556.12 : 551.581.2 (540.35)

RAINFALL PROBABILITY ANALYSIS OF KOKRAJHAR DISTRICT OF LOWER BRAHMAPUTRA VALLEY ZONE OF ASSAM

1. At present, climate change (more particularly change in rainfall) is a reality; and the consequences are particularly severe in case of developing countries including India, where major portion of populations directly depends on climate sensitive sectors (such as - agriculture, forests and fishery) and natural resources (such as - water, biodiversity, mangroves, coastal zones, grassland) for their subsistence and livelihoods (Gogoi, 2010). Considering the importance, many rainfall related risk analysis have been reported by several author (Chakraborty and Chakraborty, 1991; Rai *et al.*, 2009; Singh *et al.*, 2009; Mukherjee *et al.*, 2012; Sarmah *et al.*, 2013) for different agro climatic zones of India and Assam. In most of the studies, the scientists have suggested cropping pattern considering the rainfall amount at different probability levels. Thus, efforts has been made to analyze the seasonal rainfall pattern, different rainfall deficient year and rainfall probability of Kokrajhar of Assam by using Markov-Chain model and the findings are reported in this paper.

2. The daily rainfall data for the period 1985-2014 (30 year) at Kokrajhar district (situated in latitude 26° 4′ N, longitude 89° 9′ E and altitude 48.12 m MSL) of Lower Brahmaputra Valley Zone (LBVZ) of Assam have been used for analysis. According to India Meteorological Department (IMD), district wise or sub-district wise rainfall distribution (weekly or seasonal) are described as Large Excess (+60% and above), Excess (+20% to +59%), Normal (+19% to -19%), Deficient (-20% to -59%), Large Deficient (-60% or less) and No rain (-100%). While describing rainfall percentage departures of all India monsoon seasonal rainfall, IMD has recently (2015) added the description of rainfall condition as 'Drought' which is described as Normal (within ±10% of the long period average), Below Normal (rainfall is <10% of the long period average), Above Normal (rainfall is >10% of the long period average), Deficient Year (>10% and 20 to 40% area of the country is under drought conditions) and Large Deficient Year (>10% and when the spatial coverage of drought is >40%). The average rainfall, rainy days, standard deviation and coefficient of variation was calculated for the four seasons separately, *viz.*, Winter (Jan-Feb), Summer (Mar-May), South-West monsoon (June-Sep) and North-East (Oct-Dec). Probability of getting certain amount of rainfall (10, 20, 30 and 40 mm) in a particular week or consecutive weeks was analyzed using Markov-Chain model and incomplete gamma distribution through Weather Cock (v1.0) software develop at CRIDA.

TABLE 1

Meteorological deficient year at Kokrajhar (1985-2014)

Year	Annual rainfall (mm)	Deviation from normal (%)	Status of drought
1985	4141.4	13.20	N
1986	3107.8	-15.05	N
1987	5193.2	41.93	E
1988	5022.2	37.27	E
1989	3006.4	-17.82	N
1990	3252.1	-11.11	N
1991	3441.3	-5.94	N
1992	2791.1	-23.71	D
1993	3857.2	5.43	N
1994	2442.1	-33.25	D
1995	4598.9	25.71	E
1996	3754.9	2.63	N
1997	2882.2	-21.22	D
1998	4213.9	15.18	N
1999	4303.3	17.62	N
2000	4287.8	17.20	N
2001	3313.6	-9.43	N
2002	3423.0	-6.44	N
2003	3504.2	-4.22	N
2004	4811.4	31.51	E
2005	3297.5	-9.87	N
2006	3223.0	-11.90	N
2007	3526.2	-3.62	N
2008	3564.2	-2.58	N
2009	2786.1	-23.85	D
2010	4043.9	10.53	N
2011	2934.8	-19.78	D
2012	4253.6	16.27	N
2013	3014.6	-17.60	N
2014	3763.6	2.86	N

Large Excess (LE) = + 60% and above
Excess (E) = + 20% to +59%
Normal (N) = + 19% to -19%
Deficient (D) = - 20% to -59%
Large Deficient (LD) = - 60% or less
No rain = - 100%

TABLE 2

Seasonal rainfall analysis of Kokrajhar (1985-2014)

Season		Winter	Summer	South-west	North-east	Annual
Rainfall (mm)	Mean	26.4	689.4	2750.8	191.9	3658.5
	SD	27.8	196.9	677.7	122.9	703.8
	CV	105.3	28.6	24.6	64.0	19.2
Rainy days (nos.)	Mean	2.1	28	67	7	105
	SD	1.8	6.7	8.1	2.9	14.1
	CV	82.3	23.8	12.1	42.1	13.4

3. *Meteorological deficient year analysis* : The average rainfall of the Kokrajhar district is 3658 mm. It was observed (Table 1) that among 30 years, the average annual rainfall was Excess (E) for 4 years, Normal (N) for 21 and was Deficient (D) for 5 years. Thus, during the study period, meteorological excess, normal and deficient year occurred in 13.34, 70.00 and 16.66% years, respectively. Data also revealed that there were no any year affected by Large Excess (LE), Large Deficient (LD) or by No rain situation during the period from 1985 to 2014 in Kokrajhar district of Assam.

Among the 21 normal years, the rainfall deviation from that of normal annual rainfall was ranged from -17.82 to 17.62% causing normal year situation. On the other hand, during last 30 years (from 1985 to 2014), maximum 41.93% and minimum -33.25% deviation in rainfall was recorded over normal 3658.5 mm rainfall in Kokrajhar district (Table 1).

Seasonal rainfall analysis : The annual average rainfall and rainy days at Kokrajhar was 3658.5 mm and 105 days, respectably. The rainfall amount and rainy days during different season namely winter, summer, southwest monsoon and northeast were respectively 0.7, 18.8, 75.2, 5.2% of total rainfall and 2.0, 26.7, 63.8 and 6.7% of total rainy days. The coefficient of variation of seasonal rainfall was highest (105.3%) during winter season, followed by north-east (64.0%). However, the coefficient of variation (CV) was moderate (28.6%) during summer and lowest (24.6%) during south-west season. Likewise the coefficient of variation of seasonal rainy days was highest (82.3%) during winter season followed by north-east (42.1%). However, the coefficient of variation (CV) was moderate during summer season and lowest (12.1%) during south-west monsoon season (Table 2).

Probability of weekly rainfall : Probability of consecutive wet weeks (wet week after wet week) with different limit (10, 20, 30 and 40 mm) of weekly rainfall is illustrated in Fig. 1. Occurrence of 10 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that the probability of 70% or above confidence level of getting consecutive wet weeks (wet week after wet week) with 10 mm rainfall the period extended from 9th April to 30th September, *i.e.*, 25 weeks duration. If we consider the same amount of rainfall with the probability of 80% or above confidence level, it confined from 9th April to 30th September, *i.e.*, 22 weeks duration excluding 16, 20 and 37 SMW. Likewise having the same amount of rainfall with the probability of 90% or above confidence level confined from 23rd April to 30th September *i.e.*, 17 weeks duration excluding 18, 20, 30, 32, 35 and 37 SMW.

If we consider the occurrence of 20 mm of weekly rainfall confined from 26th March to 28th October, *i.e.,* 31 week duration. It has been observed that the probability of 60% or above confidence level of getting consecutive wet weeks (wet week after wet week) with 20 mm rainfall the period extended from 16th April to 14th October, *i.e.*, 25 weeks duration. Having the same amount of rainfall with the probability of 80% or above confidence level confined from 23rd April to 30th September, *i.e.*, 22 weeks duration excluding 19, 20, 36 and 37 SMW. Likewise having the same amount of rainfall with the probability of 90% or above confidence level confined from 11th June to 23rd September, *i.e.*, 14 weeks duration excluding 30, 31, 32, 34, 35, 36 and 37 SMW.

If we consider the occurrence of 30 mm of weekly rainfall confined from 26th March to 28th October, *i.e.,* 31 week duration. It has been observed that the probability of 70% or above confidence level of getting consecutive wet weeks (wet week after wet week) with 20 mm rainfall the period extended from 30th April to 30th September, *i.e.*, 21 weeks duration. Having the same amount of rainfall with 80% or above confidence level confined from 21st May to 30th September, *i.e.*, 18 weeks duration excluding 35, 36 and 37 SMW. Likewise, having

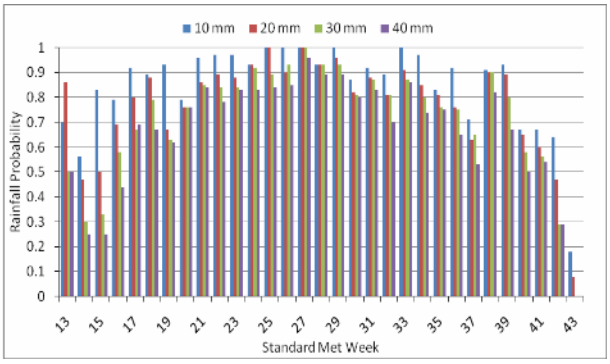

Fig. 1. Rainfall probability of wet week after wet week (W/W)

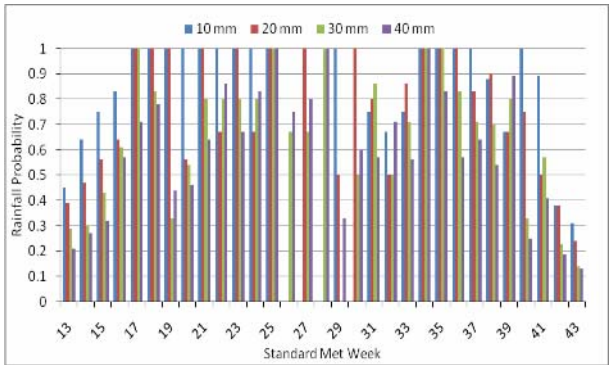

Fig. 2. Rainfall probability of wet week after dry week (W/D)

the same amount of rainfall with 90% or above confidence level confined from 11th June to 23rd September, *i.e.*, 14 weeks duration excluding 25, 30, 31, 32, 33, 34, 35, 36 and 37 SMW.

If we consider the occurrence of 40 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that the probability of 60% or above confidence level of getting consecutive wet weeks (wet week after wet week) with 20 mm rainfall the period extended from 23rd April to 30th September *i.e.*, 22 weeks duration excluding 37 SMW. Likewise, having the same amount of rainfall with 80% or above confidence level confined from 21st May to 23rd September, *i.e.*, 17 weeks duration excluding 22, 32, 34, 35, 36 and 37 SMW.

The probability of consecutive wet week after dry week (wet week after dry week) with different limit (10, 20, 30 and 40 mm) of weekly rainfall is illustrated in Fig. 2. Occurrence of 10 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that 70% or above confidence level of getting consecutive wet weeks (wet week after dry week) with 10 mm rainfall the period extended from 9th April to 14th October, *i.e.*, 26 weeks duration excluding 26, 27, 28, 30, 32 and 39 SMW. Having the same amount of rainfall with 80% or above confidence level confined from 16th April to 14th October, *i.e.*, 25 weeks duration excluding 26, 27, 28, 30, 31, 32, 33 and 39 SMW. Having the same amount of rainfall with 1% or above confidence level confined from 23rd April to 7th October, *i.e.*, 23 weeks duration excluding 26, 27, 28, 30, 31, 32, 33, 38 and 39 SMW. Occurrence of 20 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that 70% or above confidence level of getting consecutive wet week after dry week (wet week after dry week) with 20 mm rainfall the period extended from 23rd April to 7th October, *i.e.*, 23 weeks duration excluding 20, 22, 24, 26, 28, 29, 32 and 39 SMW. Having the same amount of rainfall with 80% or above confidence level confined from 23rd April to 23rd September, *i.e.*, 21 weeks duration excluding 20, 22, 24, 26, 28, 29 and 32 SMW. Having the same amount of rainfall with 90% or above confidence level confined from 23rd April to 23rd September, *i.e.*, 21 weeks duration excluding 20, 22, 24, 26, 28, 29, 31, 32, 33 and 37 SMW. Occurrence of 30 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that 70% or above confidence level of getting consecutive wet week after dry week (wet week after dry week) with 10 mm rainfall the period extended from 23rd April to 30th September, *i.e.*, 22 weeks duration excluding 19, 20, 26, 27, 29, 30 and 32 SMW. Having the same amount of rainfall with 80% or above confidence level confined from 23rd April to 30th September, *i.e.*, 22 weeks duration excluding 19, 20, 26, 27, 29, 30, 32, 33, 37 and 38 SMW. Having the same amount of rainfall with 90% or above confidence level confined from 23rd April to 2nd September, *i.e.*, 18 weeks duration excluding 18, 19, 20, 21, 22, 23, 24, 26, 27, 29, 30, 31, 32 and 33 SMW. Occurrence of 40 mm of weekly rainfall confined from 26th March to 28th October, *i.e.*, 31 week duration. It has been observed that 70% or above confidence level of getting consecutive wet week after dry week (wet week after dry week) with 10 mm rainfall the period extended from 23rd April to 30th September, *i.e.*, 22 weeks duration excluding 19, 20, 21, 23, 29, 30, 31, 33, 36, 37 and 38 SMW. Having the same amount of rainfall with 80% or above confidence level confined from 28th June to 30th September, *i.e.*, 17 weeks duration excluding 23, 26, 27, 29, 30, 31, 32, 33, 36, 37 and 38 SMW. Having the same amount of rainfall with 90% or above confidence level confined from 18th June to 26th August, *i.e.*, 10 weeks duration excluding 26, 27, 29, 30, 31, 32 and 33 SMW.

Probability of consecutive dry week after wet week (dry week after wet week and dry week after dry week)

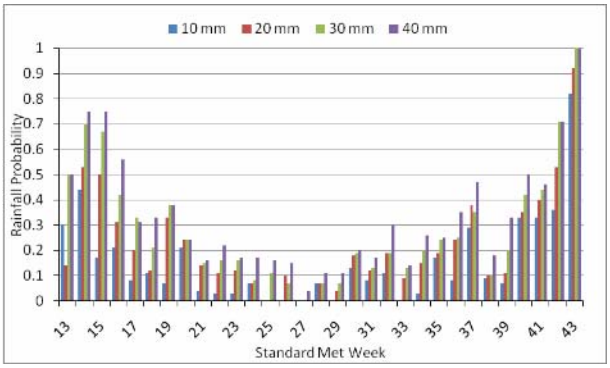

Fig. 3. Rainfall probability of dry week after wet week (D/W)

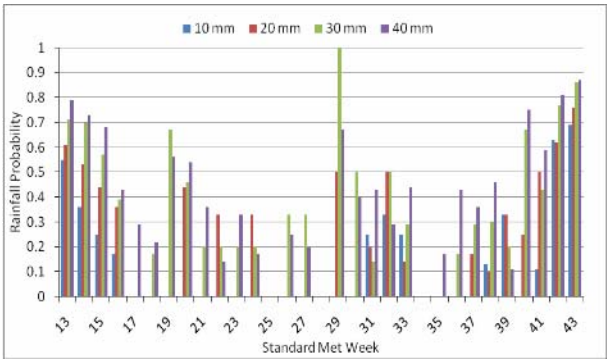

Fig. 4. Rainfall probability of dry week after dry week (D/D)

with different limit (10, 20, 30, and 40 mm) of weekly rainfall probability (Figs. 3-4) is not applicable for Kokrajhar district of Assam. This is due to most of the probability value (dry week after wet week and dry week after dry week) which is less than 50% and thus it is not useful for farming operation/community for Kokrajhar district of Lower Brahmaputra Valley Zone (LBVZ) of Assam.

4. It can be concluded that as probability of getting 50 mm assured rainfall at 75% confidence level is continues for 8 weeks which could be utilized for *Sali* rice transplanting starting from first fortnight of July. Another advantage of growing these crops in the first fortnight of July was that these could be harvested within October and another *rabi* crop like rapeseed-mustard, potato, sesame could be sown immediately utilizing rainfall of October. Since the winter rainfall was uncertain, residual moisture in medium and low, land could be utilize for growing second crops under *rainfed* condition of Kokrajhar. High valued *rabi* crops like vegetable cabbage, cauliflower, tomato, brinjal etc., could be grown only with supplemental irrigation during winter season starting from first week of November. As per meteorological analysis, the zone is under to meteorological normal year condition and thus, from rainfall probability analysis, there is an ample scope of rain-water harvesting from June to August for crop-saving irrigation as well as pre-sowing irrigation for succeeding *Rabi* crops generally sown on residual soil moisture.

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