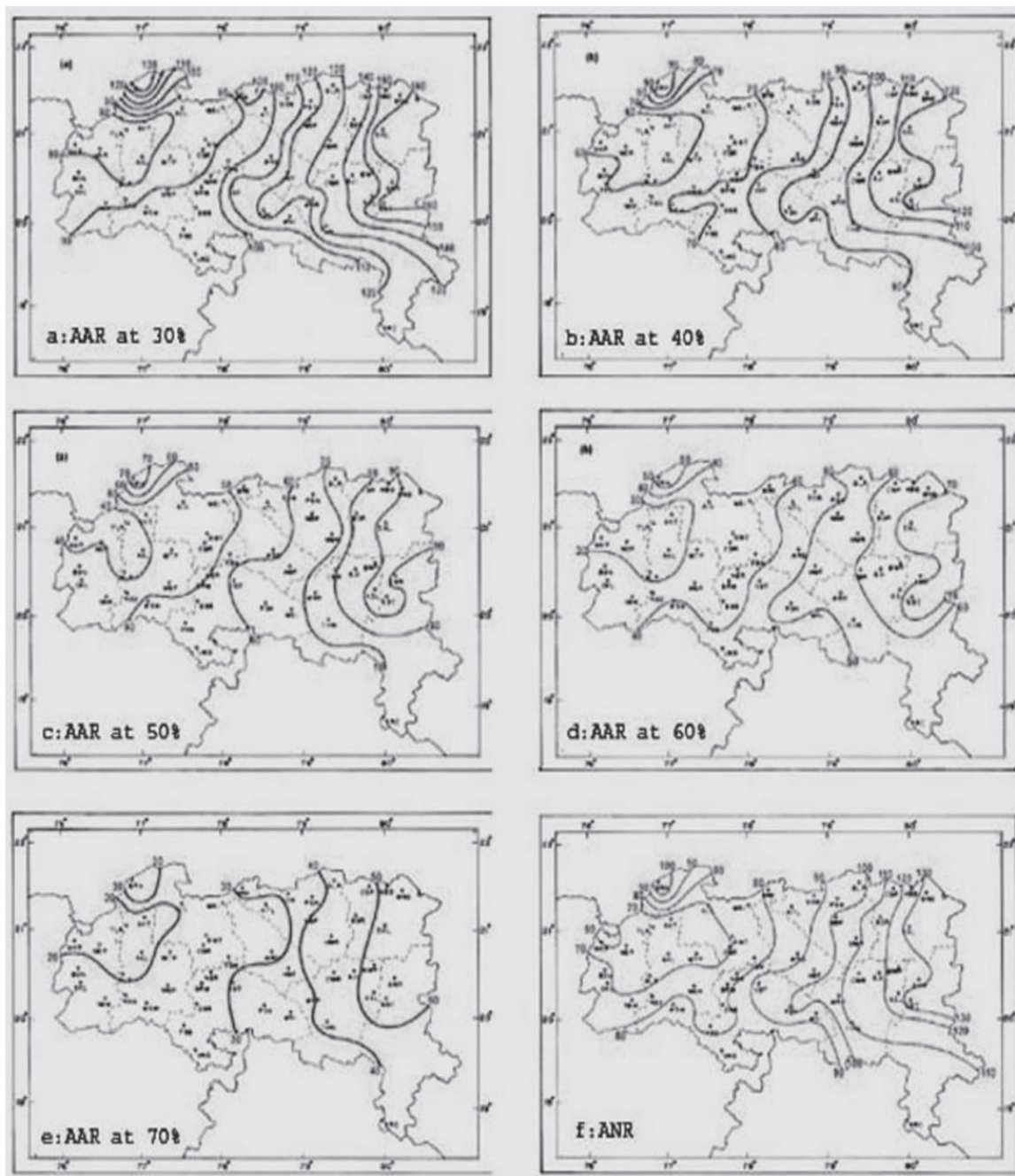
accumulated assured rainfall of the entire monsoon period (June–September). This could be taken into consideration by the policy makers while planning agricultural operations, hydrological constructions etc. in Vidarbha.

Accumulated Assured Rainfall (AAR)

Station-wise AAR values have been presented in Tables 2–6 at different probability levels (30–70%). Isohyetal analyses of AAR values of 30, 40, 50, 60 and 70% probability levels as well as that of total average rainfall have been done to examine the spatial variation of AAR

over the entire region during the entire monsoon period at different risk levels and have been presented in Figure 4 (a–f).

Examination of Figure 4(a) and Table 2 reveals that during monsoon season in 30% of the years AAR over the region varies from 74 cm at Akot (Akola district) and Malkapur (Buldhana district) to 166 cm at Sakoli (Bhandara district). There is a striking difference in AAR east and west of longitude (approximately) 78.2°E —to the east of this longitude AAR is 100 cm or more and at the extreme east isohyets of 160 cm is also observed; to



Figures 4(a–f): Accumulated Assured Rainfall (AAR) in cm at 70% probability level.

the west of 78.2°E and south of about 21.2°N AAR value is quite low (<90 cm) and reaches even <80 cm in the northern part of Buldhana and Akola districts.

A secondary high of 130 cm in AAR is noticed over the northwestern part of the Amravati district.

In 50% of the years AAR lies in the range of 38 cm at Malkapur in Buldhana district to 98 cm at Sakoli in Bhandara district (Figure 4(c) and Table 4). At this level AAR varies from ≤ 40 cm in the west to ≥ 90 cm in the east.

The secondary high in the northwestern part of the Amravati district comes down to 70 cm.

Figure 4(e) reveals that in seven out of every 10 years the spatial variation of AAR in the Vidarbha region ranges from ≤ 20 cm to ≥ 50 cm. The secondary high is now ≥ 30 cm.

At this probability level Malkapur and Nandura (Buldhana district) and Telhara and Balapur (Akola district) receive the lowest amount of AAR (17 cm) whereas Sakoli (Bhandara district), Brahmapuri (Chandrapur district) and Gadchiroli (Gadchiroli district) receives the highest amount of AAR (57 cm) (Table 6).

Isohyetal analysis of accumulated normal rainfall (ANR) reveals (Figure 4(f)) that it varies from 60 cm over a small pocket in the northwestern part of Buldhana district to ≥ 130 cm over the eastern and northern part of the Bhandara and Gadchiroli districts respectively. The secondary high in ANR is found to be 100 cm in the northwestern part of the Amravati district.

One important aspect observed here is that the accumulated normal rainfall (ANR) is more than AAR at 50% probability level but less than AAR at 30% probability level.

Homogeneous Rainfall Zones

An attempt has been made in this investigation to demarcate the entire Vidarbha region into several homogeneous rainfall zones using AAR at 70% probability level so that planners, either hydrologists or agricultural policy makers may succeed in their endeavour in seven out of every 10 years. To achieve this objective the region has been divided into five homogeneous rainfall zones which have been named as A, B, C, D and E and presented in Figure 5, using the following criteria:

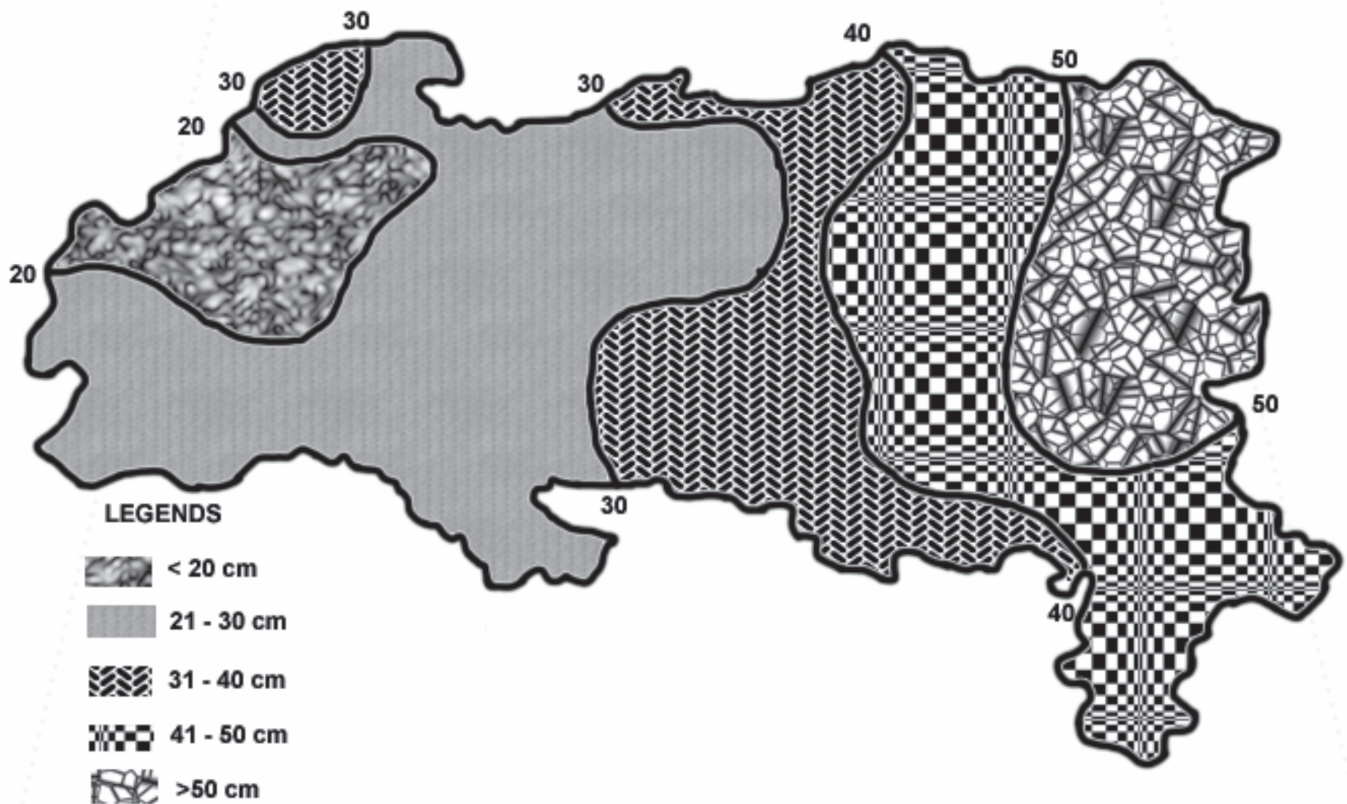


Figure 5: Homogeneous rainfall zones in Vidarbha.

<i>AAR Value (cm)</i>	<i>Zone</i>
< 20	A
20 – 30	B
31 – 40	C
41 – 50	D
> 50	E

Zone A

This zone lies over the western part of the region comprising northern part of Buldhana and Akola districts and adjoining small western part of the Amravati district. This zone receives < 20 cm rainfall during the entire monsoon season in seven years out of every 10 years.

Data in Table 5 reveal that in this zone peak rainfall is received in mw 26 and 27 and the peak amount lies in the range of 20–27 mm at 70% probability level. But in three out of every 10 years peak amount could reach to as high as 73 mm (Table 2).

In this zone lowest AAR of 17 cm is observed at Malkapur and Nandura (Buldhana district) and Balapur and Telhara (Akola district) whereas Akot (Akola district) receives the highest AAR (19 cm) in seven out of every 10 years.

Zone B

A bigger portion of western part of the Vidarbha region (west of 79 °E) falls in this zone. This zone comprises the southern part of Buldhana and Akola districts, western part of Yeotmal, Wardha and Nagpur and a major portion of the Amravati district.

In general, this zone also receives peak rainfall in 26/27th mw and the peak amount ranges from 25 to 35 mm in 70% of the years.

Lowest AAR in this zone is 21 cm and received at Umerkhed (Yeotmal district) and Chikhli (Buldhana district) whereas Katol (Nagpur district) and Risod (southern part of Akola district) receive the highest AAR (29 cm).

Zone C

This zone (AAR 30–40 cm) lies mainly over the central part of the region consisting of southern and western part of Wardha and Yeotmal districts as well as central part of Nagpur district and western part of Chandrapur district. Besides, a small pocket in the northwestern part of Amravati district (near Dharni) also comes under this zone. In this zone peak rainfall, in general, is received in 27th mw; while for stations Pandherikawara and Wani of Yeotmal district peak is reached in mw 30 and the peak amount ranges from 37 to 44 mm in 70% of the years. In this zone, Barud (extreme northeastern part of Amravati district) received the lowest AAR (31 cm) and Nagpur (Nagpur district) received the highest AAR (40 cm).

Zone D

This zone comprises eastern part of Nagpur, western part of Bhandara, central part of Chandrapur and southern part of Gadchiroli districts.

This zone generally receives peak rainfall in 30th mw and the peak amount ranges 44–59 mm in 70% of the years (Table 6). At Bhandara, Ghorajheri and Deolapur stations though peak comes much early in 27–28th mw yet near 30th mw a secondary peak is conspicuous at these stations.

Deolapur (Nagpur district), Ghorajheri (Chandrapur district) and Bhandara (Bhandara district) receive the highest AAR (48 cm) in 70% of the years in this zone.

Zone E

This is the highest rainfall zone over the region. This zone lies in the area bounded by approximately latitude north of 20°N and east of 80°E and comprising eastern part of Bhandara and Chandrapur districts and northern part of Gadchiroli district.

This zone also receives peak rainfall in 30th mw and the peak amount varies from 57–70 mm at 70% risk level.

Minimum AAR of 51 cm is received at Khyrbund (Bhandara district) and Armori (Gadchiroli district) whereas Gadchiroli (Gadchiroli district) and Sakori (Bhandara district) receive the maximum amount of AAR (57 cm) in this zone.

One important point noticed here is that at zones A, B and C, in general, peak is received quite early in 26–27th mw, whereas in zones D and E peak is generally observed in 30th mw (23–29 July).

It is found that the area west of 79 °E (approximately) (A, B and C zones) receives much lower AAR than that received by the D and E zones east of 79°E. Even the peak rainfall in these zones is much lower than that received in the D and E zones. This could be attributed to the fact that Vidarbha region mainly gets its monsoon rainfall from the monsoon lows/depressions formed over Bay of Bengal that move in a west-northwesterly/northwesterly direction and sheds much of its water over the eastern part (D and E zones), while the A, B and C zones (west of 79 °E) get rainfall when these systems already pass their heyday.

Summary

- (i) Rainfall over the Vidarbha region is mainly caused due to dynamical influences (mainly lows and depressions moving over the area).
- (ii) Assured rainfall increases considerably from west to east. The eastern most Gadchiroli, Bhandara and Chandrapur districts get at least 25 mm of rainfall per week right from mid-June till first dekad of September, whereas the western most Buldhana,

Akola and Amravati districts receive comparatively much less rainfall during the same period.

- (iii) Though July and August are the chief monsoon months, yet for the western-most Buldhana, Akola and Amravati districts, the contribution of August rainfall to the total accumulated assured rainfall of the entire monsoon period (June-September) is less as compared to that of July rainfall.
- (iv) Accumulated assured rainfall analysis at different probability levels indicates that it is maximum in the eastern part of Bhandara and northern part of Gadchiroli districts and minimum over the western Vidarbha consisting of northern part of Buldhana and Akola and adjoining Amravati districts.
- (v) At all the probability levels Sakoli in Bhandara district and Akot in Akola district receive the highest and the lowest amount of AAR respectively.
- (vi) The entire Vidarbha region has been divided into five homogeneous rainfall zones based on the accumulated assured rainfall at 70% probability level.
- (vii) The zones A, B and C lying approximately west of 79°E receive much lower rainfall than D and E zones lying east of 79°E. This could be attributed to the fact that Vidarbha mainly gets its monsoon rainfall from lows/depressions formed over Bay of Bengal and move in west-northwesterly direction and sheds much of its rainwater over the eastern D and E zones, while A, B and C zones (west of 79°E) get rainfall when these systems pass their heyday.
- (viii) This type of rainfall information at different probability levels could serve as basic input of planning for agriculture, land use, drainage requirements and water resources development. Coupled with soil information these will help deciding crop types that could be raised to increase and stabilize production.

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