# Disaster Resilience Management through Climate Risk Informed Programming with Systemic Change

A Flagship CSR initiative of IndusInd Bank

In Partnership with
UNICEF, Mission Samriddhi, Gorakhpur Environmental Action Group and Indian Institute of Technology (Gandhinagar)

# Climate Risks and Sectoral Vulnerabilities

District Baran, Rajasthan

Developed by

**Climate Risks and Sectoral Vulnerabilities – District Baran, Rajasthan**

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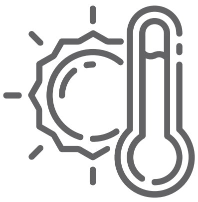

**The year 2023 has been recorded as the hottest in Earth's documented history**

## Introduction

World Meteorological Organization's (WMO) 'State of the Global Climate' report, released in 2023, highlights severe concerns for the human race. It explicitly states that climate-induced risks, both global and local, are emerging as the greatest threat to humanity. The year 2023 has been recorded as the hottest in Earth's documented history, with the global average temperature rising by 1.45°C above pre-industrial levels, within a margin of uncertainty of ±0.12°C. Extremely worrying, this rise is very close to the threshold limit of 1.5 °C agreed upon by different nations during the Paris Agreement in 2015.

The WMO has expressed serious concern over this rise in the global average temperatures, warning that this will significantly affect the occurrence of extreme weather events, such as heatwaves, torrential rains, and tropical cyclones. Such events will undoubtedly have a direct impact on many development sectors including agriculture, health, education, and WASH all around the world. The effects of such extreme weather events have been well documented in numerous reports and research articles, manifesting in human casualties, injuries, homelessness, or distress displacement. Direct economic losses due to climate risks have surged by almost 151% in the last 20 years (UNISDR 2018).

As in other parts of the world, climate induced risks, including extreme rainfall and floods, heat waves are increasing in India too (Guhathakurta et al., 2011). The warming trend over the Indian Ocean has enhanced moisture supply, leading to extreme rainfall due to cyclones in coastal areas in recent decades (Ray et al., 2019). In the country, floods due to extreme rainfall alone cause losses of about $3 billion per year, which is 10% of the global economic loss (Roxy et al., 2017). There has also been a significant increase in the probability of hydro-climatic hazards all over India (Vittal et al., 2020). Therefore, a comprehensive understanding of climate risks and their impact becomes a prerequisite to trigger collective public action at the local level.

This study report is part of the UNICEF-supported programme entitled "**Climate Risk Informed Programming Project - Nature Solves-Nature Resolves," funded by IndusInd.** The aim is to reach community groups like Mahila Sabhas and farmers through Risk-Informed Gram Panchayat Development Plans (RiGPDP), and mainstream developmental resources in DRR-CCA in selected Gram Panchayats as a pilot project. In the process, the climate risk profile of three selected districts, namely Virudhunagar, Tamil Nadu, Bahraich, Uttar Pradesh; Begusarai, Bihar; Baran, Rajasthan and Dharashiv, Maharashtra, were developed to guide and shape the mindset of key stakeholders to assess the capacity of related line departments and local technical institutions. The goal is to ensure that government development schemes and programs, at both national and state levels, are effectively aligned to contribute to resilient development.

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# Methodological framework, Approach and Process

The methodologies followed in this study are as suggested by the IPCC (2014). The IPCC defines two streams of vulnerability assessment—the contextual vulnerability assessment and the outcome vulnerability assessment. The first provides a qualitative overview of vulnerability with the help of survey instruments and case studies, while the index-based outcome vulnerability assessment is done by calculating a score, after quantifying a specific set or combination of indicators.

A score-based approach can be used at any scale such as national, sub-national, district, and sub district level (Gbetibouo and Ringler 2009). And, this study used a score-based approach to analyse the climate hazards risk and sectoral vulnerabilities in selected districts to understand the links between sensitivity of the district and its ability to cope and adapt. Risk causing climate hazards were determined based on Indian Meteorological Department (IMD) norms. The sectoral indicators which directly or indirectly increase vulnerability or resilience to climate risks, were used as sensitivity and adaptive capacity indicators. Data from each district for all identified indicators were collected from authentic sources and categorized into five components: **Climate Hazards Index (CHI)**, **Agriculture and allied sector vulnerability Index (AVI), Health Sector Vulnerability Index (HVI), Education sector vulnerability Index (EVI) and Water and sanitation sector vulnerability Index (WSVI).** The facts related to the indicators were analysed, and weightage was assigned to each as per their influence/ contribution to vulnerability using the Principal Component Analysis (PCA) statistical tool to determine indicator specific scores.

To frame out an adaptive strategy and advocacy at local level for climate risk informed programming, data related to climate risks, climate change policies and impacts across different spatial and temporal scales and sectors is essential. NITI Aayog , the 'Think-tank of India' also recognises comprehensive data gathering at the district level as essential for risk planning, developing coping strategies, and adaptation. The recently developed National Data Analytic Portal by the NITI Aayog is a comprehensive platform that provides a single window for this wide range of data at national, state and district levels.

# Identification of indicators

Vulnerability to climate induced risks is multidimensional and determined by a complex interplay of multiple factors (Piya et al. 2012). There are two approaches in the selection of indicators: data driven and theory driven (Vincent 2004); and each approach has its own limitations. Therefore, the best approach is to verify the accuracy of the theory-based indicators with data from authentic sources (Maiti et al. 2015). Theoretically, vulnerability encompasses a variety of perceptions and elements, including sensitivity and the lack of capacity to cope and adapt. IPCC defines vulnerability as "the propensity or pre disposition to be adversely affected" and is determined by the sensitivity and adaptive capacity of the system (IPCC 2014). Sensitivity reflects the extent to which a system is sensitive or responsive to external stress or hazard, such as a drought or flood. Adaptive capacity is the ability of a system (technology, infrastructure, ease of access to resources, wealth, etc.) to cope with the consequences of climate stress, which includes several factors. (McCarthy et al. 2001). Vulnerability to climate change is a function of biophysical and socio-economic factors (O'Brien et al. 2004). Thus, the dynamics of vulnerability are captured through physical, demographic, social, and environmental components to denote sensitivity and adaptive capacity of the system. Considering this, a combined approach was used to select the indicators.

A total of 34 indicators that included climate hazards and four sectors (Agriculture and allied, Health, Education and Water and sanitation) were used in the study to denote the sensitivity and adaptive capacity of the districts (Table 1). The coefficient of variation in annual rainfall, frequency of heavy rainfall events, coefficient of variation in maximum and minimum temperature were calculated from high resolution IMD daily gridded data of the last 30 years (1993-2023). The sectoral indicators, which captured the sensitivity and adaptive capacity of the districts and states, were identified and their data collected from authentic sources. The indicators, the rationale for using them, and their functional relationship with vulnerability are described below in greater detail.

**Table 1**

| Code | Indicator | Baseline | Source | Relation with climate Vulnerability impact |
|---|---|---|---|---|
| CV_A rain( %) | Coefficient of variation of Annual Rainfall in % | 1993-2023 | IMD daily Gridded data | Exposure (Positive ) |
| Fre_Hrain | Frequency of heavy rainfall events | 1993-2023 | IMD daily Gridded data | Exposure (Positive ) |
| Con_DRY_Mday | Consecutive dry days during monsoon | 1993-2023 | IMD daily Gridded data | Exposure (Positive ) |
| CV_MaxT | Coefficient of variation of Daily max Temperature % | 1993-2023 | IMD daily Gridded data | Exposure (Positive ) |
| CV_MINT | Coefficient of variation of Daily min Temperature % | 1993-2023 | Disaster Management Department, Bihar | Exposure (Positive ) |
| Area_ Flood (%) | % of area prone to flood | 2019 | Vulnerability Atlas of India , 2019 BMTPC | Exposure (Positive ) |
| Fre_ E Drought | Frequency of Severe to extreme drought event | 1991-2020 | District web portals | Exposure (Positive ) |
| **Agriculture and allied sector** | | | | |
| Mar_Small_ LandH | % of marginal and small landholders | 2011 | Census of India , 2011 | Sensitivity (Positive) |
| L_HR | No. of livestock per 000 population | 2019 | The National Data and Analytics Platform | Adaptation (Negative) |
| Rainfed_Agri | % Of the area under rainfed agriculture | 2021-22 | The National Data and Analytics Platform | Sensitivity (positive) |
| Area _Cov_ PMFVY | Area covered under crop insurance under PMFBY in 000 ha | 2023 | The National Data and Analytics Platform | Adaptation(Negative ) |
| Empy_MNERGA | Average person days per household employed under MNREGA | 2023 | The National Data and Analytics Platform | Sensitivity (Positive) |
| Y_Vari_ FoodGrain ( %) | % of yield variability of food grains | 2021-22 | The National Data and Analytics Platform | Adaptation (Negative) |
| Wo_ Part_ Labour | Women participation in the workforce (%) | 2023 | The National Data and Analytics Platform | Adaptation (Negative) |
| **Health Sector** | | | | |
| Health_ Infra | No of rural healthcare infrastructure facilities per lakh population | 2021-22 | The National Data and Analytics Platform | Adaptation (Negative) |
| Mem_Insurance | HH with any member covered under a health and insurance / financial scheme | 2020-21 | The National Data and Analytics Platform | Sensitivity (Positive) |
| Child _Vac | Children age 12-23 months fully vaccinated based on information from vaccination card (%) | 2020-21 | The National Data and Analytics Platform | Adaptation (Negative) |

| | | | | |
|---|---|---|---|---|
| Child_ Stunt | Children under 5 years who are stunted | 2020-21 | The National Data and Analytics Platform | Sensitivity (Positive) |
| Child _ underweight | Children under 5 years who are underweight | 2020-21 | The National Data and Analytics Platform | Sensitivity (Positive) |
| IMR | Infant Mortality rate (IMR) | 2022-23 | The National Data and Analytics Platform | Adaptation (Negative) |
| Women_ Anemic | All women age 15-49 years who are anaemic | 2020-21 | The National Data and Analytics Platform | Sensitivity (Positive) |
| **Education Sector** | | | | |
| Women_10_ education | Women with 10 or more years of schooling (%) | 2021-22 | UDISE Plus | Adaptation (Negative) |
| ScL_Girl_Toilet | % of schools with functional girls' toilet | 2021-22 | UDISE Plus | Sensitivity (Positive) |
| Sch_Drinking | Percentage of schools with functional drinking water facilities | 2021-22 | UDISE Plus | Sensitivity (Positive) |
| S&TR | Average Student teacher Ratio | 2021-22 | UDISE Plus | Adaptation (Negative) |
| Drop_out | Average dropout rate in secondary level | 2021-22 | UDISE Plus | Adaptation (Negative) |
| Sch_approach | % of schools approachable by all-weather roads | 2021-22 | UDISE Plus | Adaptation (Negative) |
| Sch_electricity | Percentage of schools with electricity connection | 2021-22 | UDISE Plus | Adaptation (Negative) |
| **Water and Sanitation Sector** | | | | |
| HHs_Impr_ Drinkingwater | % of households with improved drinking water sources | 2020-21 | The National Data and Analytics Platform | Adaptation (Negative) |
| Change_GW | Changes in groundwater table during last five years ( mbGL) | 2021-22 | The National Data and Analytics Platform | Sensitivity (Positive) |
| State_GW | State of groundwater utilisation( in %) | 2021-22 | The National Data and Analytics Platform | Sensitivity (Positive) |
| HHs _improv_ Sani | Proportion of HH that have an improved sanitation facilities | 2020-21 | The National Data and Analytics Platform | Adaptation ( Negative |
| Area_water_ Bodies | Area under water bodies (%) | 2023 | India Wris web Portal | Adaptation ( Negative ) |
| No_ODF | No of ODF village | 2023 | The National Data and Analytics Platform | Adaptation ( Negative |

## Normalisation of dataset

The identified indicators were from different sources, measured in dissimilar units. Since the Vulnerability Assessment is a rank, all the indicators used in the assessment had to be of common units, for which they needed to be normalized. The normalization process varies depending on the nature of the relationship of an indicator with vulnerability. The following formulae (UNDP 2006) were used to normalize indicators which tend to increase vulnerability with an increase in the values.

For the indicators that had a positive functional relationship with their respective vulnerability index, the normalization was done through the following equation:

$$\text{Normalisation} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

On the other hand, where negative functional relationship occurs, this equation was used for normalization:

$$\text{Normalisation} = \frac{\text{Maximum Value} - \text{Actual Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

### Assigning weights to indicators through Principal Component Analysis

PCA was used in this study to assign appropriate weights to the indicators (Monterroso et al. 2014). Through this, each indicator was assigned a weight to find out the leading indicator, which further influenced all other indicators. The PCA was carried out using Statistical Package for Social Sciences (SPSS) as detailed in Table 2.

**Table 2**

| S.No | Indicator | Virdhunagar | Begusarai | Bahraich |
|---|---|---|---|---|
| 1 | % of marginal and small landholders | 5.3 | 5.1 | 5.6 |
| 2 | Livstockpopulationper1000population | 5.2 | 0.2 | 4.9 |
| 3 | % of The Area Under Rainfed Agriculture | 0.8 | 0.9 | 0.0 |
| 4 | % Area Covered into crop insurance Under PMFBY in 000ha | 3.4 | 1.9 | 4.6 |
| 5 | Average person days per household employed under MGNREGA | 5.3 | 0.2 | 2.6 |
| 6 | Yield Variability Of Food Grains% | 5.4 | 4.9 | 5.3 |
| 7 | Women Participation In The Workforce(%) | 0.3 | 6.1 | 3.6 |
| 8 | No o fRural healthcare infrastructure facilities per lakh population | 5.0 | 1.6 | 0.0 |
| 9 | % HH with any usual member covered under a health and insurance/ financial scheme | 4.8 | 5.2 | 5.4 |
| 10 | Children age 12-23 months fully vaccinated based on information from vaccination card(%) | 0.4 | 0.3 | 4.4 |
| 11 | Children under 5 years who are stunted | 5.3 | 5.4 | 4.8 |
| 12 | Children under 5 years who are underweight | 5.3 | 5.7 | 3.6 |
| 13 | IMR | 5.3 | 0.8 | 4.7 |
| 14 | % women age 15-49 years who are anaemic | 4.6 | 5.9 | 5.6 |
| 15 | % Women with 10 or more years of schooling | 5.3 | 6.1 | 3.9 |
| 16 | % of schools with functional girls toilet | 4.9 | 4.3 | 5.6 |
| 17 | % of schools with functional drinking water facilities | 0.1 | 5.4 | 4.4 |
| 18 | Average Student teacher Ratio | 5.0 | 4.9 | 5.2 |
| 19 | Average Drop outrate in secondary level | 5.1 | 6.1 | 3.2 |
| 20 | % of Schools Approachable by All-Weather Roads | 1.5 | 2.6 | 2.9 |
| 21 | % of schools with electricity connection | 4.9 | 0.0 | 0.1 |
| 22 | % of households with an with improved drinking water sources | 5.2 | 5.5 | 5.4 |
| 23 | % State of goundwater utilisation (in%) | 2.4 | 2.4 | 0.1 |
| 24 | % Area Under Wetlands in | 2.4 | 2.8 | 4.8 |
| 25 | % of available groundwater used for irrigation Purpose | 4.1 | 4.8 | 0.3 |
| 26 | % of HH that has an improved sanitation facilities | 0.0 | 5.7 | 3.8 |
| 27 | % of ODF plus village to total villages | 2.7 | 5.2 | 5.4 |

# Geographical Profile

Geographically, Baran district lies between latitudes 22°24' and 25°26' and longitudes 76°12' and 77°26' in the south-eastern region of Rajasthan, India. It covers an area of 6,992 sq.km, accounting for 2.04% of Rajasthan's total area. The district is bordered on the east and south by Madhya Pradesh, and to the northwest by Kota and the southwest by Jhalawar districts of Rajasthan. Administratively, the district is divided into eight *tehsils*. As per the 2011 National Census, the district has a population of 1,222,755, representing 1.78% of the state's total population, comprising of 633,945 males and 588,810 females.

The region's arid to semi-arid climate results in irregular rainfall patterns, leading to frequent droughts that challenge farming activities, which are heavily dependent on monsoon rains. On the other hand, intense rainfall during the monsoon season sometimes causes flash floods, damaging infrastructure and disrupting local economies. Additionally, the district experiences extreme summer temperatures, sometimes reaching up to 48°C, exacerbating water scarcity and affecting public health, particularly among the vulnerable populations. Soil erosion and degradation are further concerns, as erratic rainfall and flooding often reduce agricultural output, threatening food security. Water scarcity is further compounded by the over-extraction of groundwater and fluctuating rainfall, complicating irrigation patterns and drinking water availability.

# Climate Profile

As mentioned above, district Baran's arid to semi-arid climate, is characterized by hot summers, mild winters, and a distinct monsoon season. Summers, lasting from March to mid-June, are defined by high temperatures, often reaching up to 48°C. In contrast, winters are cold, with temperatures falling to as low as 5°C. The monsoon season typically begins in mid-June and lasts until the end of September, with the post-monsoon period extending from October to mid-November. The district's climate, with its seasonal variations, significantly influences local livelihoods, agriculture, and water availability, making it essential for its residents to adapt to shifting conditions.

# Average Annual Rainfall and its Variations

The district receives an average annual rainfall of around 764.8 mm, largely influenced by the south west monsoon, which extends from June to September (Fig 1). During this period, Baran district receives over 80 % of its total annual rainfall with July and August as the peak months. Rainfall intensity remains high during this period and sometimes causes local flooding in certain low lying areas. The rainfall trend in Baran District over the past 30 years shows significant variability, reflecting both high and low extremes. Figure 1 indicates a peak in the year 2011, with an annual rainfall of 1,277.9 mm, while the lowest recorded rainfall was in year 2000, at 324.6 mm.


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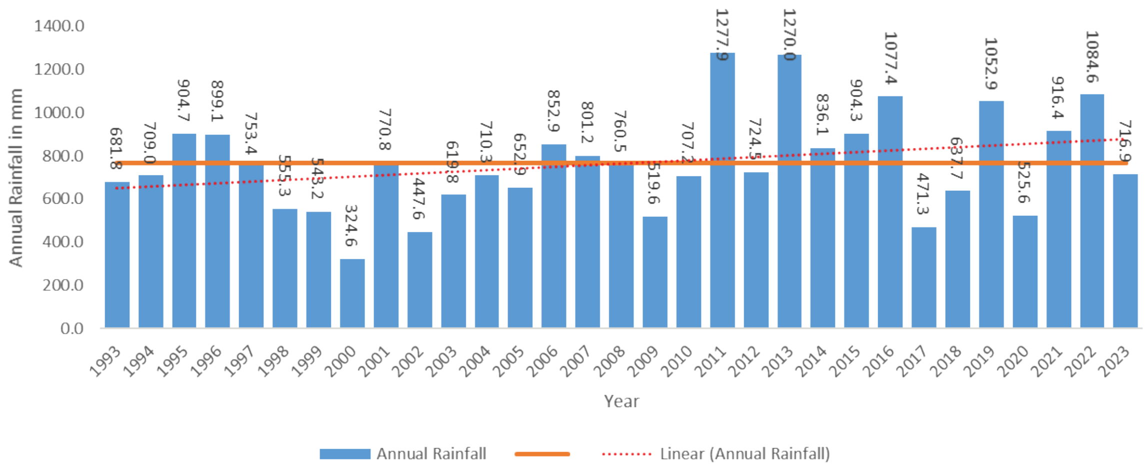
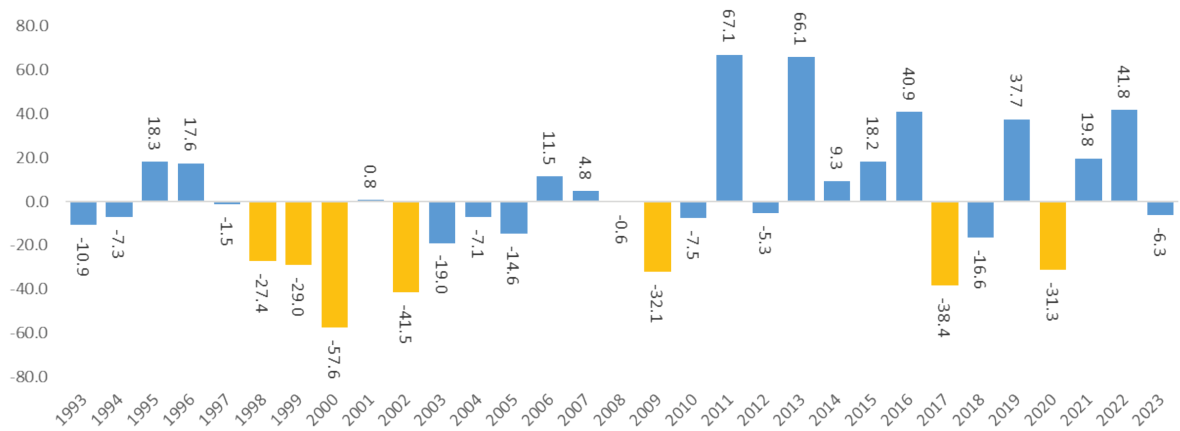
## Fig 1. Average Annual Rainfall of Baran District



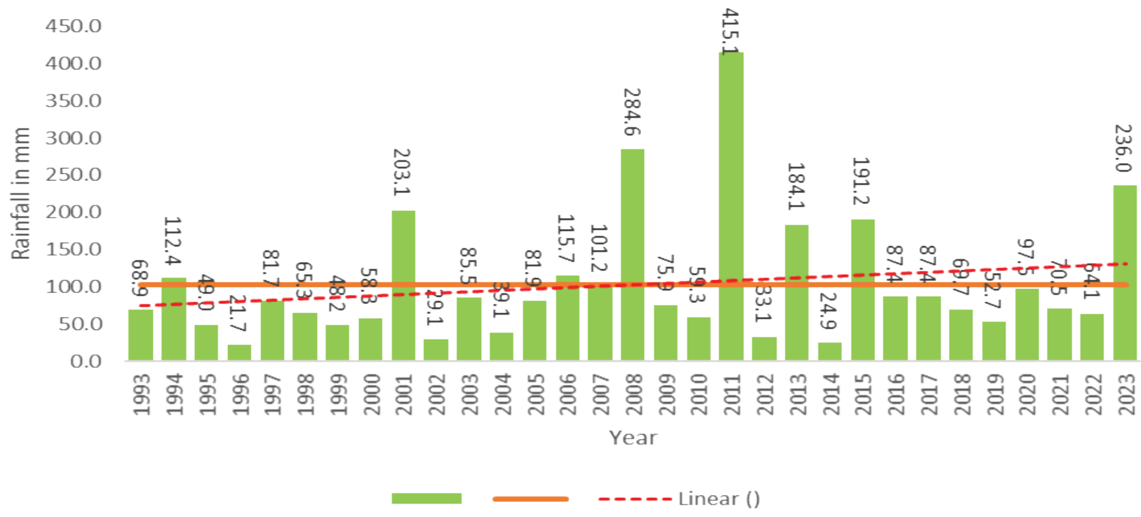

From the mid-1990s to early 2000s, rainfall generally fluctuated, with noticeable lows in 1998 and 1999. However, there was a recovery beginning from year 2001, with rainfall reaching over 700 mm consistently through much of the 2000s. The years 2011 and 2013 were particularly wet, indicating a potential for heavy rainfall during monsoon seasons. The trend also indicates a dip in 2017, where rainfall dropped to 471.3 mm, followed by a rebound in subsequent years. Fig. 2 indicates the departure of annual rainfall from its mean, with saffron coloured bars highlighting the years of meteorological drought like conditions.

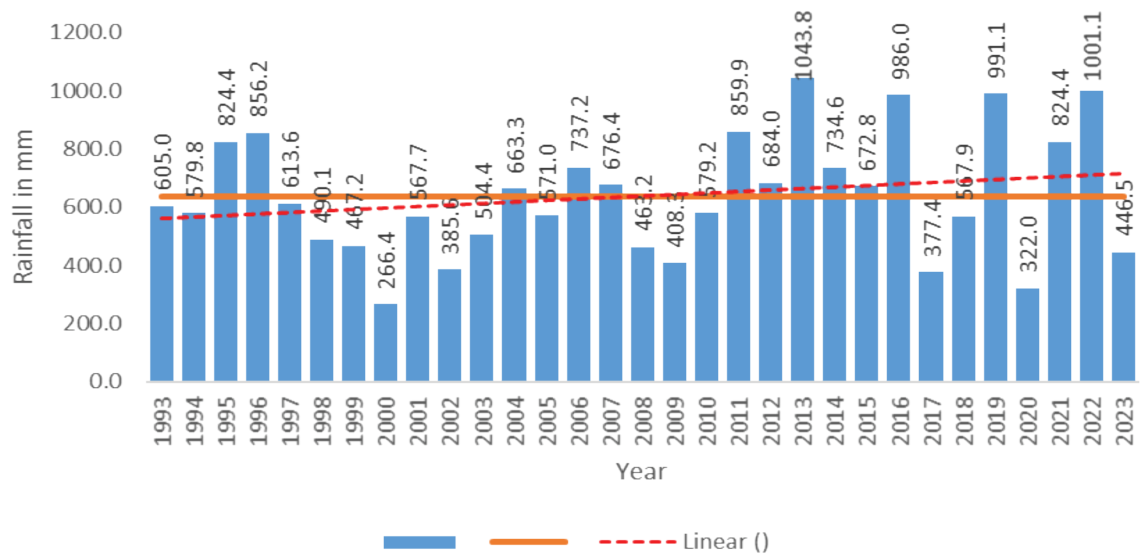
## Fig 2 Average annual departure of Rainfall from its long time average (Normal)

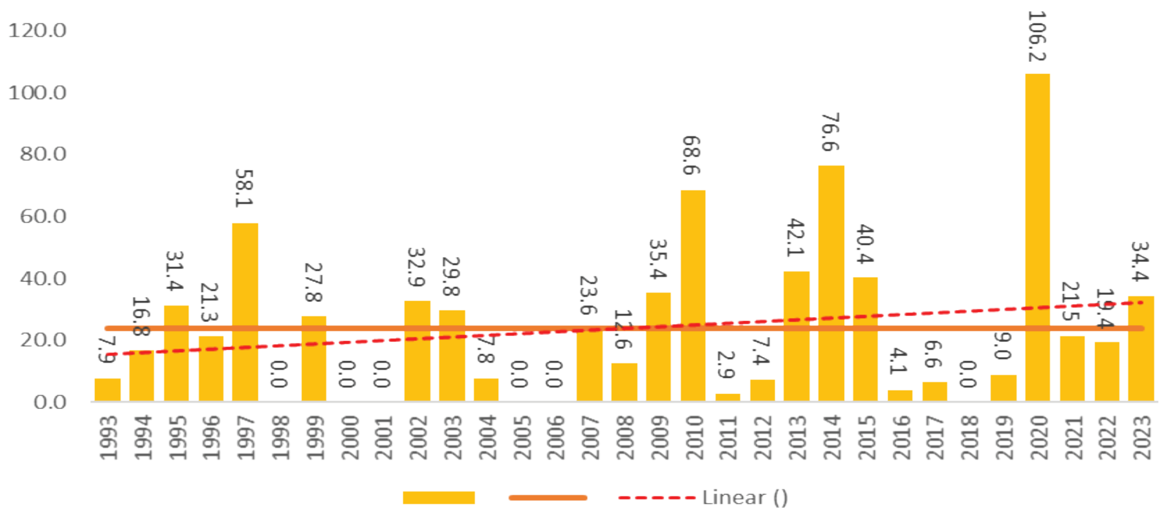



Seasonal variation in Baran's rainfall is marked by a sharp contrast between the wet monsoon and the dry winter and summer months (Fig. 3). Post monsoon, from October to December, the rainfall reduces considerably, averaging less than 50 mm for the entire period. This decline continues into the winter seasons (January to February), which sees very little precipitation due to the dominance of dry continental winds. The pre-monsoon summer, from March to May, is characterised by high temperatures with low intensity rainfall, sometimes associated with thunderstorms.

**Fig 3 Seasonal Variation of Rainfall**




This seasonal variability has implications for agriculture, as monsoon rains are critical for the districts' predominantly rainfed cropping systems, particularly for crops like soybean, wheat and pulses. However, the high dependence on monsoon rainfall makes Baran district vulnerable to droughts, impacting water availability and crops yield. Managing water resources and developing irrigation facilities remain essential for coping with this rainfall seasonality and supporting agricultural productivity in the district.

**Baran district experiences high temperatures, often exceeding 40°C, with peak temperatures sometimes reaching 46- 47°C, especially in May and early June.**

## Temperature

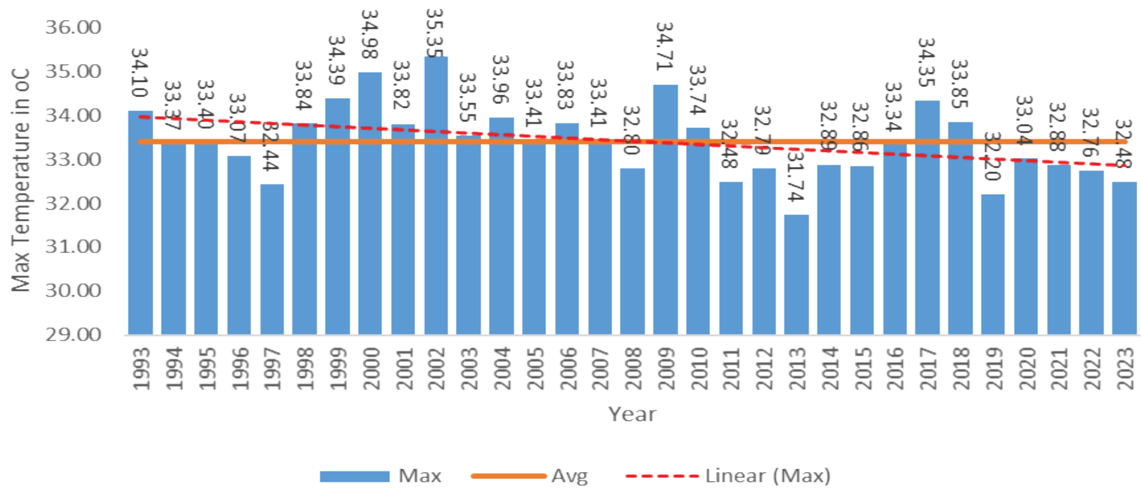
Baran district, localised in south eastern Rajasthan, experiences significant temperature variations across seasons, typical of a semi-arid to subtropical climate. The district temperature ranges widely between the summer and winter months with considerable fluctuations and some extreme temperature events recorded over the last 30 years.

### Maximum Temperature and its variations:

In the summers months, from April to June, Baran district experiences high temperatures, often exceeding 40°C, with peak temperatures sometimes reaching 46- 47°C, especially in May and early June. Heatwaves are common, intensifying summer's harshness and impacting daily life, agriculture, and water availability. The highest temperature in the past few decades has touched around 48°C, indicating the region's vulnerability to extreme heat events.

The analysis of maximum temperature data for Baran District from years 1993 to 2023 reveals declining trends and fluctuations (Fig. 4). The average maximum temperature is 33.41°C. In the early years, particularly between years 1993 to 2005, maximum temperatures show slight variations, with a peak of 35.35°C in 2002. After this peak, there appears to be a gradual decline in maximum temperatures until year 2013, when the lowest maximum temperature recorded was 31.74°C.

Fig 4 Average Annual Maximum Temperature, Trend and Variations



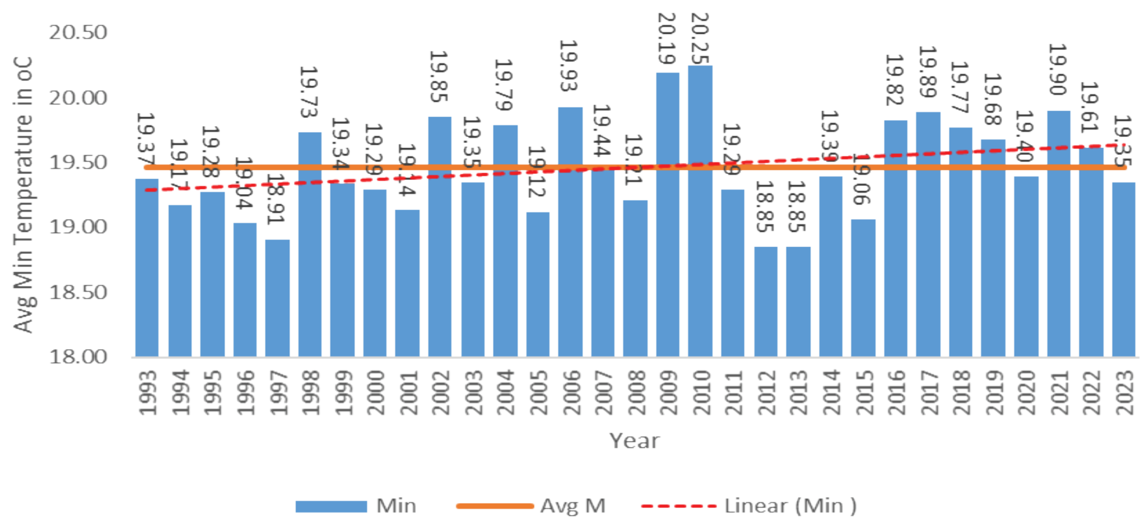

From 2014 onwards, there has been a gradual increase, with temperatures rising again, peaking at 34.98°C in 2000 and 34.39°C in 1999. The years 2011, 2018, and 2019 also exhibited relatively higher maximum temperatures, suggesting fluctuations influenced by seasonal and yearly climatic factors. The recent years, between 2020 to 2023 show maximum temperatures stabilizing around the lower 32°C range, with the highest at 33.04°C in 2020 and the lowest at 32.20°C in 2019. Hence, while the data indicates variability in maximum temperatures, the long-term average shows a slight decline.

## Minimum Temperature

During winter, from December to February, Baran district experiences a sharp drop in temperature, with night time lows ranging between 4ºC and 8ºC. Occasionally, temperatures dip close to freezing, particularly in January. The coldest recorded temperatures in recent years have been around 1-2ºC with rare events bringing frost conditions which damage crops.

The average monthly minimum temperature for Baran District from years 1993 to 2023 is recorded at 19.46°C (Fig. 5). The trend line shows a slight increase, while the average monthly minimum temperatures ranged from a low of 18.91°C in 1997 to a high of 20.25°C in 2010. The years 2008 and 2009 saw notable increase, with average minimum temperatures reaching 20.19°C and 20.25°C, indicating a possible warming trend during that period.

Fig 5 Average Annual Minimum Temperature, trend and Variations

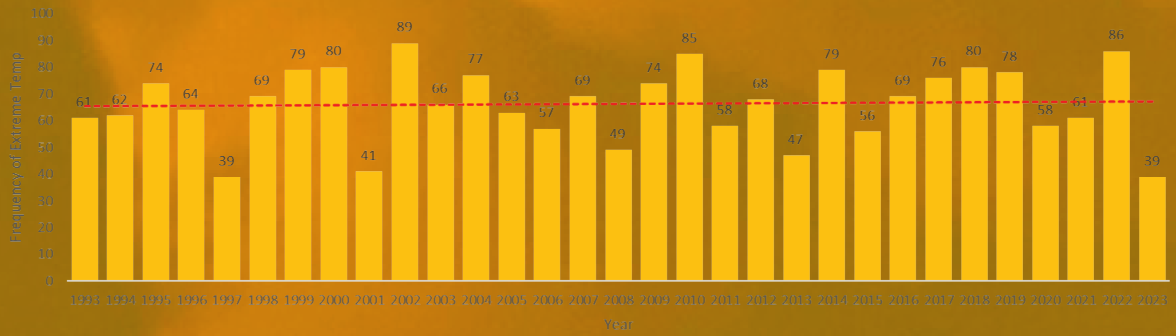


In the subsequent years, particularly from 2012 to 2023, minimum temperatures increased, with a low of 18.85°C recorded in both 2012 and 2013. This indicates an increasing trend in the latter part of the years, although minor variations persist. Understanding these trends is essential for adapting practices and developing strategies in response to shifting temperature patterns.

## Extreme Temperature Events

The frequency of extreme temperature events in Baran District over the past 30 years exhibits notable fluctuations, reflecting variations in climatic conditions (Fig. 6). The data reveals a peak in extreme temperature days in 2002, with 89 days recorded, and another significant spike in 2010, with 85 days. There have been severe heatwaves, particularly in years 2002 and 2010. These temperatures stress the agricultural system, affecting crop productivity and water resources, and pose health risks for residents, highlighting the need for climate adaptive measures in the region.

**Fig 6: Frequency of Extreme Temperature Events**




The late 1990s and early 2000s experienced higher frequencies of extreme temperature events, particularly in 1999 and 2000, with 79 and 80 days, respectively. This period suggests a trend towards more extreme weather events. On the other hand, the years 1997 and 2013 marked some of the lowest counts, with only 39 and 47 extreme days, indicating milder conditions during those years. From 2011 onwards, the numbers generally fluctuated but remained relatively high, with years like 2022 showing 86 extreme days. However, 2023 saw a significant drop back to 39 days, indicating a potential return to milder conditions.

## Potential Climate Risks

The rainfall and temperature patterns in Baran District present several potential climate risks that can have profound implications for the region's environment, economy, and public health.

Firstly, the variability in rainfall—marked by droughts to heavy downpours—poses significant risks to agriculture. Crop yields are highly dependent on consistent rainfall, and the fluctuation between excessive moisture and drought conditions can lead to crop failure, threatening food security for local populations. This instability can also drive farmers into debt cycles as they attempt to adapt to changing conditions.

Secondly, the fluctuation in max and min temperatures, along with the frequency of extreme temperature events, may increase heat stress in crops, people and livestock. This stress will not only reduce agricultural productivity but can also lead to health issues among the local residents, particularly the vulnerable groups such as the elderly and children. Additionally, the combined effects of unpredictable rainfall and rising temperature can strain water resources. Prolonged dry spells can diminish groundwater levels, while heavy rainfall can lead to runoff and flooding, impacting water quality and availability.

The region also faces ecological risks, as changing climate patterns can disrupt local ecosystems and biodiversity. Increased temperatures and altered rainfall also affect species distribution and leads to the loss of habitats. Finally, these environmental challenges can create economic instability, as farmers and local businesses struggle with the unpredictability of climate conditions. Therefore, comprehensive strategies for climate adaptation, including sustainable agricultural practices and effective water management, are essential for mitigating these risks in Baran district.

# Sectoral Vulnerability

## Agriculture and allied sector

The vulnerability of the agriculture sector with respect to potential climate risks is assessed on the basis of six indicators, which are- proportion of small and marginal farmers, percentage of rainfed agriculture, percentage of area covered under crop insurance, employment under MNERGA and work participation of women. The district has a higher percentage of marginal and small landholders (67.20%) compared to the state average of 62.02%. (Table 1), which emphasizes a greater reliance on small-scale farming. The district also has a significantly greater reliance on rainfed agriculture, with 74.50% of its area under such cultivation, compared to 59.64% state wide. This vulnerability to erratic rainfall leads to considerable yield variability, measured at 19 % in Baran, surpassing the state's average of 17%. Such variability threatens food security and farmer livelihoods. In terms of risk management, Baran shows a satisfactory adoption of crop insurance under the Pradhan Mantri Fasal Bima Yojana (PMFBY), with 48% of its area insured, compared to that of 30% statewide. This proactive approach may help mitigate some adverse effects of climate-related uncertainties.

**Table 1 : Indicators used for assessing Agriculture and allied sector vulnerability**

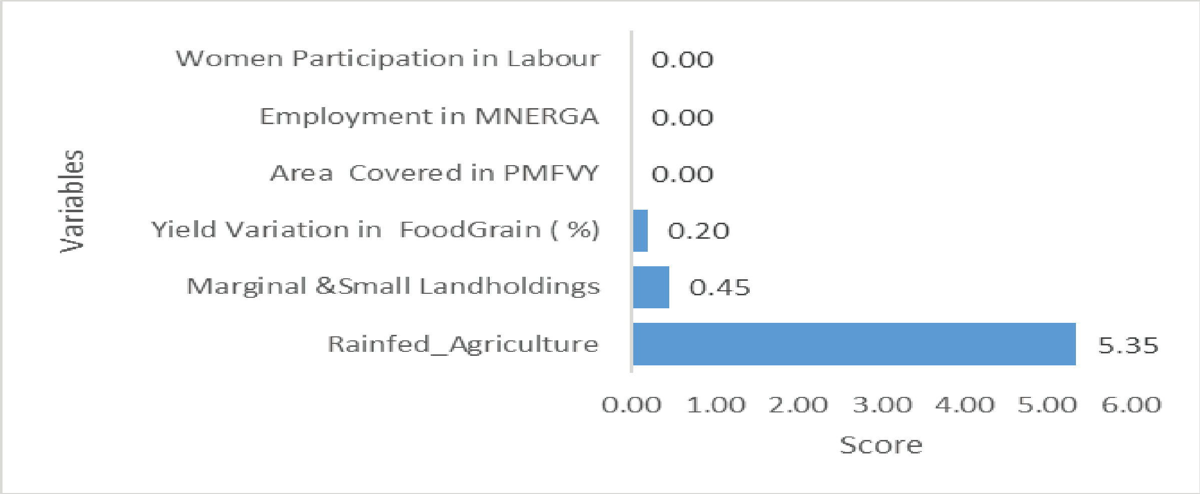
| Indicator | Bran | State |
|---|---|---|
| % of margin and small landholders | 67.20 | 62.02 |
| % of The Area Under Rainfed Agriculture | 74.50 | 59.64 |
| % Area Covered into crop insurance Under PMFBY in 000 ha | 48.00 | 30.00 |
| Average person days per household employed under MGNREGA | 58.39 | 46.00 |
| Yield VAriability of Food Grains % | 19.00 | 17.00 |
| Women Participation In The Workforce (%) | 40.00 | 35.12 |

Employment generation through the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is also notable in Baran, with an average of 58.39 person-days per household, surpassing the state average of 46.00. This suggests better utilization of employment schemes, aiding rural livelihoods. Furthermore, women's participation in the workforce is stronger in Baran (40.00%) compared to the state (35.12%), indicating progress in gender inclusivity in agriculture.

Based on the district's scores, the key driver of vulnerability appears to be a higher dependency on monsoonal rainfall. The district's score for rainfed agriculture stands at 5.35, significantly higher than the state score of 1.97 (Fig.7). This reliance on rainfed systems makes crops further susceptible to the erratic weather patterns associated with climate change, such as prolonged droughts and intense rainfall events.

A large proportion of marginal and small landholdings highlights limited resources and capacity to adapt to climatic stresses. The yield variation in food grains is another concern, with a score of 0.20, suggesting significant instability in production that jeopardizes food security. On other indicators, the district is comparatively in a better position than the state average.

Fig 7 : Baran : Ranking of Key Drivers of Agriculture sector Vulnerability




## Health Sector

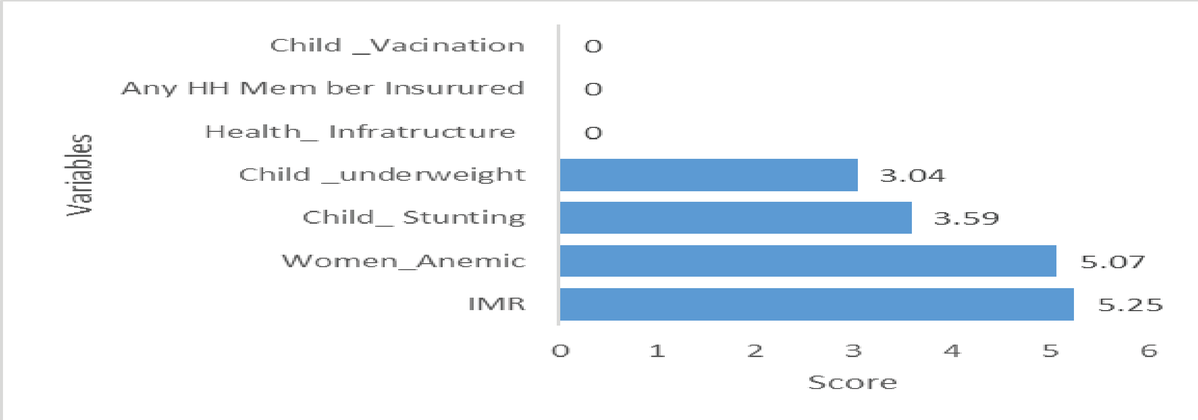
In Baran District, seven health related indicators were taken, which throw light on various facets of public health. On one hand, Baran district has relatively better healthcare infrastructure, with 27.15 facilities per lakh population, exceeding the state average of 24.3. This enhanced access is supplemented by high health insurance coverage, with 89.5% of households having at least one member covered under a financial scheme, which is above the state average of 87.8%. Furthermore, Baran excels in immunization, achieving a remarkable 93.4% vaccination rate for children aged 12-23 months, significantly higher than the state average of 85.3%.

However, the district faces critical challenges, particularly concerning child nutrition and maternal health. The percentage of stunting and underweight in children under five is alarmingly high at 46% and 40.2%, respectively, compared to 31.8% and 27.6% statewide. Additionally, the infant mortality rate in Baran stands at 68 per 1,000 live births, noticeably higher than the state average of 35, highlighting serious gaps in maternal and child healthcare. Moreover, anaemia among women aged 15-49 years is prevalent at 61.3%, surpassing the state rate of 59.4%.

The indicator wise scores highlight key vulnerabilities in the health sector, particularly concerning maternal and child health (Fig. 8). The Infant Mortality Rate (IMR) score of 5.25 indicates a critical issue. Rising temperatures and extreme weather events can exacerbate health risks, leading to increased complications during pregnancy and childbirth, thus contributing to a higher IMR.

Similarly, the high score for women's anaemia (5.07) is distressing, as climate change can adversely affect nutrition by disrupting food production. Changes in rainfall patterns and increased droughts can lead to food shortages, reducing the availability of nutrient-rich foods essential for women's health. This, in turn, affects maternal health and increases the likelihood of complications during pregnancy, perpetuating cycles of poor health outcomes. The scores for child stunting (3.59) and underweight (3.04) further underscore vulnerabilities

**Fig 8 : Baran : Ranking of key Drivers of Health Sector Vulnerability**




linked to climate variability. Nutritional deficiencies arising from disrupted agricultural yields due to erratic weather can lead to long-term developmental challenges for children.

Addressing these health disparities and interconnected vulnerabilities is essential for improving the overall health outcome and enhancing resilience against the adverse effects of climate change for the population in Baran District.

## Education Sector

The education sector in Baran District, Rajasthan, presents a mixed landscape when compared to the state averages, highlighting both areas of progress and significant challenges. One of the critical issues is female literacy; percentage of women with 10 or more years of schooling, which stands at 24.4% in Baran, is lower than the state average of 33.4%. This discrepancy highlights persistent gender disparities in education and emphasizes the need for targeted interventions to promote female education.

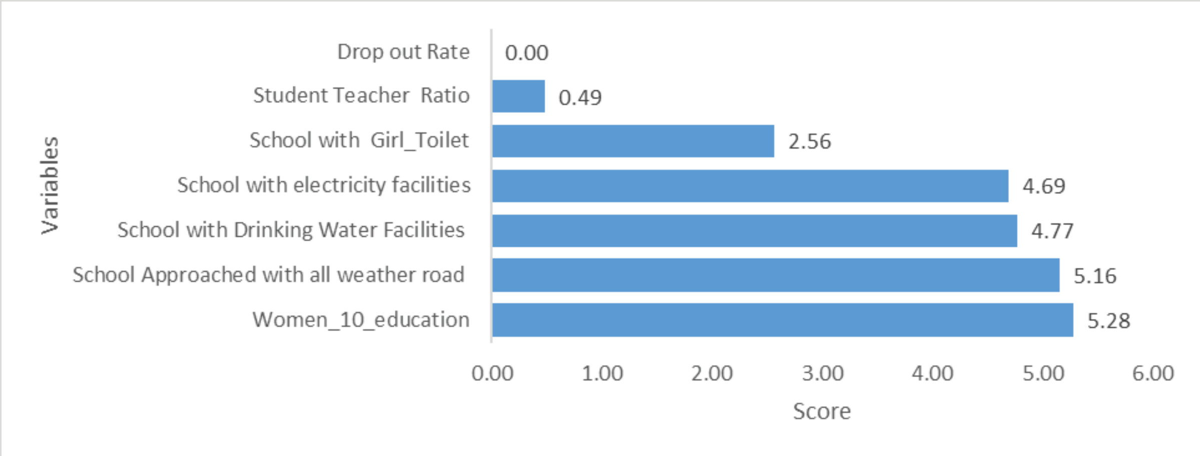
In terms of infrastructure, Baran faces challenges with functional facilities. While 88.67% of schools have functional girls' toilets, this is considerably lower than the state average of 97.95%. Similarly, the percentage of schools with functional drinking water facilities is 85.97%, compared to 97.94% state wide. These deficiencies can hinder attendance and retention, particularly for the female students.

Despite these challenges, Baran shows positive trends in dropout rates at the secondary level, with an average of 6.52%, better than the state average of 7.65%. This suggests effective retention strategies; though further improvement is necessary. The student-teacher ratio in Baran is 18.25, slightly higher than the state average of 16.5, indicating potential challenges in individualized attention for students. Furthermore, only 60.71% of schools in Baran have electricity, significantly below the state average of 86.69%, which can limit learning resources and overall educational quality.

Thus, the key drivers of education sector's vulnerability are the district's lag in female education and school infrastructure (Fig. 9). The score for women with 10 or more years of schooling stands at the top at 5.28, indicating a substantial gap in educational attainment compared to broader benchmarks. This low level of female education can perpetuate cycles of poverty and limit economic opportunities for women, impacting overall community development.

Infrastructure challenges are pronounced, with schools accessible by all-weather roads at a score of 5.16. This limitation can hinder access, especially during adverse weather conditions, discouraging attendance and exacerbating inequalities. The availability of essential facilities such as drinking water (4.77) and electricity (4.69) is also inadequate, which can affect school operations and learning environments, particularly in the context of rising temperatures and unpredictable rainfall associated with climate change.

**Fig 9 : Baran : Ranking of key Drivers of Education sector Vulnerability**




These vulnerabilities are closely linked to climate change. Increasing temperatures and erratic weather patterns can damage infrastructure, limiting access and aggravating existing disparities. Additionally, climate-induced stress on local resources can impact families' economic stability, making education a lower priority. Addressing these interconnected issues is essential for enhancing educational outcomes and resilience in Baran District.

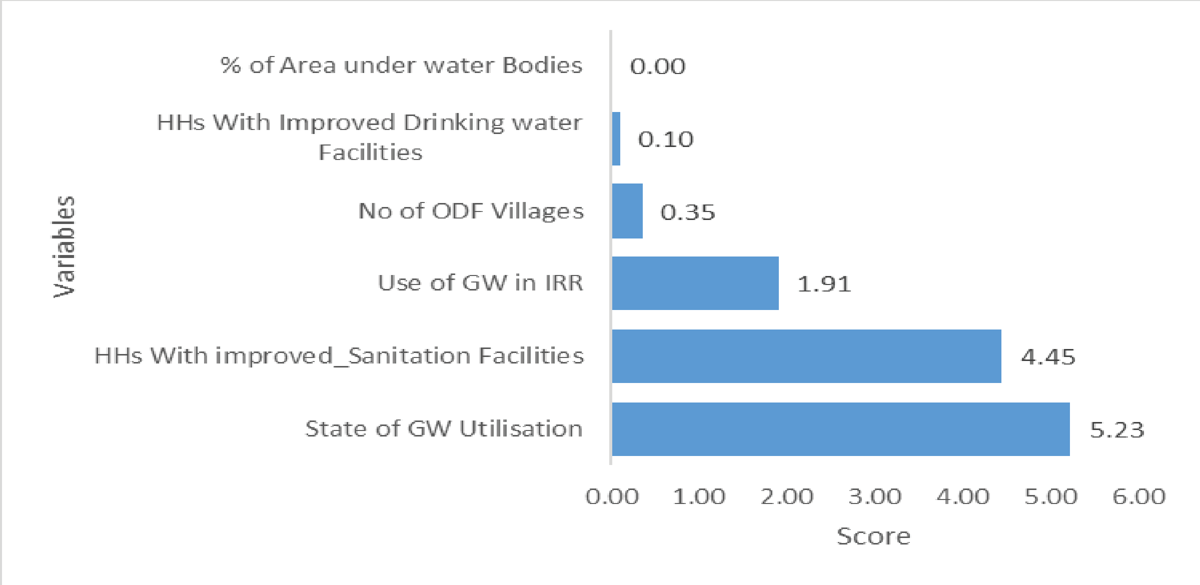
## Water and Sanitation Sector

The indicator used to assess the sectoral strength and vulnerability of water and sanitation sector of Baran district reflects that the percentage of households with access to improved drinking water sources, which stands at 96.1%, is almost at par with the state average of 96.5%. This indicates that Baran district has achieved satisfactory coverage in providing safe drinking water, a critical component for public health. However, Baran faces significant challenges regarding groundwater utilization and their sustainability. The district has an alarming groundwater utilization rate of 128%, much higher than the state average of 74%. This over-extraction raises concerns about long-term water availability and sustainability, particularly in the context of climate change, as the district is already confronting changing rainfall patterns.

With regards to data related to the coverage of Improved sanitation facilities, district Baran lags behind the state average of 71.1% at 59%. This gap in sanitation infrastructure can lead to health risks, affecting the community well-being. However, the percentage of villages certified as ODF Plus (Open Defecation Free Plus) is high at 96.9%, which is only slightly lower than the state average of 97.7%, reflecting ongoing efforts toward sanitation improvement. The district also has a higher percentage of area under wetlands at 2.89%, compared to the state's 2.29%. Wetlands play a crucial role in water management and biodiversity, but their potential is underutilized in Baran.

From the scores obtained through Principal Component Analysis (PCA), it is evident that the District highlights several key vulnerabilities that pose significant challenges for the community. The top concern is a high groundwater utilization rate, which scores 5.23. This indicates a heavy reliance on groundwater resources, raising sustainability issues, especially in the context of climate change. Increased frequency of droughts and erratic rainfall patterns can exacerbate the depletion of groundwater, threatening long-term water availability for both domestic and agricultural use. Access to improved sanitation facilities is the second critical indicator, with a score of 4.45. A substantial portion of the population lacks adequate sanitation, which can lead to public health issues, including spread of waterborne diseases. This deficiency in sanitation infrastructure becomes even more pressing as climate change can contribute to flooding and contamination of water sources, further compromising community health.

Fig 10 Baran : Ranking of key Drivers of Water and Sanitation sector Vulnerability




The score for groundwater use in irrigation stands at 1.91, reflecting inefficiencies in agricultural practices. Over-extraction for irrigation not only depletes local aquifers but also makes agriculture more vulnerable to climate impacts. The score of 0.10 for households with improved drinking water facilities highlights a satisfactory improvement.

Altogether, Baran has made important strides in water access and sanitation drives, although challenges related to groundwater sustainability and sanitation facilities require urgent attention, especially in the face of climate change. Efforts should be prioritized to improve access to improved sanitation facilities, such as toilets and waste management systems, particularly in rural areas. This can involve community-led sanitation programs, hygiene education campaigns, and the construction of decentralized sanitation facilities to ensure equitable access across the district.

## Composite level of sectoral Vulnerability and ranking of indicators

The above indicator based sectoral vulnerability analysis reveals that the education sector is the most vulnerable in Baran district, with an average composite score of 3.28, significantly higher than the state average of 0.67. This indicates significant challenges and weaknesses in the education system within the district. The high vulnerability in the education sector highlights the urgent need to prioritize interventions aimed at improving education services and enhancing access to basic facilities in the schools. Following education, the health sector also exhibits vulnerability, although to a lesser extent compared to education. With a composite score of 2.42, the health sector in Baran district faces challenges related to child stunting, underweight, IMR and anaemia in women. The third and fourth vulnerable sector in the district is water and sanitation followed by agriculture with composite scores of 2.01 and 1.00 respectively.

Therefore, prioritizing interventions in the Education sector, followed by Health, Water and Sanitation, and Agriculture, can effectively address vulnerabilities and enhance resilience in Baran district, ultimately improving the well-being and livelihood of its residents.

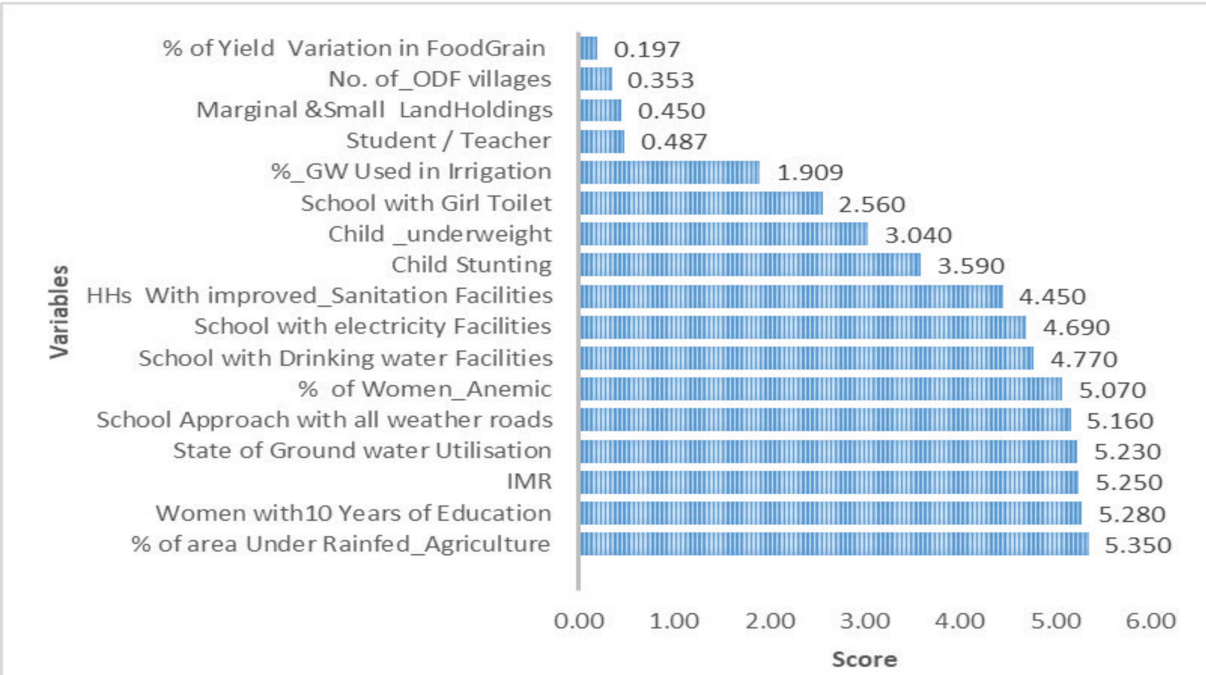
## Area of concern

Baran district faces a range of critical vulnerabilities across multiple sectors, with many indicators showing significant challenges, particularly in agriculture, health, education, and water management. Out of the 26 indicators of sectoral vulnerability, 17 indicators play a significant role in the district's vulnerability (Fig. 11). One of the most pressing concerns is rainfed agriculture, with a score of 5.35, highlighting the district's heavy reliance on unpredictable rainfall for crop production. This leaves agriculture highly vulnerable to climate variability, such as droughts and erratic monsoons, impacting food security and farmer livelihoods, thus making agricultural incomes unstable.

In the health sector, the district struggles with high infant mortality rates (IMR) (score 5.25) and higher percentage of anaemia among women (5.07), which signal underlying issues in maternal and child health. Poor nutrition, limited access to healthcare, and inadequate sanitation contribute to these health challenges. Additionally, high levels of stunting and underweight children further reflect widespread issues with malnutrition, which have long-term impacts on child development and future productivity.

In terms of education, the relatively high student-teacher ratio (5.16) and low availability of girls' toilets in schools (2.56) point to significant barriers in providing quality education. Inadequate school infrastructure, such as a lack of drinking water facilities (4.77) and electricity (4.69), further diminishes the quality of education, particularly in rural areas where these facilities are crucial for learning.

**Fig 11 Baran : Ranking of key Drivers of District Vulnerability**




The district's groundwater utilization (with a high score 5.23), particularly for irrigation, raises concerns over sustainability. The high dependency on groundwater for agriculture, coupled with inadequate sanitation facilities (4.45), creates additional vulnerability, especially in the face of climate change. Limited water bodies also restrict the district's capacity to manage water resources effectively.

Hence, addressing climate-induced risks in Baran District requires comprehensive adaptation and mitigation strategies across sectors. This includes improving irrigation systems, expanding healthcare access, promoting gender equality in education, enhancing sanitation infrastructure, and strengthening water conservation efforts to build resilience against climate-related risks. Collaborative efforts involving government agencies, civil society organizations, and local communities are essential to build resilience and mitigate the impacts of climate change on vulnerable sectors in the district.