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RESEARCH ARTICLE

ASSESSMENT OF RAINFALL VARIATION OF A VICENNIUM BY GEOGRAPHICAL INFORMATION SYSTEM (GIS)

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ABSTRACT

The current paper is an attempt to analyze the spatiotemporal variations in the average annual rainfall of Churu district for two decades. Rainfall data such as annual rainfall and number of rainy days of the study area were collected for the period (2000-2021). The method of interpolation used was Inverse Distance Weighting (IDW) method in QGIS software. The generated maps exhibited trend of increasing rainfall amount and a slow increasing pattern in rainy days of Churu district. The south-western part of the Churu district get the lowest rainfall and the north-eastern part get the maximum rainfall. The analysis of the rainfall data of Churu district displayed the maximum rainfall and minimum rainfall in the year 2011 and 2002 correspondingly. The spatial temporal study of rainfall distribution in the district would help to solve the drinking water and agricultural water scarcity in rural and urban areas of the district. The study could be utilized for maximum crop production by applying effective crop management systems.

KEYWORDS

Rainfall distribution; QGIS; Interpolation; Inverse Distance Weighting (IDW), Churu.

1. INTRODUCTION

Water has become a concerned issue in the contemporary world. Water pollution is generated by humans primarily by overexploiting resources of ground water and discharging toxic substances in water bodies. have generated water pollution. Which has become a common environmental issue. An estimation states that water-based risks would be faced by over half of the world's population by 2025 (Kulshreshtha, 1998). Water in the form of rainfall is a crucial factor in agriculture. The whole agriculture of India reliant on the rainy season. The monsoon recharges the ground water level and replenishes all water resources. Rainfall is also an important climatic factor which is immensely affected by climate change. The frequency and duration of rainfall is uncertain. It varies with place and time. Hence, it is crucial to measure, and record data related to rainfall for decades.

Rainfall analysis of Rajasthan represents variation throughout of it. Maximum rainfall comes from the south-west monsoon during July to September. The mean rainy days usually fluctuates from 6 to 42 which depends on the aridity. The mean yearly rainfall range is found from 200 mm to 400 mm in Rajasthan. The highest rainfall (1000 mm) is experienced in the south-eastern part of Rajasthan, while the lowest rainfall (100 mm) is detected in western part of Rajasthan. The extreme temperature ranges from 0 ºC to 49 ºC. Churu district is a semi-arid area and it receives very less rainfall. It gets rainfall from summer as well as winter monsoon. Summer monsoon have two branches of arrival in Rajasthan. The first branch is from Arabian sea, from which Churu district receives very less rainfall due to its parallelism to the Aravalli Mountain ranges. The second summer monsoon branch, Bay of Bengal, also delivers less rainfall to Churu because it is a rain shadow area of the Aravalli Mountain range. Churu receives more rainfall from Bay of Bengal branch as compared to the Arabian sea branch. Churu shows infrequent rainfall pattern in winter monsoon due to weakened or delayed Western disturbances or abrupt cyclonic storms (Sangomla, 2023).

Studies have been done all over the world to assess the rainfall pattern at the local, regional, or global scale. Analysis of rainfall using interpolation method was done by several researchers (Taesombat and Sriwongsitanon, 2009; Li et al., 2010; Delbari et al., 2013; Lam et al., 2015; Kadir et al., 2016; Moeletsi et al., 2016; Wijemannage et al., 2016; Varouchakis et al., 2018; Mundhe et al., 2019; Pillai et al., 2015; Verma et al., 2020; Hari and Reddy, 2022; Fung et al., 2022). The present paper is an attempt to study the rainfall pattern of the Churu district with respect to time and place. The focus of the study was identification of the extreme zones using geographic information system (GIS). The research has been conducted to analyze the variation in the average annual rainfall of Churu district of 22 years from 2000 to 2021.

2. MATERIALS AND METHODS

Study area: Churu district is a part of Northern Rajasthan. Its boundary touches Hanumangarh district (North), Jhunjhunu district and Haryana state (East), Nagaur and Sikar districts (South) and Bikaner district (West). It lies between $27^0$24'31.50" to $29^0$00'01.74" of north latitudes and $73^0$50'39.45" to $75^0$40'31.85" of east longitudes. It does not have any drainage system. However, a small portion of eastern Churu shares Shekhawati river basin. Administratively, it is divided into seven blocks namely Churu, Ratangarh, Sardarsahar, Sujangarh, Rajgarh, Taranagar and Dungargarh. Although, it has eight weather stations located at Bidasar, Churu, Dungargarh, Rajgarh, Ratangarh, Sardarsahar, Sujangarh, and Taranagar. The location and extent of Churu district is shown in Figure 1.

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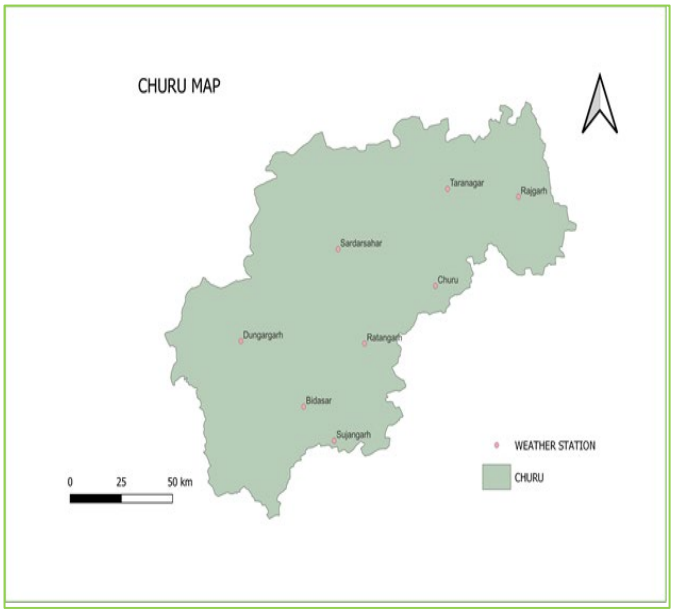

Figure 1: Map of Churu District showing weather stations.

2.1 Geology

The whole central and northern part of the district is occupied with primarily aeolian sand and partly by fluvial deposits. The southern part of the district has some exposures of hard rock covered by Marwar Super Group which includes the rock formation of sandstone, shales, and limestone. The small south-western part of the district (in Sujangarh block) occupies Erinpura granite and gneiss (PHED, 2013).

2.2 Topography

District Churu is a part of the Great Indian Thar Desert with sand dunes. The overall topography is an undulating plain area except hillocks in the south part of Churu. The general topographic elevation in the district is between 250-300 m above mean sea level (PHED, 2013).

2.3 Climate

Churu district is a part of the arid region with a dry climate. The area is recognized for the highest (more than 50 ^{0}C) and the lowest (less than 0 ^{0}C) temperature in India. There is a great variation in minimum and the maximum temperature of Churu. Average rainfall is 353.9 mm spread over three monsoon months of July to September (PHED, 2013).

2.4 Agriculture

According to Department of Agriculture (Extension), Zila Parishad, Churu and Ministry of Agriculture, the major crops of the area are Bajra, Moth, Moong, Guar, Wheat, Gram, Mustard oil seeds, fruits, and vegetables etc.

2.5 Forest

The district has only 6663-hectare area under the forest which is only 0.46% of the total area of the district. The vegetation cover in the district is almost negligible due to extremes of temperature during winter and summer and scanty rainfall established sand dunes inside Grass Reserves of inside areas, free from biotic interference, contain very poor and open forest (Rajasthan Foundation, 2023).

Figure 2 illustrates the flowchart of the methodology.

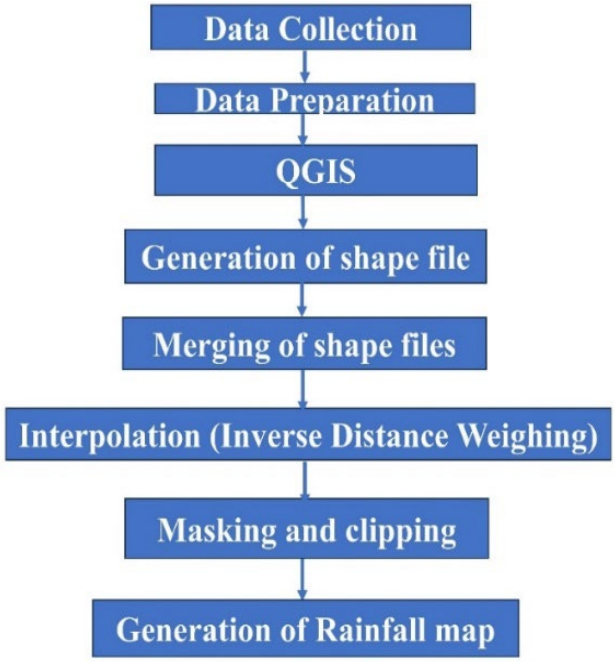

Figure 2: Flowchart of methodology.

2.6 Data

Rainfall related data were taken from the Department of Irrigation, Government of Rajasthan (Water Resources Department). The last twenty-two year's data (from 2000 to 2021) were collected from the department for the analysis.

2.7 GIS analysis

Annual rainfall and annual rainy days data of the Churu district from the year 2000 to 2021 was established in Microsoft Excel. These data were prepared in graphical form with a trend line. The data of year 2000, 2010 and 2020 were used in preparing the thematic map of Churu district of these three years with the help of QGIS.

2.8 Data processing with QGIS

Quantum GIS (QGIS) is a freely available geographic information system (GIS) software. Excel data was imported in QGIS. The most common GIS system i.e., interpolation was applied. Inverse Distance Weighting (IDW) interpolation method was used for the study. Maps were generated, and they were utilized for interpretations.

3. Results and Discussion

The data of rainfall and rainy days from 2000 to 2021 of Churu district were used to find out the average annual rainfall and average rainy days which is depicted in Tables 1-4 and Figures 3-4.

Table 1: Average annual rainfall of Churu district from 2000 to 2010.

Weather Station	Lati-tude	Longi-tude	Annual Rainfall (mm)										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Churu	28.3	74.97	230	413	288	570	253	444	251	449	636	165	635
Rajgarh	28.64	75.38	187	465	210	366	427	437	341	532	648	315	564
Ratangarh	28.67	75.03	184	297	78	446	250	217	226	415	431	245	713
Sardarshahar	28.44	74.49	317	336	110	366	151	355	243	303	502	220	556
Sujangarh	28.08	74.62	352	276	130	371	397	370	378	272	294	317	627
Taranagar	27.71	74.47	127	429	157	363	300	312	344	460	525	327	802
Dungargarh	28.09	74.01	283	209	73	442	115	431	202	231	369	199	417

Table 2: Average annual rainfall of Churu district from 2011 to 2021.

Weather Station	Annual Rainfall (mm)										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Churu	648	430	456	566	500	575	343	394	488	515	650
Rajgarh	680	431	453	502	453	746	531	344	627	500	748
Ratangarh	533	400	606	414	394	328	237	305	330	442	586
Sardarshahar	591	283	463	421	657	258	314	272	393	612	428
Sujangarh	509	665	564	461	554	407	395	301	578	304	620
Taranagar	1001	368	413	466	529	478	306	429	391	485	413
Dungargarh	380	193	466	371	495	346	289	237	259	235	360
Bidasar	-	-	-	-	-	-	-	-	528	537	705

Table 3: Number of rainy days in Churu district from 2000 to 2010.

Weather Station	Number of Rainy days										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Churu	19	26	14	26	22	30	17	32	36	19	36
Rajgarh	13	24	16	21	23	31	18	27	35	21	35
Ratangarh	14	23	10	27	17	17	15	24	27	14	35
Sardarshahar	10	17	11	20	13	29	18	25	29	14	22
Sujangarh	13	19	11	25	14	22	16	22	24	16	32
Taranagar	8	23	11	16	19	24	26	29	29	22	40
Dungargarh	14	15	7	21	12	28	14	20	29	16	23

Table 4: Number of rainy days in Churu district from 2011 to 2021.

Weather Station	Annual Rainy days										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Churu	33	22	31	36	35	28	25	24	27	31	38
Rajgarh	32	21	28	27	30	30	29	25	27	24	29
Ratangarh	30	26	36	26	21	17	21	20	25	30	27
Sardarshahar	32	20	28	24	38	20	21	20	26	36	29
Sujangarh	27	22	35	29	31	29	30	20	32	26	37
Taranagar	37	23	29	28	28	26	18	22	26	31	31
Dungargarh	28	19	29	28	32	24	21	12	20	21	25
Bidasar	-	-	-	-	-	-	-	-	26	37	40

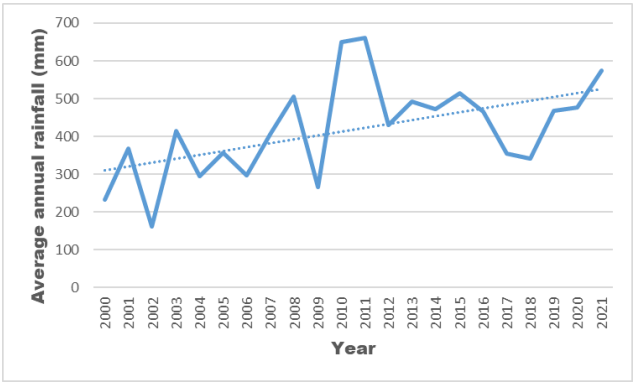

Figure 3: Average annual rainfall of Churu district from 2000 to 2021.

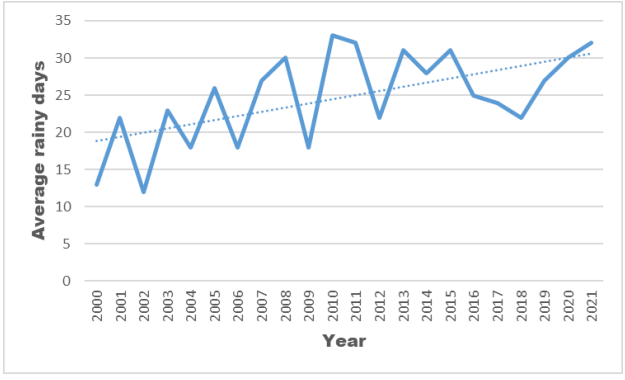

Figure 4: Average rainy days of Churu district from 2000 to 2021.

Churu district received average rainfall in the range of 162-660 mm in the last 22 years. In the year 2011, the average rainfall was the highest and it was the lowest in the year 2002. The mean rainfall figures showed a steady increase in the last years in Churu. While, the range of mean rainy days are 12-32 of the past twenty-two years. A consistent increasing pattern is observed for mean rainy days. The maximum and minimum average rainy days of the study area were 32 and 12 in the year 2021 and 2002 respectively. In last 10 years average rainy days are higher than 20 days and crossed 30 days line 6 times.

Rainfall distribution map of year 2000, 2010 and 2020: Figure 5 is rainfall distribution map of Churu district of the year 2000. Here, when we move north to south or east to west direction of Churu district, there is a decrease in rainfall. Further, Taranagar and Rajgarh blocks get the maximum rainfall. Sujangarh block get the lowest rainfall. Ratangarh and Dungargarh block get second position in the lowest rainfall in the region while Churu block gets an average rainfall.

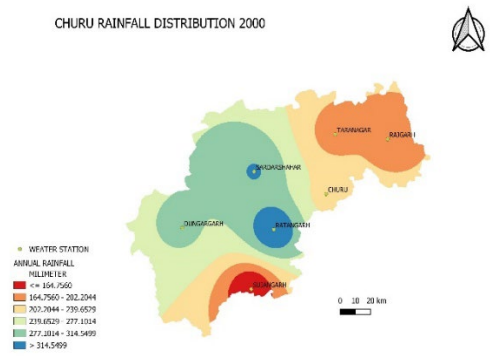

Figure 5: Churu district thematic map 2000.

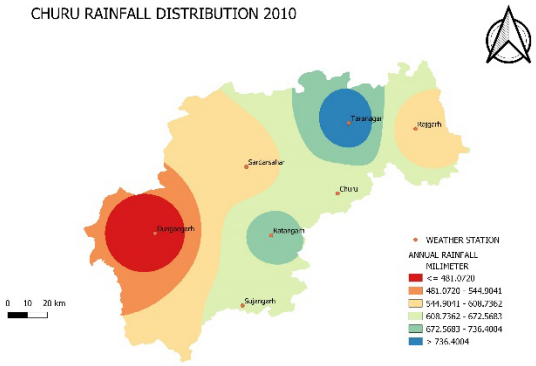

Figure 6: Churu district thematic map 2010.

Figure 6 is the map of Churu rainfall distribution of the year 2010. Distribution of rainfall in Churu district shows a decline pattern when going north to south or east to west. Taranagar and Rajgarh receive the highest rainfall in 2010 while Sardarsahar block shows second highest rainfall. Sujangarh block get the lowest rainfall. Ratangarh and Dungargarh block get second position in lowest rainfall in the region. However, Churu block gets an average rainfall.

Bidasar as weather station is added in Churu district in 2020 which makes total eight weather stations there. Figure 7 shows Churu rainfall distribution map of 2020. And it shows the same rainfall distribution pattern as depicted in years 2000 and 2010. The highest rainfall is observed in Sardarsahar block. The second highest rainfall is found in Taranagar, Churu and Rajgarh blocks. Though, Dungargarh and Sujangarh block get the lowest rainfall. The average rainfall pattern is shown by Ratangarh and Bidasar blocks.

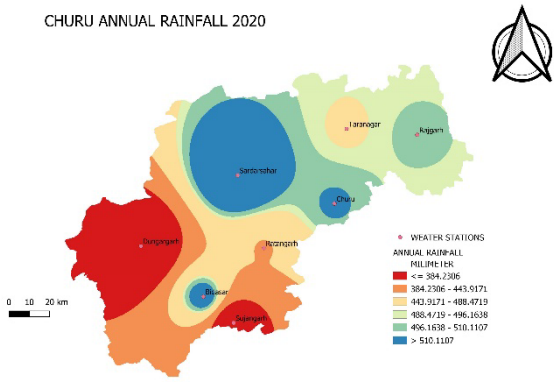

Figure 7: Churu district thematic map 2020.

Figure 8 is the thematic map of average rainfall of Churu from year 2000 to 2021. It is observed that the maximum rainfall was more than 542 mm in Bidasar block. Nonetheless, Dungargarh block receives the minimum rainfall (less than 348 mm).

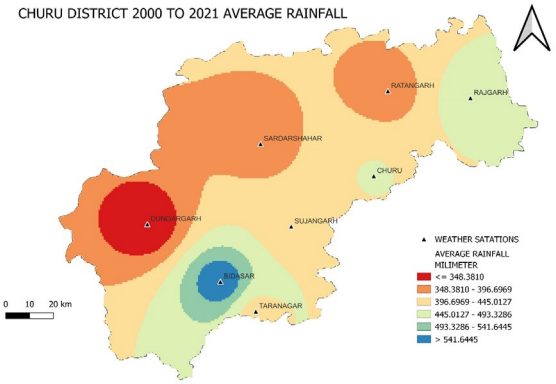

Figure 8: Thematic map of average rainfall of Churu district from year 2000 to 2021.

4. Conclusion

The two decades rainfall study of Churu district shows increasing trend in rainfall quantity and a slow increasing pattern in number of rainy days of Churu district. The south-western part of the Churu district get the lowest rainfall and the north-eastern part get the maximum rainfall. The analysis of the rainfall data of Churu district displayed the year 2011 as the highest precipitation year and the year 2002 as the lowest precipitation year of past twenty-two years study. The spatial temporal study of rainfall distribution in the district would help to solve the drinking water scarcity and agricultural water scarcity. The study could be utilized for maximum crop production by applying effective crop management systems.

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