ANALYSIS OF RAINFALL INTENSITY OF KUNIGAL TALUK, TUMKUR DISTRICT, KARNATAKA USING GIS TECHNIQUES

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Abstract

Land, water and soil are limited natural resources and their wide utilization with increasing population is a major area of concern. to mitigate the demand and supply gap between resources and ever increasing demand, it is of prime importance to conserve the natural resources with proper prioritization for its sustainable development. The present work mainly analysis of rainfall intensity for Kunigal Taluk. The study area of Kunigal taluk is located in southern part of Tumkur district in Karnataka state. The taluk covers an area of 981 Sq.km. and average rainfall of 802mm . The area is bounded by the latitude North $12^0$44'38.74" to $13^0$8'1.16" and the longitude East 76^0 49' 43"to 77^0 9' 57". The main part of the area is covered under Survey of India (SOI) Toposheet numbers 57 C/16, 57 G/4, 57 D/13, 57 C/12, 57 D/9, and 57 H/1 (Scale 1:50,000) and having eight rain gauge stations each rain gauge stations of monthly of pre monsoon, south west monsoon and north east monsoon rainfall data is analyzed from 1901-2011. The study of uneven distribution of rainfall causes scarcity fresh water/potable water, agriculture purpose, etc. The water table fluctuation under the influence of rainfall and drought. The rain fall data is analyzed by time series and its components, and by conventional methods. Here we are mainly discussing about rainfall data and its intensity throughout the year, and water table fluctuation data by graphical method, and using software for the analysis of the rainfall to know variation of its value across a vast area in a systematic manner using Arc view 3.2a software and DBF files.

Keywords: *Rain gauge station, time series, water level fluctuation, Arc view 3.2a etc…*

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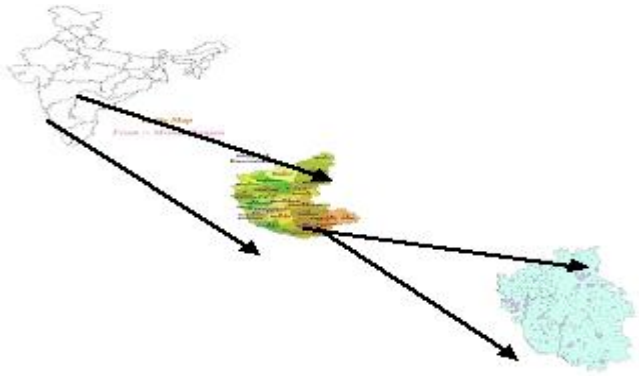
1. INTRODUCTION

Rainfall is the key climatic variable that governs the regional hydrological cycle and engineering design projects including water design etc. Rainfall is the only source for both surface and ground water resources in the world. The evaporated water when condensed at the high altitude in the form of clouds, at high altitude due to reduction in the atmospheric pressure these water vapors expand by absorbing energy from the surrounding air, which cools down. The capacity of the atmosphere at the high altitude depends on its temperature, humidity, wind direction and wind speed. When it falls below the due point, it cannot retain the excessive moisture, which starts falling in the form of rain, hails, dew sleet, precipitation. Changing precipitation pattern, and its impact on surface water resources is an important climatic problem facing society today associated with global warming, there is strong indication that rainfall changes are already taking place on both the global and regional scales. Variation in the monsoon rainfall has both social and political impact in India, agricultural activities are largely depends on rain.

1.1 Location of Study Area

The study area of Kunigal taluk is located in southern part of Tumkur district in Karnataka state. The taluk covers an area of 981 Sq.km. and average rainfall of 802mm . The area is bounded by the latitude North $12^0$44'38.74" to $13^0$8'1.16" and the longitude East 76^0 49' 43"to 77^0 9' 57". The main part of the area is covered under Survey of India (SOI) Toposheet numbers 57 C/16, 57 G/4, 57 D/13, 57 C/12, 57 D/9, and 57 H/1 (Scale 1:50,000). Tumkur district was formed in 1966 under Nandidurga division; the district is having geographical area of 10648 sq. km. Tumkur district falls in the southern dry agro-climatic zone. The average temperature of district is 40° C .the location of study area is shown in Map No 1.



Map No 1: Location map of study area.

1.2 Measurement of Rainfall

Rainfall and other forms of precipitation are measured in terms of depth, the values being expressed in millimeters. One millimeter of precipitation represents the quantity of water needed to cover the land with a 1mm layer of water, taking into account that nothing is lost through drainage, evaporation or absorption. Instrument used to collect and measure the precipitation is called rain gauge. Rainfall varies greatly both in time and space with respect to time – Temporal variation, with space – Spatial variation. The temporal variation may be defined as hourly, daily, monthly, seasonal variations and annual variation (long-term variation of precipitation), and spatial variation is due to space, time and geographical area.

1.3 Objectives of Study

In the study area total 108 years rainfall data is collected and it is analyzed by the conventional methods and non conventional methods To analyze the rainfall data (1901 to 2011) of Kunigal taluk, Tumkur by a standard methods which is mentioned below. Interpretation of South-west, North-east monsoons over an area about 108 years.

2. METHODOLOGY

The rainfall details collected in monthly wise of 108 years in the eight locations in the Kunigal taluk prior existing rain gauge stations in taluk currently maintained by KSDMC and analyzed conventional methods such as arithmetic mean method Thiessen polygon method, and non conventional methods are Thiessen polygon using Arc GIS software. . Rain fall data is analyzed by time series followed by the trend variation, the seasonal variation, and also by moving average method of three years and five years .

2.1 Computing Average Rainfall:-

2.1.1 Airthematic Mean Method:-

$$\bar{p} = \frac{p_1 + p_2 \ldots + p_i + \cdots + p_n}{N} = \frac{1}{N}\sum_{i=1}^{N} p_i$$

2.1.2 Thiessen Polygon Method

$$\bar{p} = \frac{\{P_1A_1 + P_2A_2 \ldots\ldots\ldots + P_mA_m\}}{(A_1 + A_2 + \cdots + A_m)} = \sum_{i=1}^{m} P_i \frac{A_i}{A}$$

Where: The ratio $(\frac{A_i}{A})$ is called the weight age factor of station i.

2.1.3 Moving Average Method

$$F_{(t+1)} = \frac{\sum(\text{Most Recent K data values})}{K}$$

i.e.,

$$F_{(t+1)} = \frac{(A_1 + A_2 + A_3)}{K}$$

For 3-years moving average similarly for 5- years where $F_{(t+1)}$ - Forecasting period values, t- Time / period A - Actual value of the time series in period.

2.1.4 Drought Calculations:-

$$\%drought = \left(\frac{P(1, 2, 3 \ldots)}{\sum P} - 1\right) * 100$$

3. RESULTS

The table 1 shows the average annual rainfall from the 2001 to 2010 the maximum rainfall accrued the taluk during 2001-2010 is 883.94mm and minimum rainfall is 668.77mm. Thiessen polygon area of the concern raingauge station is as shown below and the total entire area of the taluk will be 981 sqkm .

Table 1 Annual rainfall and Theissen polygon area

SL.NO	STATIONS	ANNUAL RAINFALL (2001-2010)	Thiessen polygon area Sqkm
1	Amruturu	786.97	131.6596
2	Bilidevalaya	668.77	186.2881
3	Huliyurudugra	877.24	216.9549
4	Kunigal S F	855.48	82.24542
5	Kunigal T B	798.09	54.47195
6	Markonahalli	685.84	109.2605
7	Nidasale	762.66	59.55078
8	Santhepete	883.94	141.1155
9	Maximum	883.94	216.9549
10	Minimum	668.77	54.47195

3.1 Drought Calculations

The table 2 is shown the drought calculations of the study area from the 1901 to 2010 of pre monsoon south west monsoon and north east monsoon the NR = Normal rainfall, SLD = slight drought, MD = Moderate drought, SR = Sever drought.

Table 2 Drought calculations.

	total rainfall	NR	SLD	MD	SD	Min.	Max.	Mean	SD
Pre monsoon (1-4)	168.28	56	17	22	14	54	375	115	73.17
south west monsoon (5-8)	413.03	60	18	23	8	123	864	398	153.1
north east monsoon (9-12)	220.67	58	18	17	16	10	604	206	11.2

Rainfall calculations of 108 years of pre monsoon , south west monsoon and north east monsoon as shown in table 3, 4,&5 .

Table 3 pre monsoon rainfall statists

Year (1901-2011)	Jan	Feb	Mar	Apr	May	Pre-Monsoon
AVG	2.28	2.82	11.41	43.3	108.4	168.28
MIN	0	0	0	0	4	54
MAX	64	33	164	174	290	375
SD	7.98	6.94	30.79	39.93	53.89	73.19
VAR	53.8	43.5	906.4	1535.8	2814.1	5354.5

Table 4 South west monsoon statists

Year (1901-2011)	Jun	Jul	Aug	Sep	South West Monsoon
AVG	67.3	81.2	114.5	149.9	413
MIN	0	11	4	0	123
MAX	185	282	413	388	864
SD	43.1	54.5	81.97	91.95	153.1
VAR	1888.4	2976.7	6720.5	8456.5	23462.1

Table 5 North East monsoon statists

Year (1901-2011)	Oct	Nov	Dec	North East Monsoon	Total
AVG	156.4	54	10.1	220.67	802
MIN	0	0	0	10	292
MAX	421	365	126	604	1322
SD	91.55	57.3	18.9	111.22	207.08
VAR	8383.2	3290.6	359.03	12370.5	42886

3.2 Thiessen Polygon Area

The Thiessen polygon is studies performed by using Arc GIS 3.2a and Arc view software, fig 1 shows the construction of Thiessen polygon with concern rain gauge stations existing in Kunigal taluk, area of the each polygon is calculated and tabulated in table no 1.

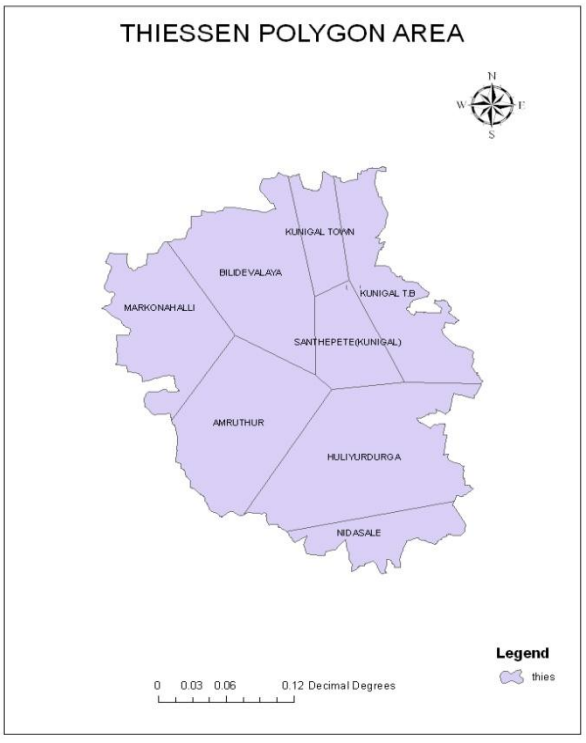


Fig 1 Thiessen polygons of Kunigal area

4. CONCLUSIONS

The graph of pre monsoon, south-west & north-east monsoons shows the increasing trend rainfall in which it shows Kunigal taluk receives normal rainfall of 802 mm annually, 413 mm in south-west Monsoon, 221mm during North-East Monsoon and 168 during Pre-Monsoon season. Therefore, the average annual rainfall of Kunigal taluk is 802mm and the standard deviation of this taluk is 20.708. Hence, the co-efficient of variation is 25.821 . From the three years and five years moving average calculations the rainfall for three and five years maximum and minimum rainfall will be notified and the average rainfall of the entire taluk from 1901-2011will be analyzed and trend analysis is tabulated. And the coefficient of variance C_v of rainfall is about 25.82% during annually, 37% in South-West Monsoon, 50.4% in North-East Monsoon & 43.48% in Pre-Monsoon season. Maximum rainfall received during the end of September & in the October and particularly during 40th to 45th standard Weeks. The trend line shows the increasing pattern of rainfall.

ACKNOWLEDGEMENTS

The special thanks to Dr V.S Prakesh Director and Dr Srinivasa reddy scientist KSDMC for the providing the rainfall data

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BIOGRAPHIES

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The below table (Q1= jan+feb+mar+apr) followed remaining Q2, Q3 &Q4 , shows the moving average of rainfall throughout the year in every monthly data is tabulated and formulated as show in table no 6.

Table 6 Rainfall data with seasonal

YEAR	Q1	Q2	Q3	Q4	Total Rainfall	3yr-moving avg	5yr-moving avg
1901	16	220	468	307	1011	-	-
1902	0	121	176	213	510	-	-
1903	0	293	530	385	1208	-	-
1904	0	158	258	175	591	909.67	-
1905	41	158	236	117	552	769.67	-
1906	11	128	766	241	1146	783.67	774.4
1907	18	267	205	68	558	763	801.4
1908	0	166	110	16	292	752	811
1909	23	200	417	279	919	665.33	627.8
1910	0	171	458	341	970	589.67	693.4
1911	0	193	132	206	531	727	777
1912	0	179	443	221	843	806.67	654
1913	6	217	457	87	767	781.33	711
1914	0	137	241	228	606	713.67	806
1916	0	225	520	284	1029	738.67	743.4
1917	70	269	545	175	1059	800.67	755.2
1918	16	173	310	178	677	898	860.8
1919	18	247	194	270	729	921.67	827.6
1920	1	147	196	60	404	821.67	820

1921	7	175	362	252	796	603.33	779.6
1922	11	286	242	401	940	643	733
1923	47	194	263	24	528	713.33	709.2
1924	1	151	367	32	551	754.67	679.4
1925	2	226	450	217	895	673	643.8
1926	11	152	338	120	621	658	742
1927	0	138	410	45	593	689	707
1928	12	96	316	319	743	703	637.6
1929	7	207	327	278	819	652.33	680.6
1930	0	207	168	358	733	718.33	734.2
1931	11	219	235	180	645	765	701.8
1932	0	209	288	494	991	732.33	706.6
1933	0	208	694	195	1097	789.67	786.2
1934	0	140	107	205	452	911	857
1935	0	172	463	302	937	846.67	783.6
1936	82	190	404	175	851	828.67	824.4
YEAR	Q1	Q2	Q3	Q4	Total Rainfall	3yr-moving avg	5yr-moving avg
1937	28	289	191	159	667	746.67	865.6
1938	13	131	625	10	779	818.33	800.8
1939	4	264	287	604	1159	765.67	737.2
1940	0	345	232	321	898	868.33	878.6
1941	0	213	232	190	635	945.33	870.8
1942	0	285	222	254	761	897.33	827.6

1943	17	268	318	407	1010	764.67	846.4
1944	142	245	336	176	899	802	892.6
1945	0	298	222	95	615	890	840.6
1946	18	123	309	330	780	841.33	784
1947	9	144	241	115	509	764.67	813
1948	7	241	222	157	627	634.67	762.6
1949	0	83	417	296	796	638.67	686
1950	0	170	332	276	778	644	665.4
1951	0	305	382	143	830	733.67	698
1952	0	217	297	416	930	801.33	708
1953	0	216	230	351	797	846	792.2
1954	5	341	247	171	764	852.33	826.2
1955	39	309	449	222	1019	830.33	819.8
1956	0	214	92	488	794	860	868
1957	19	325	212	308	864	859	860.8
1958	21	446	207	178	852	892.33	847.6
1959	0	279	440	91	810	836.67	858.6
1960	8	269	512	266	1055	842	867.8
1961	10	246	109	198	563	905.67	875
1962	22	270	339	248	879	809.33	828.8
1963	0	155	202	286	643	832.33	831.8
1964	0	182	496	361	1039	695	790
1965	0	166	328	68	562	853.67	835.8

1966	0	169	429	259	857	748	737.2
1967	7	189	191	133	530	819.33	796
1968	14	263	187	87	551	649.67	726.2
1969	0	200	208	306	714	646	707.8
1970	14	318	282	208	822	598.33	642.8
1971	30	178	456	147	811	695.67	694.8
1972	0	334	329	207	870	782.33	685.6
1973	0	294	599	395	1288	834.33	753.6
1974	4	250	561	153	968	989.67	901
1975	34	225	716	347	1322	1042	951.8
1976	0	163	276	135	574	1192.67	1051.8
1977	37	388	361	453	1239	954.67	1004.4
1978	0	139	367	175	681	1045	1078.2
1979	17	132	309	189	647	831.33	956.8
1980	0	307	350	199	856	855.67	892.6
1981	0	201	422	136	759	728	799.4
1982	0	258	187	53	498	754	836.4
1983	0	200	377	142	719	704.33	688.2
1984	172	131	351	204	858	658.67	695.8
1985	61	217	440	84	802	691.67	738
1986	17	107	476	125	725	793	727.2
1987	0	286	357	362	1005	795	720.4

1988	36	274	838	86	1234	844	821.8
1989	7	141	318	177	643	988	924.8
1990	1	213	143	248	605	960.67	881.8
1991	26	409	341	272	1048	827.33	842.4
1992	0	294	370	243	907	765.33	907
1993	0	277	389	243	909	853.33	887.4
1994	64	158	210	208	640	954.67	822.4
1995	18	121	388	108	635	818.67	821.8
1996	6	235	521	146	908	728	827.8
1997	0	227	462	169	858	727.67	799.8
1998	0	123	602	183	908	800.33	790
1999	4	199	401	390	994	891.33	789.8
2000	6	143	372	345	866	920	860.6
2001	0	153	370	207	730	922.67	906.8
2002	29	173	146	187	535	863.33	871.2
2003	35	66	201	236	538	710.33	806.6
2004	5	427	504	126	1062	601	732.6
2005	33	323	429	319	1104	711.67	746.2
2006	134	178	43	144	499	901.33	793.8
2007	0	337	479	144	960	888.33	747.6
2008	162	228	436	185	1011	854.33	832.6
2010	30	256	373	292	951	823.33	927.2
2011	15	299	291	264	869	974	905

The trend analysis map shows the slightly increasing trend but the rainfall is same because it is unevenly distributed. Shown in fig 2

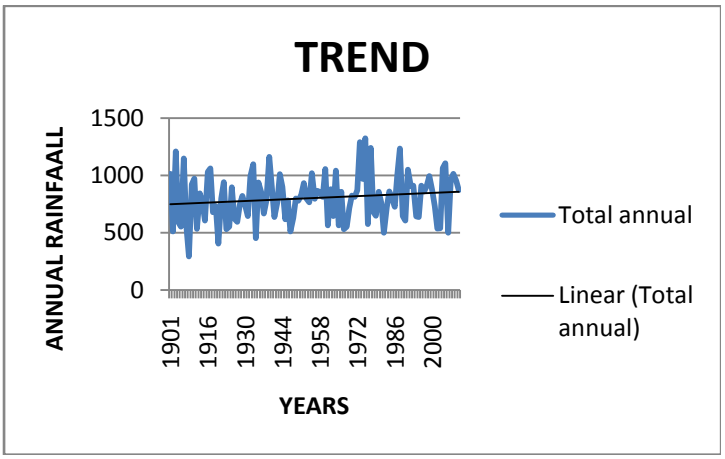

Fig 2 shows the trend analysis of rainfall (1901-2011)

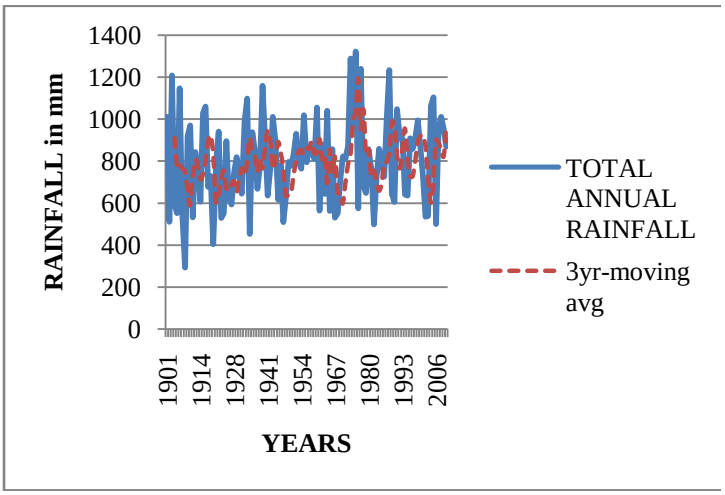

Fig 3 shows the 3y moving average of rainfall

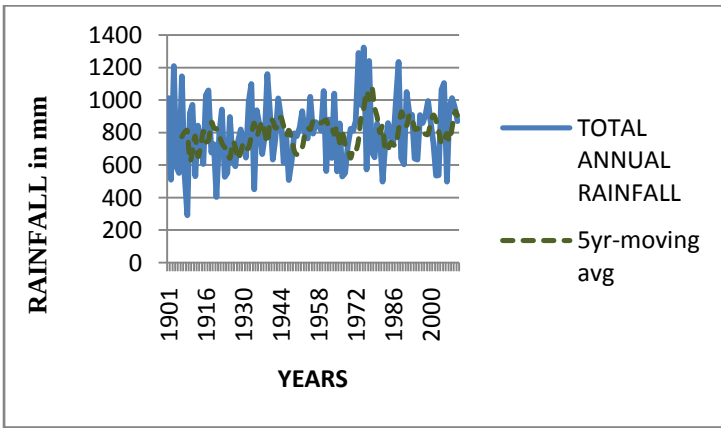

Fig 4 shows the 5y moving average of rainfall

Seasonal variation of rainfall (2001-2010) corresponding to table no 1.is shown in fig 6.

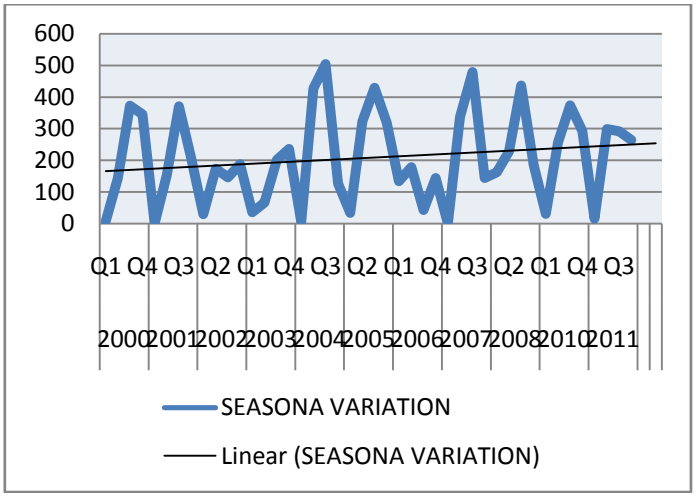

Fig 6 seasonal variation of rainfall

Seasonal variation of rainfall from 1901-2011 and each season wise like pre monsoon, southwest monsoon and North east monsoon is shown in the fig 8,9,&10

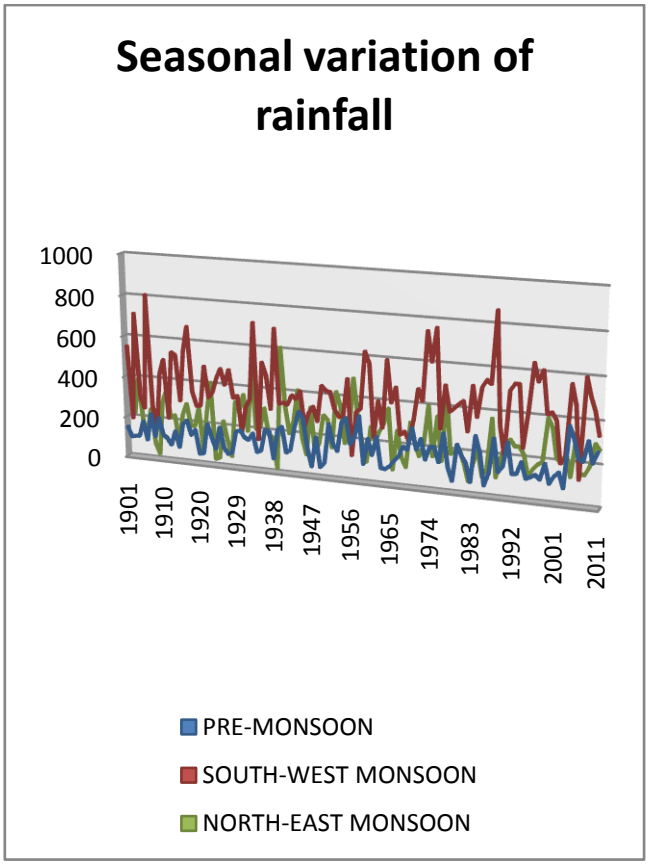

Fig 7 seasonal variation of rainfall(1901-2011)

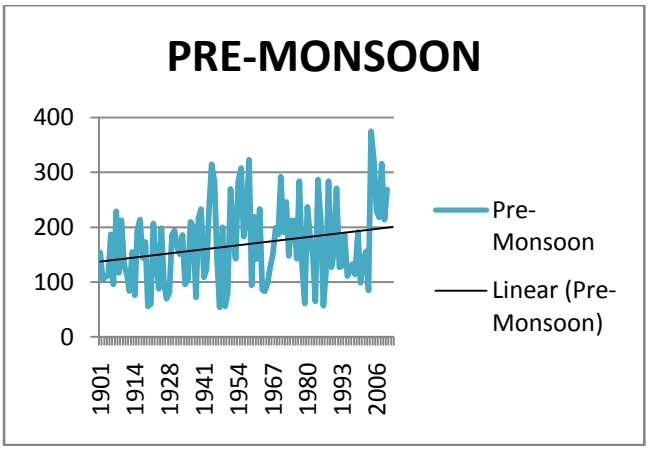

Fig 8 Pre monsoon rainfall (1901-2011)

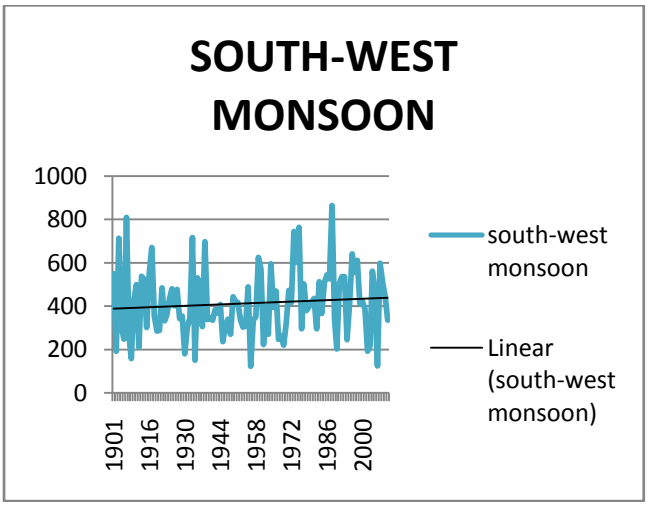

Fig 9 south west monsoon (1901-2011)

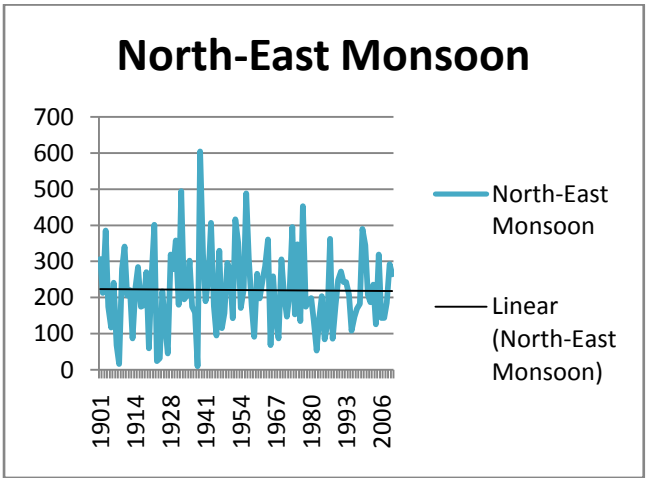

Fig 10 North east monsoon (1901-2011)