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Changing Spatio-Temporal Rainfall Fluctuation over North East India

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ABSTRACT

This study is analysis of changes in rainfall fluctuation in North East India. Using the longest instrumental monthly rainfall data of well spread 316 stations across India available from Indian Institute of Tropical Meteorology (IITM), the fluctuation characteristics as well as the spatial-temporal variability of the seasonal, monsoon monthly and annual rainfall pattern over the north eastern region of India (NER) have been examined. On an average, NER receives about 2450 mm of rainfall with 1093.0 mm as its annual evapo transpiration. The winter (JF) rainfall contributes 2.1% to the annual rainfall; summer (MAM) rainfall 24.3%; summer monsoon (JJAS) rainfall 65.1% and the post-monsoon (OND) rainfall contributes 8.5% to the annual rainfall. The region shows great variation in surface temperature regime (15°C to 32°C in summer and 0 to 26°C in winter). The spatial-temporal rainfall variability shows random fluctuating characteristics of expansion / contraction of desert area but overall it is showing a slight decreasing over the NER as well as whole India.

Keywords : Monsoon Rainfall, Spatio-Temporal rainfall, Variability, North East India, Climatic region

I. INTRODUCTION

India, with its annual rainfall of over 130 cm, varied topography and climatic regimes support and sustain diverse and unique wetland habitats. It occupies geographical area of 3,287,263 sq. km. (including territorial sea) on the southern plank of the Asian landmass (16, 20, 7, 6, 12). The country gets a variety of land use and land cover terrain consisting of permanently ice covered lofty Himalayan part in the north and a very vast Thar Desert plain in the south-western part of this Himalayan mountain ranges. The Great Indo-Gangetic plain which is well known for its fertile soils lies to the south of the Himalaya (17, 32, 27). The South of this plain is the peninsular India comprising of the uneven plateau which is surrounded by eastern coastal Plain in the east and western coastal plain in the west (32, 1, 6, 5). Indian landmass gets an abundance of sunshine from the tropical sun and splashing rains from the monsoons (3, 27). Due to large physiographic diversity coupled with large rainfall diversity (2). Long period area-average rainfall series of physiographic regions provides vital input to the study on influence of rainfall variability on land formation, flora and fauna, as well as environmental consequences of dynamics of wetland, dry land, desert, forest, grassland, drainage, etc. Studies on rainfall fluctuation over administrative

(states), meteorological sub-divisions, physiographic units and hydrologic units (basins/catchments) of the country have been reported (26, 20, 9, 24). The northeast area has witnessed severe soil erosion in its deforested uplands and ensuing downstream problems of siltation of waterways, reservoirs, irrigation works and aquatic ecosystems (2, 16, 3, 19, 26). Large efforts have been directed towards introducing soil conservation measures to upland dwellers that practices jhum cultivation, however, because of the uncertainty surrounding their tenure status, farmers were reluctant to invest in soil conservation and agronomic improvements as long as they could not be certain of reaping the benefits of their investment (28, 4, 5, 24). Although some important restraints to improved land husbandry were of a socio-economic nature, the study also identified a number of physical research questions related to the impact that changes in soil conservation management on the bench-terraced hillsides can be expected to have on crop water use, surface runoff generation, soil loss and subsequent transport of sediment through the drainage network (16, 18, 9, 31, 11).

II. STUDY AREA

The study area consists of the state of West Bengal and the North East India (NEI) of India comprises of the states of Arunachal Pradesh, Assam, Manipur, Nagaland, Mizoram, Sikkim and Tripura. The region stretches between 21°50' and 29°34' N latitude and 85°34' and 97°50' E longitude. The region has a geographical area of 26.2 million hectare with about 60% of its total area are under forest cover (9, 11, 29). The North Eastern Region of India is characterized by a unique physical setting dominated by extremely dynamic earth processes, intensely powerful monsoon rainfall system, active seismic city and a rich biological and cultural diversity (8, 12, 14). The study India of this region of India and adjoining parts of Myanmar, China, Bhutan, and Bangladesh comprise one of the most active seismic regions of the world.

OBJECTIVE

1. To analysis features of rainfall in India.
2. To understand the rainfall fluctuations over the India.
3. To understand the rainfall fluctuations in North East India.
4. To study of spatial – temporal rainfall variability in India.
5. To study of spatial – temporal rainfall variability in North East India.

III. DATABASE AND METHODOLOGY

Instrumental monthly rainfall data from a well spread network of 316 rain gauge stations (25, 23, 32, 10) from earliest available year up to 2006 have been used in the present study. Missing observation in the continuous data sequence has been filled by the ratio method (17, 34, 11, 26) using nearest available observation as reference value. Number of filled values is less than 2% of the total number of monthly rainfall records.

IV. RESULT AND DISCUSSION

To understand nature of spatial variation of the monsoon rainfall variation in the area under four specified rainfall conditions is examined using data from well spread 316 locations (18, 13, 15). Studies on spatial variability of rainfall rely on the premise that during deficient rainfall years relatively dry areas spread over wet areas and vice versa (30, 23, 20). Longest instrumental area-averaged annual, seasonal and summer monsoon monthly rainfall series for the whole country as well as the North east India have been developed in two parts: (i) simple arithmetic mean for the period with all available observations from the selected network and (ii) construction by applying established objective method for the period with lesser available observations (33, 21, 5, 25, 22). The complete process and computational steps are

described step by step in abstract statistics mean, median, standard deviation (SD), coefficient of variation and the quantiles (Q_1, Q_2, Q_3, Q_4)) for the rainfall series of whole country and the north east India based on the period 1901–2000 are tabulated in (Table 1 & 2) for the benefit of the users. Mean is measure of central tendency, standard deviation and coefficient of variation gives the nature of variability while quantiles are measures of the frequency distribution which divides the rainfall sequences in five equal parts (4, 2, 11, 13, 21, 28). The table also lists the Index of Areal Representativeness (IAR), the mean correlation coefficient (CC) between the area-averaged series and the individual stations (R) and the mean of CC between all possible combinations of rain gauges that are averaged (r).The IAR is defined as the ratio of "variance of area-averaged rainfall series" to the "mean variance of the individual rainfall series averaged" expressed in percentage and it provides a measure of spatial representation of the area-averaged rainfall series (21, 13, 9). The mathematical expression of IAR is:

$$IAR = \frac{S_R^2}{\frac{1}{M}\sum_{i=1}^{M} s_i^2} \times 100 \qquad \ldots\ldots\ldots \quad \text{(i)}$$

That is,

$$IAR = \frac{\text{Variance of the area-averaged rainfall series}}{\text{Mean variance of the rainfall series at all stations}} \times 100$$

$$\ldots\ldots\ldots \text{(ii)}$$

The $\bar{R}$ is also an indicator of areal representation of area-averaged rainfall series and is very useful in theoretical derivation dealing with the problem of rainfall spatial variability. The $\bar{r}$ is a measure of spatial coherency in the rainfall field and the inverse of $\bar{r}$ provides a broad idea of number of observations optimally required to prepare that particular representative area-averaged rainfall series (1, 21, 34, 15, 17).

Table I

Important statistics and the parameters of the spatial coherency and representation of annual, seasonal and monsoon monthly area-averaged rainfall series (1901-2000) of the whole country

INDIA									
	Ann	Win	Sum	Sum Mon	Post Mon	Jun	July	Aug	Sep
Mean (mm)	1165.9	31.5	101.6	906.5	126.3	169.1	297.4	263.4	176.6
Median (mm)	1177.2	29.9	100.5	919.4	126.3	166.0	300.4	264.6	177.0
SD (mm)	105.8	13.4	21.3	88.2	35.2	37.1	40.5	37.6	42.2
CV (%)	9.1	42.5	21.0	9.7	27.8	21.9	13.6	14.3	23.9
Q1 (mm)	1060.7	18.2	81.9	831.09	92.8	138.0	270.5	232.8	137.0
Q2 (mm)	1143.2	26.5	91.7	893.3	113.8	161.4	291.1	250.1	161.8
Q3 (mm)	1190.6	33.0	106.2	944.1	130.7	176.1	310.4	279.4	185.5
Q4 (mm)	1244.0	42.7	119.3	978.7	150.6	201.7	328.3	296.7	213.5
$\bar{r}$	0.13	0.17	0.15	0.11	0.19	0.14	0.08	0.07	0.11

$\bar{R}$	0.37	0.41	0.36	0.34	0.42	0.37	0.28	0.28	0.34
IAR (%)	11.1	13.5	6.9	9.8	12.2	10.8	7.0	6.9	11.7

Table 2

Important statistics and the parameters of the spatial coherency and representation of annual, seasonal and monsoon monthly area-averaged rainfall series (1901-2000) of the North East India.

North East India									
	Ann	Win	Sum	Sum Mon	Post Mon	Jun	July	Aug	Sep
Mean (mm)	2159.6	41.1	430.2	1509.9	178.5	400.5	434.7	376.0	298.8
Median (mm)	2171.2	40.8	429.6	1517.4	183.4	403.3	434.0	372.9	297.4
SD (mm)	176.9	21.3	86.3	124.7	69.5	67.4	72.6	66.3	60.9
CV (%)	8.2	51.8	20.1	8.3	38.9	16.8	16.7	17.6	20.4
Q1 (mm)	2001.6	23.8	350.3	1400.4	113.0	342.6	376.1	314.0	238.8
Q2(mm)	2124.9	36.5	407.7	1472.7	148.3	383.1	417.1	354.7	280.6
Q3(mm)	2214.3	44.0	442.0	1544.7	199.5	413.7	448.6	386.4	311.5
Q4(mm)	2322.7	54.8	492.1	1605.6	232.5	453.1	504.1	428.3	340.7
$\bar{r}$	0.15	0.35	0.25	0.10	0.35	0.15	0.15	0.13	0.16
$\bar{R}$	0.43	0.61	0.52	0.36	0.61	0.42	0.41	0.40	0.43
IAR (%)	17.2	34.5	24.7	13.2	33.8	16.5	17.0	16.9	17.5

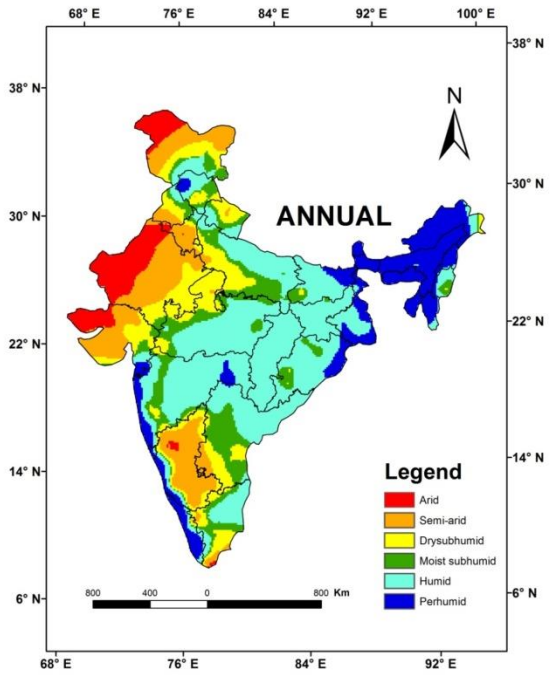

Fig.1: Map of the country showing climatic moisture regions

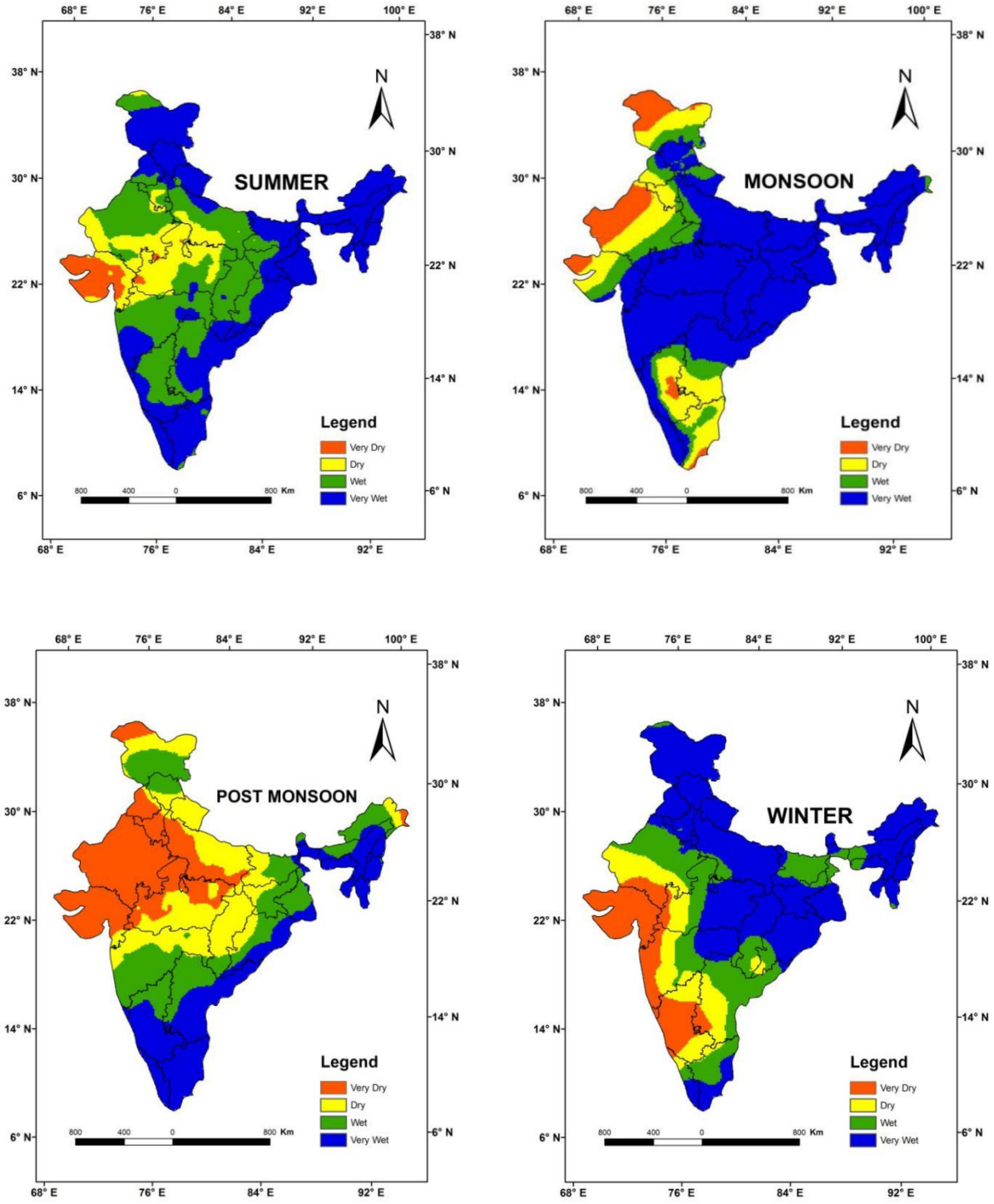

Fig. 2: Maps of the country showing climatic Dry and Wet zones during summer, monsoon, Post monsoon and winter season

The monthly rainfall data of well spread 316 stations across India obtained from the India Meteorological Department (IMD), Pune have been used to examine the fluctuation characteristics as well as the spatial-temporal variability of the seasonal, monsoon monthly and annual rainfall pattern (27, 5, 19, 7).

Thematic maps of the country showing the normal (1901–2000) position of the moisture regions and dry/wet condition of the seasonal and monsoon monthly have been prepared using state of the art ArcGIS 9.3 software (31).

Thematic maps of the country showing the normal (1901–2000) position of the moisture regions (Fig A.1) as well as their yearly positions have been prepared using state of the art ArcGIS 9.3 software. The different moisture regions of the country show large variations from one year to another. Overall climatic condition of the country shows drier tendency in the recent years/decades (19, 20, 15, 16). On the mean isohyetal seasonal and monthly rainfall chart of the country, the area of the country have been classified into four rainfall conditions, viz. very dry (VD), dry (D), wet (W) and very wet (VW).The thematic maps of the country showing the normal (1951–2000) position of the dry /wet conditions of the winter (JF) seasons, summer (MAM) season, summer monsoon (JJAS) season and post-monsoon (OND) season and four monsoon months (Fig 2) have been prepared using ArcGIS 9.3 software (1, 28, 30, 31).

V. NORTH EAST REGION (NER) OF INDIA

The study area, the North Eastern Region (NER) of India comprises of seven states of Arunachal Pradesh, Assam, Manipur, Nagaland, Mizoram, Sikkim, Tripura and the state of West Bengal has a geographical area of 26.2 million hectare with about 60% of its total area are under forest cover. The rainfall data for all the 25 stations (*Tezpur, Goalpara, Guwahati, Dibrugarh, Nowgong, Sibsagar, Silchar, Imphal, Tura, Shillong, Kohima, Demagiri, Haflong, Agartala, Cooch Bihar, Jalpaiguri, Darjeeling, Itahar, Malda, Sagar Island, Krishnan agar, Berahampore, Hooghly, Kolkata and Howrah*) of the selected network are available in this region. The longest instrumental All-India summer monsoon rainfall variations during 1813-2012 along with 9-point Gaussian low-pass filtered values have been displayed in (Fig.3). The NE region receives about 2450 mm of rainfall with 1093.0 mm as its annual evapotranspiration. The winter (JF) rainfall contributes 2.1% to the annual rainfall; summer rainfall contributes 24.3% to the annual rainfall; summer monsoon rainfall contributes 65.1% to the annual rainfall and the post-monsoon rainfall contributes 8.5% to the annual rainfall has applied an objective criterion '*continuous period with each of the monthly rainfall greater than 50mm*' to obtain start and cessation dates of normal rainy (or wet) season at stations across India (24, 11). The rainy season starts by 22nd March and ends by 21st October with its average duration 214 days. The average annual rainy days over this region is 114.4 days. The Cherrapunji-Mawsynram range receives rainfall as high as 11,500 mm, annually. The region shows great variation in temperature regime too. The temperature varies from 15^{o}C to 32^{o}C in summer and 0 to 26^{o}C in winter. The annual rainfall in the region is received mainly from south-west monsoon from middle of May and continues till October. Chief features of the rainfall fluctuations are as: Annual- 1848–1947 Normal(N), 1948–1982 Decrease(D), 1983–2006 Increase(I); winter- 1848–1978 D, 1979–1993 I, 1994–2006 D; summer- 1848–1947 N, 1948–1960 D, 1961–2006 I; summer monsoon- 1848–2006 D; post-monsoon- 1848–1887 D, 1888–2006 I; June- 1848–1896 D, 1897–1934 I, 1935–2006 D; July- 1848–1859 I, 1860–1887 D, 1888–1974 I, 1975–2006 D; August- 1848–1905 I, 1906–2006 D; and September- 1848–1878 I, 1879–1962 D, 1963–1987 I, 1988–2006 D. Dominant epochs of the annual rainfall fluctuation are: 1857-1883 wet, 1884-1909 dry, 1910-1956 wet and 1957-2003 dry. Over the north eastern range and its provinces, the respective annual mean potential evapotranspiration (PE) is significantly smaller than that of the annual rainfall received. This is an indicative of the annual excess water availability in this region but, being mostly hilly terrain with orographic barrier, requires a proper water resource management for its proper use (4).

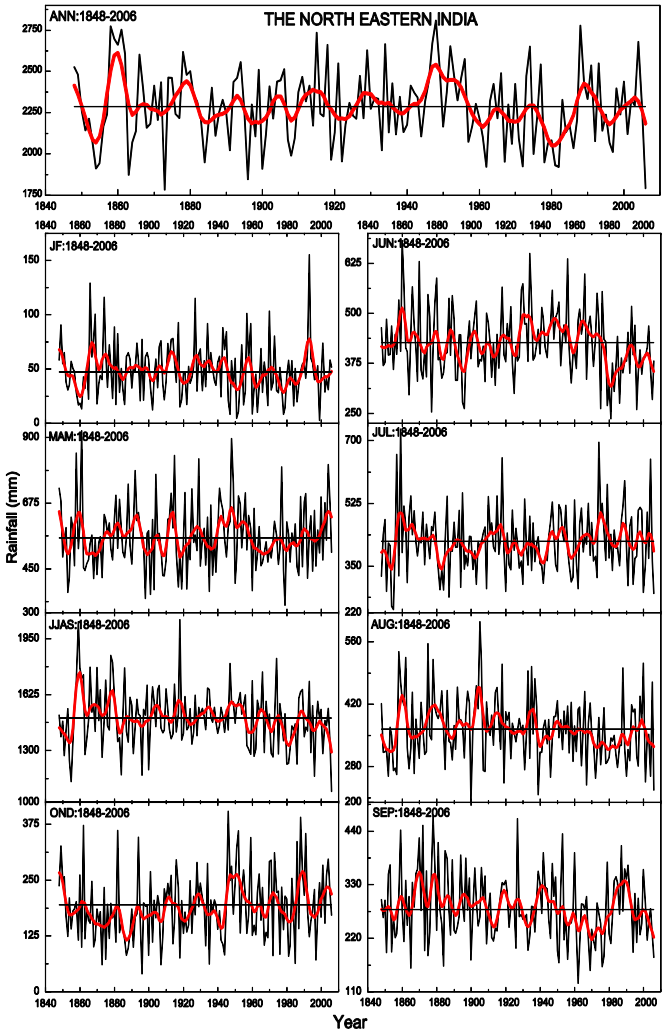

Fig . 3: Instrumental period time series plots of annual, seasonal and monsoon monthly rainfall over the North East India.

VI. CONCLUSION

The year-wise variability of the moisture region and dry/wet conditions is shows a random expansion and contraction with a large variation from one year to another. However, overall climatic condition of the country shows drier tendency in the recent years. Over the north eastern region, the annual mean potential evapotranspiration (PE) is significantly smaller than that of the annual rainfall received. This is an indicative of the annual excess water availability in this region but, being mostly hilly terrain with orographic barrier, requires a proper water resource management for its proper use.

Due to warmer atmosphere, the perceptible water (PW) has declined by 0.05mm from 24mm to 23.95mm) during the recent 30 years over India on annual scale but shows slight increasing during summer monsoon season. The monsoon monthly time series of the total cloud cover over the north east India and the whole India show a significant decreasing trend. Because of changes in the atmospheric conditions, the monsoon rainfall has lessened by 2.47% (from 948.53mm to 925.12mm).

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VIII. REFERENCES

[1]. Chavhan G. K., (2020) Role of Information in Development of Rural Farmers: A Case Study of Shevgaon Tahsil of Ahmednagar District (MS), Shodh Sarita, 7 (28), pp -91-94.

[2]. Chavhan, G. K., Salve, P. N., et al., (2020) Aarthik bhoogol, Prashant Publication, Jalgaon, pp- 1-312.

[3]. Chavhan, G. K., (2013) Socio- Economic Impact of Co-operative Sugar industries on Kopargaon tahsil of Ahmednagar district (M. S.): A Geographical Analysis, Interlink Research Analysis, 5 (VII), pp-49-57.

[4]. Chavhan, G. K., (2013) Weather Conditions Key Based Agricultural Insurance and Indian Cultivator: An Overview, Indian Streams Research Journal, 3 (XI), pp-1-2.

[5]. Chavhan, G. K., (2015) Analysis of Work Done During 1950 to 2000 on Sugar Industry and Socio-Economical Changes in India, International

Journal of Research and Scientific Innovation, 2 (IX), pp-110-113.

[6]. Chavhan, G. K., (2018) Past & Future Development of Co-operative Sugar Industry in India: A Regional Analysis, International Journal of Research in Social Sciences,Vol.8, 9(1), pp-286-294.

[7]. Chavhan, G. K., (2019) Changing Relationship between Human being and Environmental Resources: A Geographical Analysis, Changing Trends in Man & Environmental Relationship, pp-1-12.

[8]. Chavhan, G. K., (2019) Landuse Changes through Irrigation in Ahmednagar District: A Temporal Study, Research journey, Special issue, pp-142-146.

[9]. Chavhan, G. K., (2019/9), The Comparative Study of Pixel & Object based Techniques used in IRS-P6, LISS-IV Data, Rajesh Publication, New Delhi, pp-1-110.

[10]. Chavhan, G. K., (2020) A Brief Review of Common Health Problems in India, Current Major Issues in India, Current Major Issues in India, Volume 1, Redshine Publication, Lunawada, pp-93-95.

[11]. Chavhan, G. K., (2020) Analysis of Work done on Temporal Changes in Agricultural Land Use Pattern in India from 1985 to 2010, Agriculture and Forestry: Current Trends, Perspectives, 1, Immortal Publication, Vijaywada, pp-22-29.

[12]. Chavhan, G. K., (2020) Review of Research work done on Sex Ratio in Doctoral work in Pune University, Our Heritage, 68 (30), pp-8320-8325.

[13]. Chavhan, G. K., and Pagare, S. R. et. al. (2020) Analysis of Sustainable Agricultural Development in Ahmednagar District of Maharashtra (India), Waffen-Und Kostumkunde Journal, 11 (II), 250-258.

[14]. Chavhan, G. K., Najan, R. E., et al., (2020) Paryavarniy Bhoogol, Prashtant Publication, Jalgaon, pp- 1-292.

[15]. Chavhan, G. K., Pagare, S. R. (2018) The Past Perspective Views on Challenges ahead of Indian Economy, with Special reference of Planning Commission in India, Vidyawartha International Multidisciplinary Research Journal, Speical issue, pp -79-85.

[16]. NATMO (1986): National Atlas of India Physiographic Regions of India. Third edition, Plate 41, Prepared under the Direction of G.K. Dutt, Director NATMO (the National Atlas & Thematic Mapping Organization), Kolkata, India.

[17]. Rainbird A.F. (1967): Methods of Estimating Areal Average Precipitation, WMO/IHD Report No. 3, WMO, Geneva, 42 pp.

[18]. Singh H.N., Singh N., and Sontakke, N.A. (2009): Monitoring Large-scale rainfall variations across India, Hydroinformatics in Hydrology, Hydrogeology and Water Resources Edited by Ian D. Cluckie, Yangbo Chen, Vladan Babovic, Lenny Konikow, Arthur Mynett, Siegfried Demuth & Dragan A. Savic, IAHS Publ.(Red Book) 331, 2009, Pp. 514-522.

[19]. Singh HN and Singh N (2011): Water Resources and its Management in India. NE Quest Bulletin, North East Research Forum, March, 2011, 8 pp.

[20]. Singh N, Sontakke NA, and Singh HN. (2005a): Longest instrumental rainfall series of physiographic divisions/subdivisions and provinces of India: 1871-2003, Volumes IV (210 pp, Sup A3), IITM, Pune.

[21]. Singh N. (1994): Optimizing a network of raingauges over India to monitor summer monsoon rainfall variations. International Journal of Climatology, 14: 61-70.

[22]. Singh N., Mulye S.S., Pant G.B. (1992): Some features of the arid area variations over India: 1871-1984, Pure and Appl. Geophys., 138, pp. 135-150.

[23]. Singh N., Sontakke N.A. and Singh H.N. (2005b): Indian Atlas of Rainfall Spatio-temporal variations, Volumes I (322 pp, Sup A3), IV (210 pp, Sup A3), IITM, Pune.

[24]. Singh, N., 1986: On the duration of the rainy season over different parts of India, Theor. Appl. Climatol., 37, 51-62.

[25]. Sontakke N.A., Singh H.N., Singh N. (2008): Chief Features of Physiographic Rainfall Variations

across India during Instrumental Period (1813-2006). IITM Research Report No. 121, 132 pp.

[26]. Tribhuvan L.K., Anita B., (2014): Impact of Changing Climatic Scenario on Environmental processes over North Eastern India Using RS-GIS.

[27]. Tribhuvan L.K., (2020) Contribution of Arab School of Geographical thought, PG Notes.

[28]. Tribhuvan L.K., (2020) Visual Image Interpretation Techniques, PG Notes.

[29]. Tribhuvan L.K., (2020) Arc GIS Software Introduction, PG Notes

[30]. Tribhuvan L.K., (2020) Introduction of Remote Sensing, PG Notes.

[31]. Tribhuvan L.K., (2020) Topic no.1: Introduction to Geographical Information System, PG Notes.

[32]. Tribhuvan L.K., (2020) Topic no. 3: Data Model, PG Notes.

[33]. Wigley T.M.L., Briffa K.R., Jones P.D. (1984): On the average value of correlated time series, with application in dendroclimatology and hydrometeorology. Journal of Climate and Applied Meteorology, 23, pp. 201-213.

[34]. Winstanley D. (1973): Rainfall patterns and general atmospheric circulation, Nature (London), 245, pp. 190-194.

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