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Impact of Bhadla solar power plant on the rainfall: A study of western Rajasthan, India

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Abstract

Bhadla Solar Park is solar power plant developed and located in Bhadla village in Jodhpur district, lying in the Thar Desert of Rajasthan, India. It covers an area of about 56 Sq. Km. It has a total installed capacity of 2245 Megawatts, making it the largest solar park in the world as of 2023. Its construction cost was about US\$ 2.175 billion. The date of Commission was 20.03.2020. Geographically, its latitudes and longitudes coordinates are 27 degree 32' 23'' North and 71 degree 54' 55'' East. The Rajasthan Renewable Energy Corporation (RREC) has allotted the land for the execution of the project in co-ordination with the state of Rajasthan government. The plant generates electricity by utilizing clean solar energy and sell it to the national grid. This research paper attempts to map and analyse the rainfall pattern of the last few years of western Rajasthan especially due to establishment of the plant. Here, the rainfall in the selected areas of India shows remarkable temporal and spatial variations after the workings of the solar panel power plant. It also highlights the increasing temperature and irregularity of rainfall in Jaisalmer district during the last few years.

Keywords: Solar park, solar panel, rainfall pattern, temporal variations, reliability

Introduction

The solar power plant of Bhadla of western Rajasthan was initiated in 2015 but started with full capacity from 2020. It was established between Jaisalmer and Pokhran near the same village- Bhadla. This solar park helps India meet its commitments under the Paris Agreement to reduce its carbon intensity by 33 to 35 percent by 2030. Here, 1 MW= 3000 panels and for 2245 MW= 6735000 panels were installed. And approximate 1KW energy by solar produce 40 gm of Co₂. On an average, 3-4 litre water is used for every solar panel. Here are some of the facts that give a picture of selected districts of western Rajasthan. For example,

1. Flood situation is seen in the selected driest part of western Rajasthan in India during the last few years. There is also noticed the gradual hike in temperature.
2. According to IMD, Jaisalmer received 185 mm rainfall till 09.08.2023 and the normal rainfall in this area is 107 mm. It is noticed approximate 72 percent changes.
3. Barmer received 437.2 mm rainfall till 09.08.2023 and normal rainfall is 168.9 mm. It is approximately 159 percent changes.
4. In 2022, Jaisalmer received 152 mm rainfall in just 2 months of monsoon.
5. On 30.04.2022, Jaisalmer broke the record of highest temperature in a single day that was 45.9 degree C in place of 45.8 degree C on 29.04.2009.
6. In the month of July 2023, a highly low pressure zone was built up in the western part of Rajasthan.
7. As per IMD and Rajasthan Climate Board, the temperature and rainfall increase year by year in western Rajasthan, especially various parts of Jaisalmer and Barmer faces flood situation.
8. The average temperature of Jaisalmer on the bases of IMD data from 1951 to 2009 was 26.7 °C. But now, it is continuously increasing gradually.

Study Area and Findings

Bhadla Solar Park is solar power plant developed and located in Bhadla village in Jodhpur district, near Jaisalmer and lying in the Thar Desert of Rajasthan, India. It covers an area of about 56 Sq. Km. Geographically, its latitudes and longitudes coordinates are 27 degree 32' 23'' North and 71 degree 54' 55'' East respectively. Figure-1 shows the study area in detail. Here, Jaisalmer is one of the old commerce hub located in the western part of India.

It has its own geological importance. This region experiences a desert environment characterized by dry air, wide temperature variations and irregular rainfall. Jaisalmer receives very scarce and scanty rainfall. During the past decades, there has been a variation in the trend of rainfall and other atmospheric conditions in the district. During summer, the minimum temperature is 25 degree C and

highest is 49 degree C. In the present study area, it is tried to check and analysis the main reason of rainfall variations. And temperature is another important meteorological variable after rainfall. A significant change in temperature can pose a serious threat to agriculture, vegetation, habitat and biodiversity.

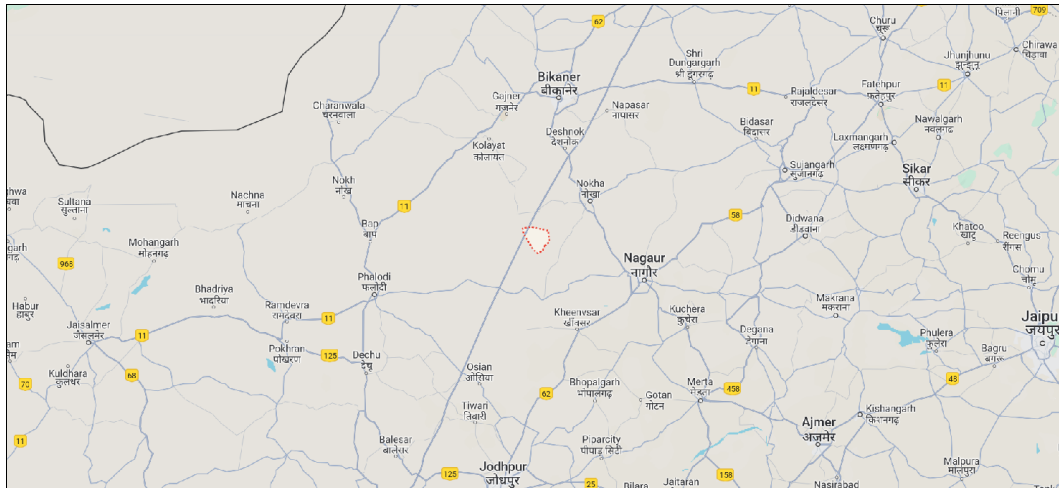


Fig 1: Bhadla Solar Park, Rajasthan (India), Area enclosed in Red Dotted Line, Source- Google Maps

Table-1 shows the annual average temperature and rainfall information. in Jaisalmer as per data from IMD, Pune and from local area

Table 1: Jaisalmer: Annual Average Temperature and Rainfall, 2017-2023

Year	Temperature (°C)	Rainfall (mm)
2017	26.8	43.5
2018	27.0	79.3
2019	27.0	76.6
2020	27.1	147.0
2021	27.3	249.0
2022	27.4	152.0
2023	27.1	209.5

Source: IMD and Meteorological Centre Pune/Jaipur, Rajasthan, India etc.

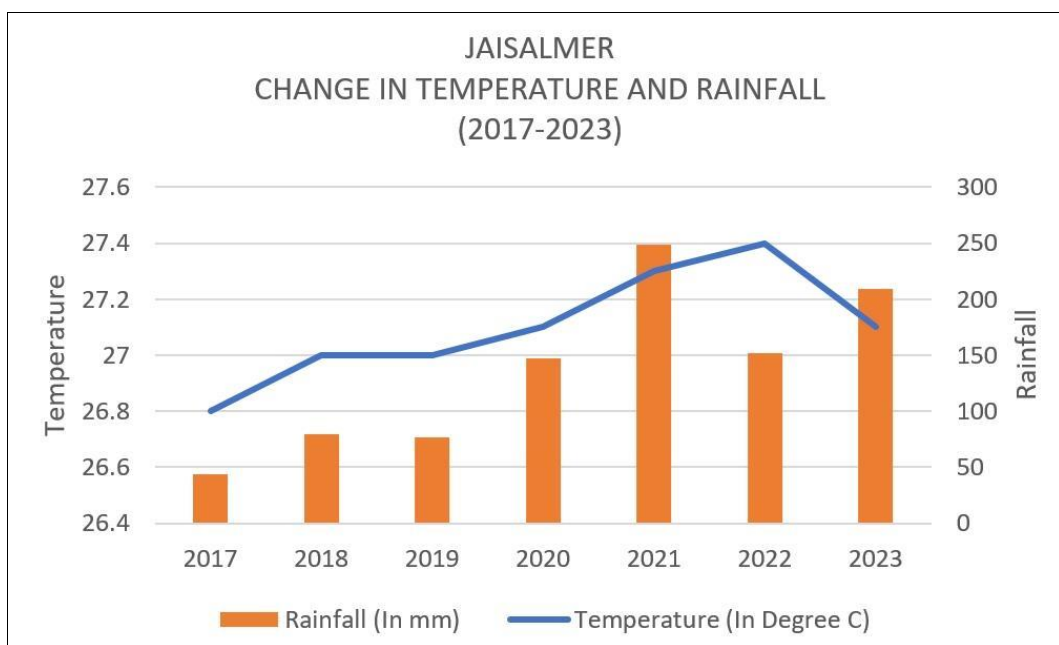


Fig 2: Represents the temperature and rainfall of Jaisalmer by combined line and bar graph

Table-2 shows the patterns of monsoon conditions (rainfall in mm) of selected districts of western Rajasthan from 2020 to 2023. As per data, normally rainfall occur about 285 mm

during the preceding years in Rajasthan. But during the year 2023, it was very high i.e. 401 mm. It shows the gradual change in rainfall.

Table 2: Rainfall in Selected Districts of Western Rajasthan, 2020-2023 (mm)

Year	Jaisalmer (Departure from Normal)	Jodhpur (Departure from Normal)	Hanumangarh (Departure from Normal)	Rajasthan (Departure from Normal)
2020	252 (+55%)	444 (+60%)	221 (-16%)	8%
2021	273 (+69%)	294 (+6%)	293 (+11%)	17%
2022	346.7 (+96%)	457 (+56%)	317 (+25%)	37%
2023	187.0 (+18%)	368 (+42%)	204 (-8%)	16%

Source: Internet, IMD and Meteorological Centre Pune/Jaipur, Rajasthan, India

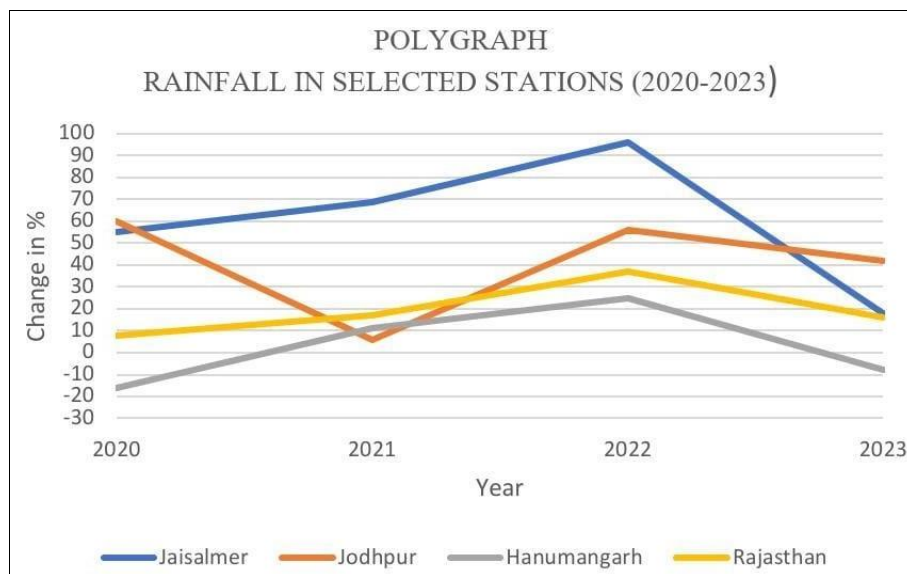


Fig 3: Shows the changing patterns of rainfall in different areas including Rajasthan.

Concept and Limitations of Study

Solar power is the conversion of energy from sunlight into electricity either directly using photovoltaic or indirectly using concentrated solar power. The solar panels absorb around 30 percent of the heat energy from the sun, re-emitting half towards the sky and the other half to the roof, which then absorbs back 30 percent of the heat that the solar panels emit, giving a total absorption of 5 percent of the heat of the sun. It is also to mention here that the Albedo of solar panels is low to allow efficient light absorption. But the actual conversion efficiency is below 20 percent.

Due to various causes excluding or probably including above solar plant, the summer of this year 2024 is unprecedented in large parts of India especially the North-western parts. It suggests that more indicators are needed to describe the heat waves from May 16 to June 19, 2024, which is what the following four descriptions attempt; Trends in night temperature can be seen through minimum temperatures. During this period, 75-87 percent of Rajasthan, Punjab, Haryana and Uttar Pradesh experienced minimum temperatures that were on average 2 degree C or more above normal. Delhi had an average minimum- 3.4 degree C above normal.

1. The average minimum temperature for May 16 to June 19 period was the hottest since at least 1951- the first year for which IMD has created gridded date for temperatures. In 69-75 percent of Uttar Pradesh, Haryana, Punjab, Rajasthan and Gujarat, Delhi's average minimum was also the highest since at least 1951.

2. The nature of heat waves in Eastern parts or even Gujarat and the adjoining parts of Rajasthan may have been very different from Punjab, Haryana, Delhi and western Uttar Pradesh.
3. Humidity becomes dangerous only when accompanied with some heat. For example, North Eastern and peninsular states have also experienced high humidity but that is because it is raining there. Therefore, humidity has to be read with temperature to understand its impact on human body.

North India has been bearing the brunt of the longest stretch of a heat wave in the last 15 years. Figure from government sources shows that at least 100 or more people have died across India. As of now, 12 disasters are notified in the Guidelines on Constitution and Administration of the State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF), namely- Cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloudburst, pest attack, frost and cold waves. Earlier, in most years, Andhra Pradesh, Odisha, Telangana, Gujarat, Rajasthan are the states that report most casualties from heat. Recently, on June 19, 2024 in Delhi, the night lowest temperature was noticed 35.3 degree C where as the highest temperature of the same day was 43.8 degree C. The range of temperature was almost 8 degree C only. That was also an example of temperature in the capital city in north India. Till 20.09.2024, in case of rainfall in west Rajasthan, it has been noticed 75% of departure where actual was 481.2 mm and the normal remained 275.1 mm.

Concluding Remarks

In fact, this research paper is based on an idea and efforts are made to check the same idea in reference to the data of rainfall and temperature of the stipulated periods in the study areas of this Bhadla Solar Panel Power Plant of Rajasthan, India. Some of the basic problems were faced while collecting data. And it is also noticed that the area has lack of research on the related topic. So here, an endeavour has been taken into consideration to highlight such a drastic variation in the latest data of temperature and especially of rainfall of the area under study. Despite the best efforts to develop a comprehensive survey, there remains a risk of minor data error. There could also potentially impact the reliability and generalizability of our findings.

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