Journal of Agrometeorology 4 (2) : 181-185 (Dec 2002)

Short communication

Rainfall probability analysis for sustainable crop production strategies in coastal Orissa

G. KAR

Water Technology Centre for Eastern Region (I.C.A.R), Bhubaneswar-23, Orissa

The coastal Orissa which comprises of 4 undivided districts viz., Balasore, Cuttack, Puri and Ganjam, covering an area of 3.902 mha, is 25.1% of total geographical area of the state. These places receive annual rainfall varying from 1400 to 1800 mm. Though this region has high crop production potential, due to lack of appropriate water and soil management, the region has one of the lowest agricultural productivity level in the country. Major portion of rainfall occurs due to southwest monsoon with heavy downpour resulting in substantial runoff and flood. During other seasons water stress creates adverse conditions for growing crops and agricultural droughts of varying intensities limit crop production The Markov Chain model has been extensively used to study probabilities of rainfall occurrence (Gabriel and Newman, 1962), long term frequency behaviour of wet and dry weather (Victor and Sastry, 1979). Singh and Bhandari (1998) found the potential of Markov Chain model for crop planning in mid hill region of Himachal Pradesh. Panigrahi (1998) analyzed probability distribution of short duration rainfall at different coastal stations of Orissa. Gupta *et al.*, (1975) suggested that the rainfall at 80% probability can safely be taken as assured rainfall, while 50% probability is the medium limit for taking risk. The weekly rainfall probability analysis using Markov chain model is considered thus useful for command area planning, watershed characterization, water harvesting and cropping system characterization.

Thirty years rainfall data (1966-95) of 5 coastal stations of Orissa viz., Balasore, Cuttack and Ganjam (Gopalpur), Puri and Bhubaneswar were collected from IMD, Pune for computing seasonal distribution of rainfall, coefficient of variability of monthly rainfall and probability of monthly and weekly rainfall. At these stations number of rainy days ranges from 55-75 days.The weekly probability of rainfall was estimated using Markov Chain probability model for receiving 10,20 and 30 mm rainfall in a given week Results are reported for initial and conditional probabilities of a wet week, P(W) and conditional probabilities of a wet week followed by a wet week, P(W/W). The monthly probability of rainfall at 90%, 75% 50%, 25% and 10% confidence level was also estimated using incomplete gamma distribution.

Total annual rainfall and its seasonal distribution for different coastal stations of Orissa were analyzed and are presented in the Table 1. Total rainfall ranged from 1209 mm in Ganjam (Gopalpur) to 1688 mm in Balasore. Among seasons, the south west monsoon rainfall (June to September) varied from 718.9 mm in Ganjam (Gopalpur) to 1186 mm in Cuttack, contributing 59.5 to 76.1% of the total annual rainfall. Since winter rainfall and pre monsoon

Table 1: Seasonal distribution of rainfall (mm) at selected coastal stations of Orissa.

Station	Total	Pre Monsoon	Rainy	Post Monsoon	Winter
1. Bhubaneswar	1462.6	119	1011.8	280.8	51.0
2. Cuttack	1557.2	118.3	1186.3	209.0	43.6
3. Puri	1438.7	88.4	996.5	317.3	36.5
4. Balasore	1488.6	183.7	1172.7	275.1	57.1
5. Gopalpur	1209.5	87.5	718.9	358.4	44.7

showers are meager and erratic, excess water harvested during monsoon could be utilized for providing supplementary irrigation to the rabi crops for enhancing agricultural productivity of the region. July is the wettest month with the lowest coefficient of variation, ranging between 39% in Cuttack to 79% in Ganjam (Gopalpur).

The initial, P(W) and conditional probabilities, P(W/W) by Markov chain model for three coastal stations, viz., Balasore, Cuttack and Ganjam (Gopalpur), representing three different agro-climatic zones are presented in Figs. 1(a-c). Study revealed that initial and conditional probabilities of getting 10, 20 and 30 mm rainfall during 24th to 38th standard meteorological week were more than 50% in coastal stations. In general, from weekly rainfall probability analysis it can said that (i) at all the coastal stations, dependable rainfall occurs between 24th and 38th standard weeks (ii) rainfed crops can successfully be grown during *kharif* season while growing of *rabi* crops in winter season without supplementary irrigation could be risky (iii) in coastal region pre- monsoon showers may occur around 18th - 20th standard weeks, making preparation of seed beds for *kharif* crops feasible.

The monthly rainfall probability at 10, 25, 50, 75 and 90% confidence level was computed using gamma distribution and results are given (Table 2) for Cuttack, Balasore and Ganjam (Gopalpur). At 75% probability level, 46 and 41 mm rainfall can be expected to occur during May in Balasore and Cuttack, respectively. This pre monsoon rain at 75% probability level can be utilized for summer ploughing or seed bed preparation for raising rice seedlings. At 90% confidence level amount of rainfall which occurs during June at Balasore and Cuttack is around 220 mm while at Ganjam it is 172 mm. Therefore, the *kharif* crops like maize (*Zea mays*), cowpea (*Vigna chinensis*), pigeonpea (*Cajanas cajan*), groundnut (Arachis hypogea), Blackgram (*Vigna mungo*), direct sown rice (*Oryza sativa*) etc. can be taken and rice nurseries can be prepared in 2nd fortnight of June with the commencement of southwest monsoon in these regions. Maximum amount of rainfall occurs during July at all the stations. Higher amount of rainfall at 90% confidence level can be utilized for rice transplanting starting from first fortnight of July. The transplanting of *kharif* rice in first week of July will have additional advantage of almost assured water through rain during August and September.

Since, the winter rainfall is uncertain and

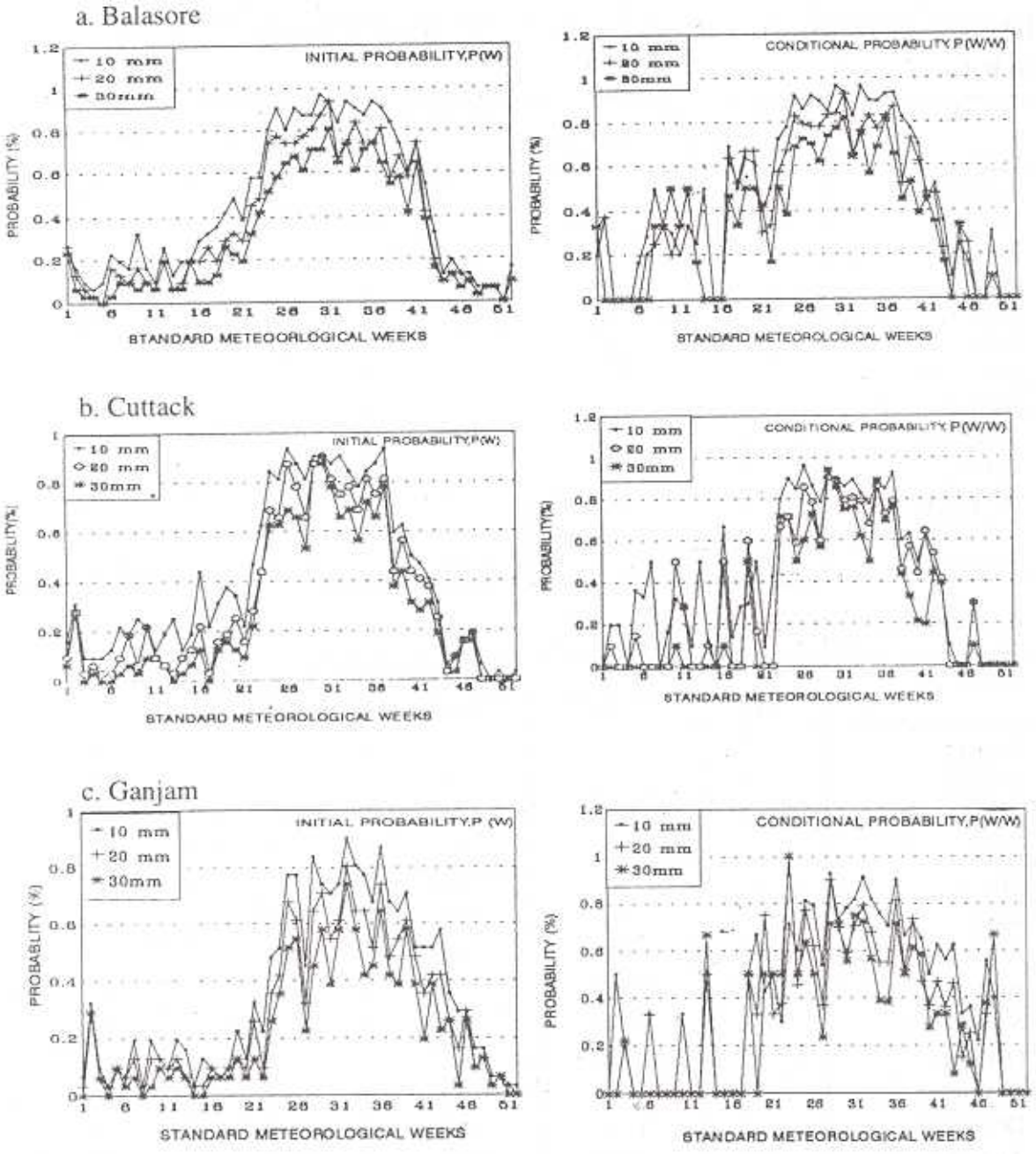

Fig.1: Initial and conditional probabilities at (a) Balasore (b) Cuttack (c) Ganjam

Table 2: Incomplete gamma distribution of monthly rainfall at different probability levels

(a) Balasore

Month	Probability levels				
	90%	75%	50%	25%	10%
January	0	2	7	20	40
February	1	4	15	40	79
March	1	6	21	52	98
April	4	11	27	56	96
May	28	46	76	117	164
June	219	252	287	324	537
July	305	344	387	431	470
August	179	215	255	296	333
September	110	144	190	245	302
October	23	44	82	136	201
November	1	6	21	53	100
December	0	1	3	7	13
Annual	871	1075	1344	1777	2253

(b) Cuttack

Month	Probability levels				
	90%	75%	50%	25%	10%
January	0	1	4	9	16
February	1	3	11	26	48
March	5	11	24	46	75
April	8	15	25	40	57
May	24	41	69	107	151
June	221	251	282	315	344
July	291	323	357	393	424
August	226	265	306	349	388
September	132	158	190	227	263
October	15	26	43	67	95
November	1	4	12	27	50
December	0	1	3	7	13
Annual	924	1099	1326	1613	1924

(c) Ganjam

Month	Probability levels				
	90%	75%	50%	25%	10%
January	0	1	5	15	30
February	0	2	10	28	56
March	1	5	14	32	58
April	2	6	14	26	42
May	8	18	39	73	116
June	172	211	253	297	335
July	250	289	333	378	418
August	164	203	246	290	329
September	84	112	151	198	247
October	34	51	77	111	149
November	3	10	30	69	122
December	0	2	6	14	25
Annual	718	910	1178	1531	1927

erratic, residual moisture in medium and low land regions can be utilized for growing a second crop under rainfed conditions. In these regions, high value *rabi* crops like groundnut, sunflower, wheat can be grown only with assured supplemental irrigation during *rabi* season starting from first week of November.

REFERENCES

Gabriel, K.R. and Neuman, I. 1962. A Markov Chain model for daily rainfall occurrences at Tel Aviv", *Quart. J. Roy. Meteorol Soc.*, 88: 90-95.

Gupta, R.K., Rambabu and Tejawani, K.G. 1975. Weekly rainfall of India for crop planning programme. *Soil Cons. Digest*, 3:31-39

Panigrahi, B. 1998. Probability analysis of short duration rainfall for crop planning in coastal Orissa. *Ind. J. Soil Cons.*, 26 (2): 178-182

Singh M. and Bhandari A.R. 1998. Wet and dry spells analysis using Markov Chain model for mid hill region of Himachal Pradesh. *Indian J. Soil Cons.*, 26(2) : 147 - 152.

Victor, U.S. and Sastry, P.S.N. 1979. Dry spell probability by Markov Chain model and its application to crop development stage. *Mausam*, (30) : 479 - 484.