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CLIMATE CHANGE IN THAR DESERT: A CASE STUDY OF CHURU TOWN, RAJASTHAN, INDIA

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Abstract: *Human induced climate change is the largest most pervasive threat to the natural environment and societies the world has ever experienced. Arid ecosystem is more prone to such phenomenon. Deserts are most typically associated with soaring temperatures, permanently dry air, and endless rolling sand dunes. But in summer in "Thar" desert, it becomes so cold and freeze. The Thar desert climate refers to a specific type of climate that encompasses more than one weather type. But for last one decade its changing in a very different ways, i.e., Too hot in summer and too cold in winter. It is an alarming situation of climate change, where we can understand with this small example. In Churu district of north Rajasthan, where the sandy ground sizzles in the summers and the wind feels like a hot air boiler in the month of June. The temperatures in those months easily climb up to the high 40^0 Celsius. Just month, May 2020, the temperature rose to 50^0 Celsius – and was the highest in the world. Two years, when the mercury breached even the 51^0 Celsius marks in Churu in early June 2019 – more than halfway to the boiling point of water – for many it was a side bar. Six months later, by December-January in some years, Churu has seen just-below zero degrees Celsius temperatures. And in February 2020, the India Meteorological Department found the lowest minimum temperature in the plains of India to be in Churu, at 4.1^0 Celsius. In view of above the present study has been undertaken to deliberate the climate change impact in small desert town.*

Key word: Arid Zone, Small Desert Town, Climate Change, Extremes of temperatures, Freeze Clod

Introduction

It is hard to imagine that global warming would have much effect on the world's already hot deserts. But even small changes in temperature or precipitation could drastically impact plants and animals living in the desert. In some cases, global warming is predicted to increase the area of deserts, which already cover a quarter of Earth (National Geographic). We are in the 21st century. The population is expanding, the demand for resources is increasing, the climate is changing and the impact of humanity on the earth is increasing day by day. There would be daunting challenges for human society and the environment in coming times to facilitate safe, sufficient, and secured resources for all dimensions of life. We must achieve a better quality of life for our growing population sustainably, without compromising the requirements of future generations to achieve the same**.**

Environmental changes, including changing rainfall patterns and vegetation, have affected Rajasthan's desert ecology, impacting local flora and fauna. The rainfall pattern of the state has been changing over the past three decades. According to the India Meteorological Department, there has been an increasing trend in the number of rainy days in the year, and heavy rainfall days during monsoons have risen in several districts. IMD's analysis says that between 1989-2018, a period of 30 years, there has been a "significant" increase in heavy rainfall days in the entire year, particularly for the western parts of the state. Heavy rainfall days indicate more than 65 mm of rain in a day. The analysis also points to an increase in the total number of rainy days in a year for several districts within the same period. The draft Rajasthan State Action Plan on Climate Change (Anon. 2022)) also says that the western part of the state shows an increasing trend of more than 2 mm of rainfall per year, and so does the south eastern part. "The annual maximum rainfall shows a positive trend in several grids spread all over Rajasthan," the action plan said.

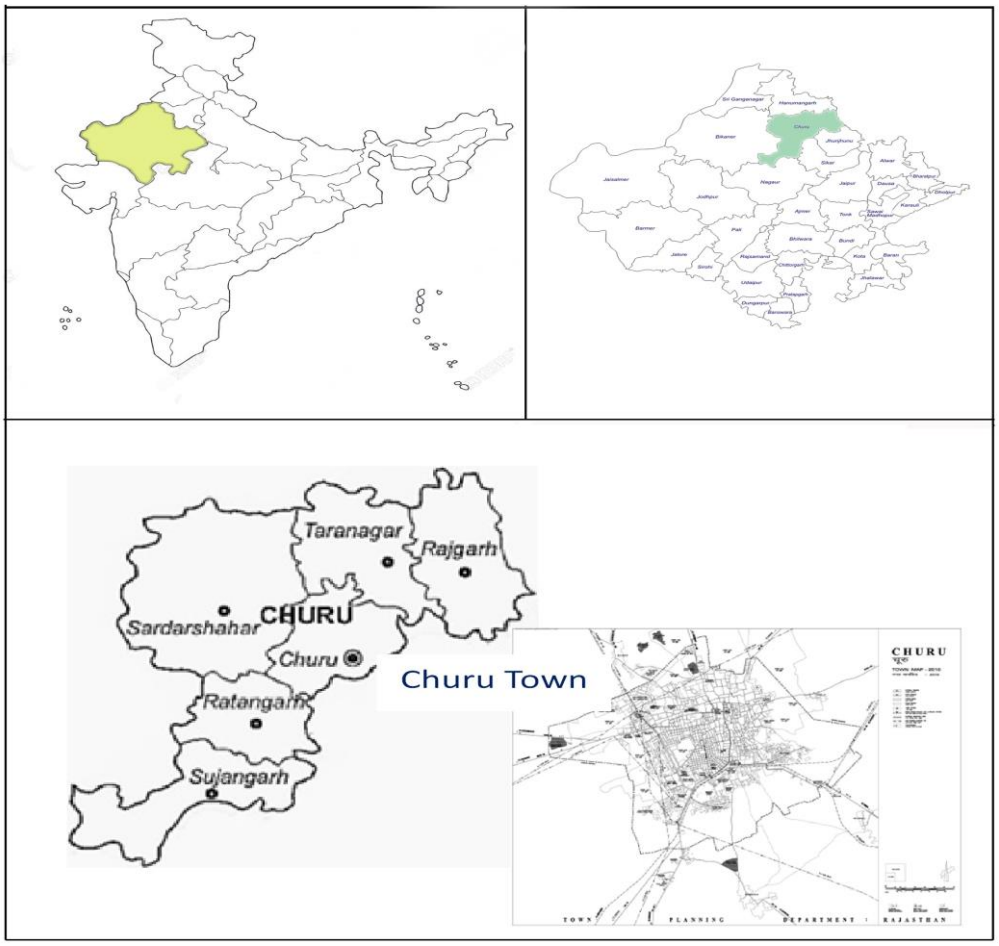
Over the last few decades, major efforts have been underway to boost agriculture and increase the state's green cover. The Indira Gandhi Nahar Project (IGNP), or the Indira Gandhi Canal, whose origin in 1952 was aimed at improving irrigation and drinking water facilities in Rajasthan, has played an important role in boosting agriculture. Sand deposition on the canal, however, was identified as a challenge. Hence shelter belt plantations on either side of the canal began to be carried out. In the same vein, afforestation efforts to stabilise shifting sand dunes were also carried out. Bare dunes were planted with 'brushwood and windbreaks, perpendicular to wind direction' so that the dunes do not interfere with the canal system and irrigated farmlands. Having said that, between1970 to 2013, there has been a 16 percent decline in sand dunes which is "a concern (Moharana *et al.* 2016).

Study Area

Churu town (area 45.0 Km^2 in 2011) is the headquarters of Churu district located in northern part of the Rajasthan State. It is positioned at latitude 28^0 18‟ north and longitude 74^0 58‟ east, at a height of about 286 meters above the mean sea level. Churu district with a total geographical area of 13835 Km^2 is located between 73^0 52' 40" and 75^0 40'30" east longitude and between 27^0 25'10" and 28^0 59'20". It is surrounded by Hanumangarh district in the north, Nagaur, Sikar and Jhunjhunu districts in the south. Hissar (Haryana state) district in the east and Bikaner in the west (Fig. 1). There are seven tehsil headquarters in this district. viz. Churu, Sujangarh, Bidasar, Ratangarh, Sardarsahar, Rajgarh and Taranagar. Churu is well connected by road network to all its neighbouring areas, along with metro-cities like Jaipur, Bikaner, Delhi, and other important cities. The National Highway 65 (Pali-Ambala) passes through the town.

The nearby towns of Sikar, Jhunjhunu, Hanumangarh, Fatehpur, Sardarshahar are very well connected by regional roads. The town is directly connected by broad gauge rail with Delhi, Jaipur, Bikaner, Sri Ganganagar. It is about 282 kms. from Delhi, 198 kms. from Jaipur and 180 kms. from Bikaner by rail. The nearest Airport is at Jaipur (206 kms.). Thus, the city is well-associated with several other big cities.

Figure 01: Study Area Key Map



Sources: Collected from India and Rajasthan State Government websites

The district is mosaic of sand dunes and interdune plains. About 92.26 percent area of the district is occupied by aeolian landforms mainly sand dunes and sandy undulating interdunal plains (CAZRI, 2012).

Climate

The climate of Churu city is hot and arid with large variation in temperature. Rainfall is scanty. The average temperature variation in summers and winters are 37.54^0 to 24.94^0 C and 29.05^0 to 9.15^0 C respectively. The maximum and minimum temperature recorded is 49.2^0 C in summer and -2.7^0 C in winter. Dust storm and thunder storm occur all through the summer and are particularly active in pre-monsoon period. The predominant wind direction is from west and south-west and average wind speed 5.7 to 9.2 mph. The south-west monsoon is active in the region from July to mid-September and contributes73 percent of the mean annual rainfall which is 413.61 mm (mean annual rainfall from 1956 to 2016). So far, the rainfall variability is concerned, the mean annual rainfall over the region from 1986 to 1995 was 364.4 mm with CV 31.21 percent; 1996-2005 (408.5mm with CV 39.68 percent) and 2006-2016 (463.0 mm with CV 32.05 percent) respectively (Yadav et. al. (2018). There is large inter- annual variation in

rainfall. Lowest 20.3 mm was recorded in 1918 and highest 1036.0 mm during 1978 (CAZRI, 2012). Average number of rainy days comes to 20.4. In summer the mean humidity is 60 percent.

Table 01: Monthly Minimum and Maximum Average Temperature, 2010 to 2022

#	Months	Maximum Temp. (^{0}C)	Minimum Temp. (^{0}C)
1.	January	21.6	11.0
2.	February	25.2	14.5
3.	March	31.4	19.6
4.	April	37.5	25.0
5.	May	41.7	29.6
6.	June	42.6	31.9
7.	July	38.3	31.3
8.	August	36.3	29.3
9.	September	35.6	27.4
10.	October	34.2	24.0
11.	November	28.6	18.1
12.	December	23.3	12.6

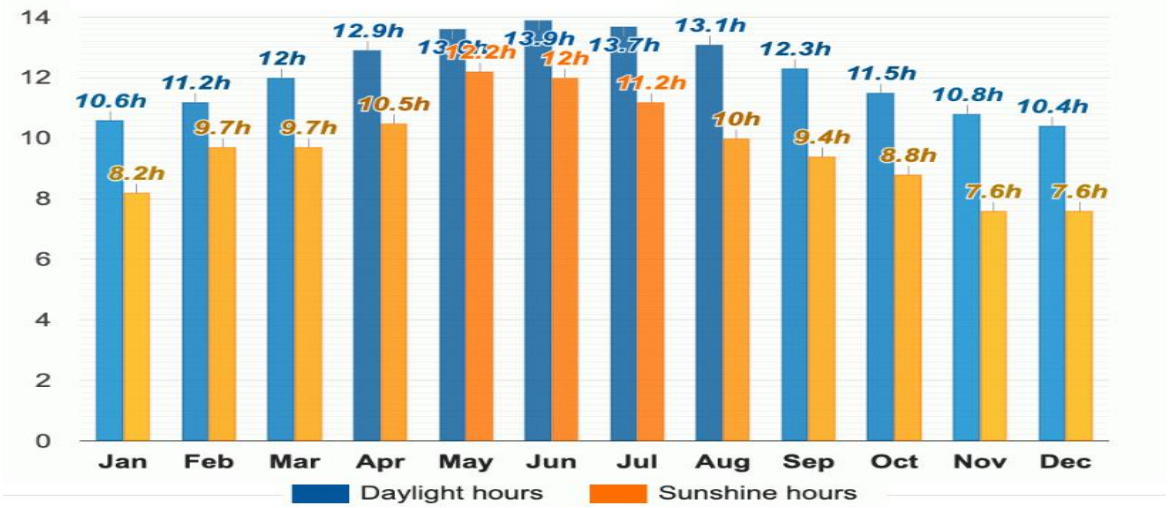
Source: IMD, Govt. of India

Table 02: Minimum Temperature Recorded in Different Years, 2011 to 2023

Date	Year	Minimum* Temp. (^{0}C)	Year	Minimum Temp. (^{0}C)
25 December	2011	-1-4	21 January, 2012	-1.1
31 December	2012	1.9	08 January, 2013	-1.1
29 December	2013	-0.5	03 January, 2014	2.7
30 December	2014	0.1	29 January, 2015	2.1
14 December	2015	-0.4	22 January, 2016	-1.9
19 December	2016	4.1	12 January, 2017	1.0
08 December	2017	1.5	07 January, 2018	1.0
29 December	2018	-0.6	29 January, 2019	-1.1
27 December	2019	-0.6	11 January, 2020	1.8
30 December	2020	-1.1	01 January, 2021	-0.2
21 December	2021	-2.6	03 January, 2022	0.03
			03 January, 2023	-0.9

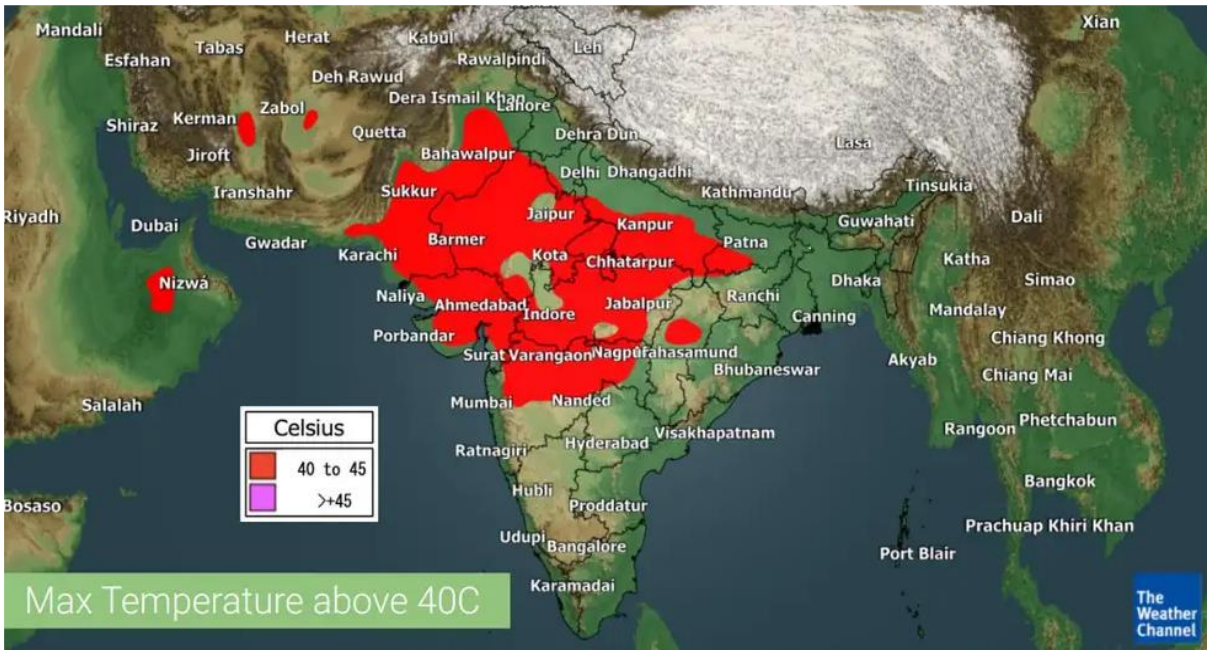
Source: *IMD, Govt. of India, # Dainik Bhaskar, Churu 04.01.2023

Figure 02: Average Minimum and Maximum Sunshine Hours, Churu



Source: https://www.weather-atlas.com/en/india/churu-weather-december#temperature

Figure 03: Maximum Temperature in India and surrounding Countries, 2022



Source: www.weather.com

Geology

The climate of the area is semi-arid to arid and the average annual rainfall is 320 mm. The major part of the district is irrigated by Indira Gandhi Canal System. The Geology of the district is largely concealed by windblown sand and has been worked out on the basis of scanty exposures and from dug well and borehole data. The area a part of the Thar desert, is basically a fluvio-aeolian depositional basin containing 255 m thick pile of Quaternary sediments. It is characterized by an undulatory topography consisting of sand dunes interspersed with interdunal valley and linear depressions. The various rock types of the area belong to the Delhi Supergroup, Erinpura Granite, Malani Igneous Suite and the Marwar Supergroup and the tertiary sediments including the Palana Formation of Palaeocene age. The oldest rock sequence in the area belongs to the Punagarh Group comprising slate, phyllite, quartz-mica schist, ferruginous quartzite etc. of the Delhi Super Group. These rocks are well exposed south of Bidasar and east of Pandurai. The metasediments of the Punagarh Group are intruded by Granite, Pegmatile and amphibolite. The youngest Malani Igneous Suite is represented by Porphyritic rhyolite and granite. The dug-well and borehole data have revealed rocks of the Marwar Super Group occurring beneath thick pile of Quaternary Sediments in Southwestern part of the district. These are divisible into three groups, namely, the Jodhpur Group, the Bilara /Hanseran Evaporite Group and the Nagaur Group. Ground water potential in the area ranges from less than 10 to 100 litres per second (LPS).

Mineral Resources

The mineral resources of Churu are substantially good. Phyllite, Slate and Quartzite quarried at Bidasar, Biramsar, Dungras and Gopalpura are utilized as building stone. Rhyolite is extensively quarried from Randisar hill for use as road metal and building stone. Small isolated patches of gypsum are seen at several places around Taranagar. Gypsite occurs at 0.3 to 1.5 meter below the surface. The occurrences of gypsum near Baen, Bhanin, Deogarh and Satyun are promising. Potash minerals such as polyhalite and sylvite have been intersected around

550-meter depth in several boreholes drilled by the Geological Survey of India at and around Lakhasar, Jhanjheu etc. in halite – bearing evaporate sequence of the Hanseran Evaporite Group. Limestone occurrences are located near Asrasar and NW of Mundra. Occurrences of salt are reported from south of Pandurai. Efflorescence of salt petre (Potassium Nitrate) is found on the soil in some places in Rajgarh tehsil. They also contain some amount of sodium chloride and sodium sulphate. Besides this copper mineralization is also observed in the Biramsar hill and in Bidasar area.

Soils

Soils of Churu district are dominantly of very deep coarse textured sand with low moisture retention capacity. They are somewhat excessively drained, loamy sand to fine sand, single grained, moderately alkaline and are of normal, moderately and highly hummocky. Soil of the region falls within rainfall zone of 100-350 mm. The soil is desert type. Sand dunes Aeolian soil is loamy coarse in texture and calcareous. Most of the area in the district falls under this Loamy soil. This soil covers an area of about 45 percent. It is also poor in fertility status. Only kharif crops are grown. Sandy soils are found in the area. High longitudinal sand dunes are spread in the district. These shifting sand dunes restrict the crop production to stabilized sites only. These soils are very poor in organic carbon as well as other essential plant nutrients. This type of soils covers an area of about 30 percent. Sandy Loam soils are poor in organic carbon and water holding capacity. This results in Churu having very sparse vegetation. These soils are suitable for conserved moisture farming. Soils irrigated with underground water face certain challenges. The salt gets accumulated in the soil which becomes problematic. Under such soil conditions only salt tolerant crops are raised. This type of soils covers an area of about 17 percent. Saline or Alkaline soil covers an area of about 5 percent of the total area, Saline or Alkaline Soils are irrigated with underground water which again, get salts accumulated and become problematic. Under such soil conditions only salt tolerant crops are raised. The nutrition value of the soils is very poor. The low content of organic matter in these soils has been attributed to high temperature, low rainfall, scanty and scrub vegetation cover and sandy texture of the soils. High temperature and good aeration in these soils increased the rate of oxidation of organic matter resulting in the reduction of soil organic carbon content (Meena et al. 2006; Singh et al. 2007; Mahesh Kumar et al. 2009b). 23.96 percent soils qualify for land capability class III and 49.29 percent under class VII (CAZRI, 2012).

Drainage

The topography of Churu city is cup shaped, the town being surrounded by sand dunes takes the shape and structure of a cup. Due to scanty rains in the region, natural drainage system has not been evolved. In fact, there is no river/rivulet in the entire Churu district. In Churu town itself no natural drainage system exists to drain away the rainwater or wastewater from the town. Presently there exists a minimal network of storm water drains in the city. The existing network of (roadside) storm water drains in Churu has been identified under three broad categories as follows: (i) open pucca (concrete drains) and (ii) closed pucca. (iii) kutcha.

Geohydrology and Groundwater

Geohydrological of the Churu district is broadly grouping geological formations from ground water occurrence and movement considerations, the various lithological units have been classified into two groups on the basis of their degree of consolidation and related parameters. These are, (i) Porous Formations- unconsolidated quaternary formations (ii) Porous Formations – semi unconsolidated porous tertiary formations (iii) Fissured formations –

consolidated protereozoic formations. On an average 80 percent of the district area covered with porous formations. There are number of National Hydrographic monitoring stations of Central Ground Water Board in and around Churu. In most of the cases ground water table ranged between 20 -60 meter below ground level. Annual extirpable ground water resources in the district comes to 116.11 mcm while current ground water extraction for all uses comes to 134.10 mcm. Thus, the stage of ground water development comes to 115.49 percent (CGWB, 2022). It varies from 59.52 percent in Sardarshahr to 304.43 percent in Rajgarh CD Block.

The entire Churu city is considered dark zone from groundwater exploitation point of view. As far as groundwater condition is concerned, it is available at a depth of approximately 45-50 m and that too is brackish with TDS level is in the range of 1890 to 4,200 ppm, Chloride level is between 320 to 1160 ppm, Nitrate between 70 to 230 ppm and Fluoride between 1.2 to 1.9 ppm (Ref. PHED). Groundwater quality of Churu city is not in conformity with the set norms of Government of Rajasthan. It is highly brackish and TDS, Chloride, Nitrate and Fluoride content is far beyond the set safe limits and WHO standards. Consumption of this high fluoride content has resulted in medical issues like bone deformity and joint pains (as evident from public perception). Further high nitrate water is not appropriate for infants as they may develop 'Blue-Baby' disease and elderly persons may face gastric and digestive problem. So, the quality of water is a big challenge for people who are forced to consume it as they have no alternative option for replacement of the hard water. The mean surface water resources in the district are estimated to 99.06 mcm and imported water 1420.5 mcm (Beg and Ahmad, 2015).

Review of Literature

Churu, called the 'gateway to the Thar desert' in some accounts, is of course just one link in a larger global chain of climate change. The Rajasthan State Action Plan on Climate Change discusses the growth of greenhouse gas emissions globally after 1970. It focuses on nationwide factors, beyond just Rajasthan, that feed into the larger scale GHG-driven changes. Many of these arise in greater activity in the energy sector, increased use of fossil fuels, emissions in the agriculture sector, growing industrial processes, and due to 'land-use, land-use change and forestry.' All these are ever-shifting links in the complex web of climate change. (www.undp.org). In order to bring out impact of climate change in the study area, it is essential to review the research work carried out on natural resources, human activities, and regional developments in the region. CAZRI (2012) carried out natural resources appraisal of the district; CGWB (2022) assessed the ground water and made plans for its management and development. Scientist of CAZRI also carried out study on drought and desertification (Moharana et.al 2016), Mahesh Kumar et. al (2009b) on soil resources; Singh et al (2007) on soil nutrients. Studies on surface and ground water has been carried out by Beg and Ahmad, (2015), Yadav et. al (2018) on rainfall variability, Chuwah et. al (2016) on climate impact on aerosol; Das et. al (2013) on change in rainfall and temperature pattern; Pai et. al (2013) on trends of heat wave; Rohini et.al (2016) on variability and increasing trend in heat wave. Besides the reports of various line departments of Rajasthan Government, are consulted to assess the impact of climate change on various aspect/fields and locations.

The analysis found that human-induced climate change increased the risk of 51^0 C. maximum temperatures to be exceeded in the grid-box around Phalodi in 2015 from a 1 in 20-30 year event to a 01 in 7-10 year event, so a small increase in probability. At the same time

an event of this magnitude is only expected to occur every 40-49 years in a year of the same overall warming as 2015 but without the specific sea surface temperatures that were observed (World Weather Attribution 2016). Increasing concentrations of aerosols in the atmosphere block sunlight and so cause a cooling effect on the ground (Wild et al. 2007). There is general agreement between the decreasing trend in optical depth and increasing trend in maximum temperature.

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This hypothesis is supported by another research. Kumari et. al. (2007), using station data collected from the IMD, find that the average solar dimming as a result of increased aerosols from human activity is approximately −0.86 W/m2 per year over India for the period 1981–2004. Over the past decade aerosol optical depth has been increasing 4 percent per year over India (Kumari et. al., 2007; K. Moorthy, 2013). As energy policies shift away from fossil fuels, it is likely the cooling effect of aerosols across Asia will diminish, resulting in an increase in the intensity of heat waves over the coming decades. Earth System Model (ESM) experiments indicate an increase in the intensity, duration, and frequency of severe heat waves for the 2070-2099 period in most parts of India, with the highest increase in intensity projected to occur in northern India (Murari et. al., 2015).

Another well-known effect that can counteract heating, especially in the maximum temperatures, is increased irrigation. The extra water availability means that incoming solar energy is used more for evaporation and less for raising the temperatures. There is evidence that increased irrigation has decreased dry season maximum temperatures in many regions of the world, e.g., by up to 5 ºC in California (Kueppers et al, 2007, Lobell et al, 2008).

Results and Discussion

So far, the temperature in Churu city is concerned, the first important aspect is the high variation in the daily temperature. The main reason fort this is the desert geographical feature that persists here. Second there is a higher temperature than normal in the summer season. In the winter season the temperature below normal is recorded. Both the extremes of temperature are experienced here. In the summer season, especially in the months of May and June, the maximum temperature goes up to more than 50 degrees Celsius. Due to which strong hot winds (locally called *Loo*) start blowing here in the afternoon.

In the winter season (between December 15 to January 26), there is a significant drop in temperature due to which the city of Churu reels under cold wave. There are many climatic and geographical reasons for the fall in temperature in winter. A lot of difference is also seen in the daily temperature here. Where the temperature during the day exceeds 20 degrees centigrade, at night, especially between three o'clock in the morning and five o'clock in the morning, the temperature goes down to less than zero. On 28 December 1973, the minimum temperature of Churu city was recorded at -4.6 degree centigrade. The same minimum temperature on 15 December 2021 is -2. 6 degrees centigrade was recorded. Thus, we see that from 15th December to 26th January the temperature remains around the freezing point. And the main reason for the drop in temperature is the icy winds coming from the Himalayan Mountains. The main reasons for the high temperature in Churu region are highlighted below.

1. **Presence of fine particles of sand soil***:* The city of Churu is located at the extreme end of the desert part, due to which the particles of sand soil are fine here because when the sand soil comes with the wind, the coarse particles are left behind, fine Soil

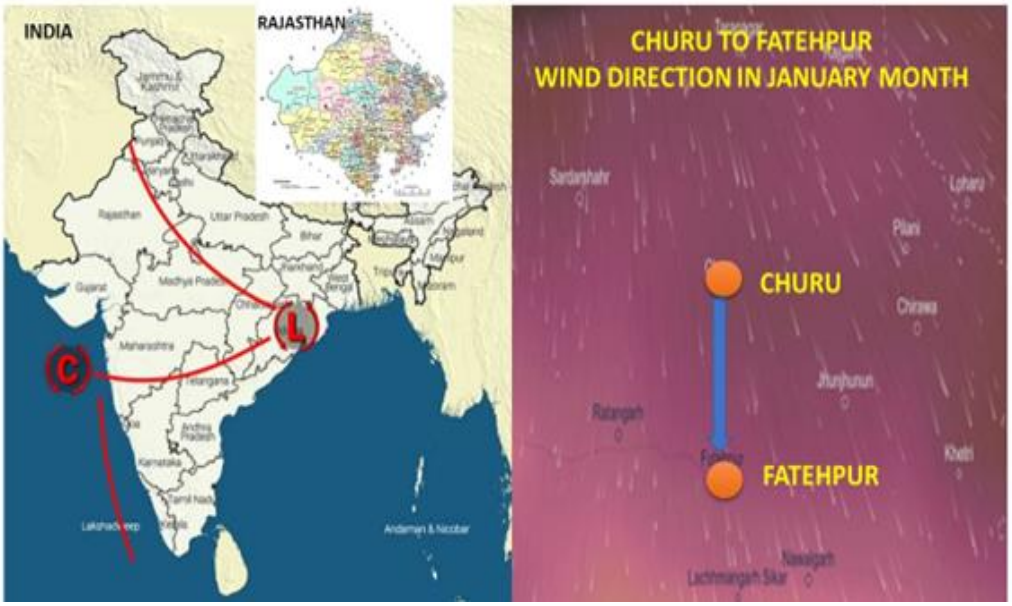
particles heat up and cool down more quickly than other soil particles. For this reason, the temperature in the desert areas is high during the day and the temperature is low in the night. The daily variation in temperature is seen in both summer and winter season. A mixture of fine and coarse particles is found here. This can be observed in the following picture (Fig. 5) that the average maximum temperature is found to be high in this entire region.

2. **Due to lack of moisture in the soil,** there is a lack of fertility, high salt content increases this problem as it absorbs more of the sun's heat and increases the temperature of the surface.
3. **In the month of May-June,** due to the absence of any type of crop in the area, the temperature of the area remains high. Due to which in these two months, due to the high temperature in the summer season, hot strong wind, which is called 'Loo', blows here. It causes a lot of damage to the flora and fauna other living beings.
4. **Temperature***:* The average length of the day in May in Churu is 13 hours and 34 minutes. April through June, with an average maximum ultraviolet (UV) index of 9, are months with the highest ultraviolet index in Churu, India. An Ultra Violate Index of 8 to 10 symbolizes a very high health vulnerability from unsafe exposure to ultraviolet radiation for the ordinary person. December has the shortest days of the year in Churu, India, with an average of 10 hours and 23 minutes of daylight.
5. **Humidity:** May is the least humid month in Churu, with an average relative humidity of 17 percent.
6. **Minimum Vegetation Cover:** Less than one percent of the total area in the district is covered by vegetation or forest cover which is the lowest in the state of Rajasthan. The area which is found under the forest is also scrub dominated and degraded.
7. **Area of low air pressure***:* Due to high temperature in summer, there is a low-pressure situation in the area. As a rule, air flows towards the least pressure. Similarly, even in winter, the temperature during the day is higher than in the surrounding areas. Due to this phenomenon of low air pressure, direct effect of cold air coming from the north is seen in the area.
8. **Due to biodiversity and climate change,** the temperature of almost all the places is increasing. In Churu also the temperature is increasing due to the destruction of local vegetation like Ker (*Capparis desidua*), Khejri (*Prosopis cineraria*), Khimp (*Leptadenia pyrotechnica*), Phog (*Calligonum poligonoides*), Sinia (*Crotolaria burhia*), Aak (*Calotropis procera*) etc. In nature, many small and big plants arise naturally. But for the last two decades, due to their lack of conservation and domestic use and pastoralism, they are slowly disappearing from the area
9. **Terrestrial energy:** The rays coming from the sun on the earth heat the surface and along with it the particles of dust, soil and micro water vapour present in the atmosphere also keep heating up. The soil particles are fine here, the vegetation cover is less, the agricultural yield is also zero (in summer and winter season), the moisture content in the soil is also less, the fertility is also less, in the soil Salt content is high etc. Due to all these reasons the surface heats up rapidly. That is, by absorbing the rays of the sun, the surface itself starts heating up rapidly due to which the temperature is recorded higher between two o'clock in the afternoon to four in the evening. This condition occurs in both summer and winter season. This is the reason why the temperature is always high during the day. Whereas at night the temperature drops rapidly due to the opposite situation and the temperature is recorded less. There is less moisture in the

atmosphere, that is, the amount of moisture is less, the amount of dust particles is more, due to which the temperature of the area increases.

10. **Geographical Location:** Churu is located at the eastern margin of the desert land. Due to this an area of low air pressure with hot winds is developed in the summer season. Similarly in winter, cold winds coming from the north come directly to this region. Such uninterrupted cold and icy winds bring temperature below zero degree Celsius. Thus, the position of Churu acts like a greenhouse and when the temperature of the area is more or less, the air cannot move it forward at the speed with which it should increase. This is the reason that the effect of temperature in both the seasons is more visible in Churu city. The Fig. 5 shows the Churu and Fatehpur towns covered under low pressure zone.

Figure 04: Location of Churu and Fatehpur City

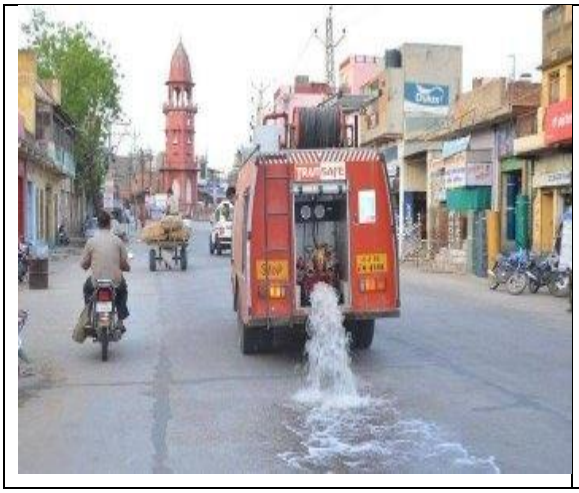


11. **Location of the city on the globe:** The location of the city of Churu on the globe is such that it comes in direct contact with the warm air coming from the west in summer and the cold air coming from the north in winter.
12. **Due to the lack of water vapour** or moisture or humidity in the air and the excess of fine particles of dust, soil energy plays its role in increasing or increasing the temperature of the area.
13. **Many other factors also** play their role in reducing and increasing the temperature of the area such as – wind direction, wind speed, amount of humidity, amount of solar energy etc.
14. **Climate Change:** The impact of climate change is being seen globally as well as locally due to the damage to the environment. Such changes also affect human health, their working capability as well as working hours. The frequency of climate extremes will change in response to shifts in both mean climate and climate variability. Variability in weather and climate inherently leads to the occurrence of extreme weather or climate events. These events, more unusual and more severe than normal or average weather, include for example heatwaves (high-temperature events), cold waves (low-temperature events), downpours (heavy-precipitation events) and droughts (low-precipitation events).

15. **Average Annual Rainfall***:* As we know that the average annual rainfall in desert areas is very less. The average annual rainfall of Churu district is around 300 mm. Due to which the vegetation cover is also less here and due to over-exploitation of ground water and due to lack of rainfall, the recharge of water is not possible. At the same time, due to the excess of salt in the ground water in almost all the areas, it is not suitable as drinking water.

16. **Other unnatural causes***:* Apart from the above mentioned natural and geographical reasons, there are some other reasons which show their effect in some degree. For example, rapid increase in population, increase in residential i.e., built-up area, change in building material, because earlier this type of building material was used which was environment friendly. Due to excess means of transport and increase in industrial units due to increase in air pollution etc.

1. Watering on Road in Summer, Churu **2. Dense Fog in Winter, Churu**



Conclusion

Churu town, the district headquarters of Churu district in Rajasthan State is located within hot arid 'Thar' desert. Sand dunes and sandy undulating interdunal plains are dominant landforms covering 89 percent district area. Virtually no natural drainage system exists in the region except a tiny Kantli dry river. Soils of Churu district are dominantly of very deep coarse textured sand with low moisture retention capacity. Only 24 percent soils qualify for land capability class III while 49.3 percent area falls in Class VII. Vegetation is very poor (mainly scrub) in terms of density and vigour. Forest land just cover 0.48 percent district area. These scrub-based forest are in almost degraded state. Surface water resources are meagre (99.96 mcm). Ground water is very deep, saline (61.2 percent) and over exploited (11.4 percent). Extremes of temperatures (both regional and local level), low, high variable, erratic, ill distributed and unpredictable rainfall pattern; high wind speed and frequent occurrence of droughts mark the climatic characteristics of the region. Human activities viz. mining, removal of vegetation (particularly of 'Phog'), encroachments over common lands, levelling of sand dunes and development of irrigated farming, mechanized farming, and industrialization. The combined impact of these natural phenomenon and human intervention lead to widen and intense negative impact of climate change. The behaviour of rainfall, temperature and other climatic parameters are enormously changed towards negative mode. Together these happenings badly affected agriculture, animal husbandry and forestry on one side and human livelihood on the other.

The time now calls for reduction of unwarranted activities from all the corners; come together; conserve, use and manage natural resources properly; develop eco-friendly, indigenous and low-cost technologies and finally plan viable and sustainable development plans and cooperation from all sectors to minimise the impact of alarming climate change.

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