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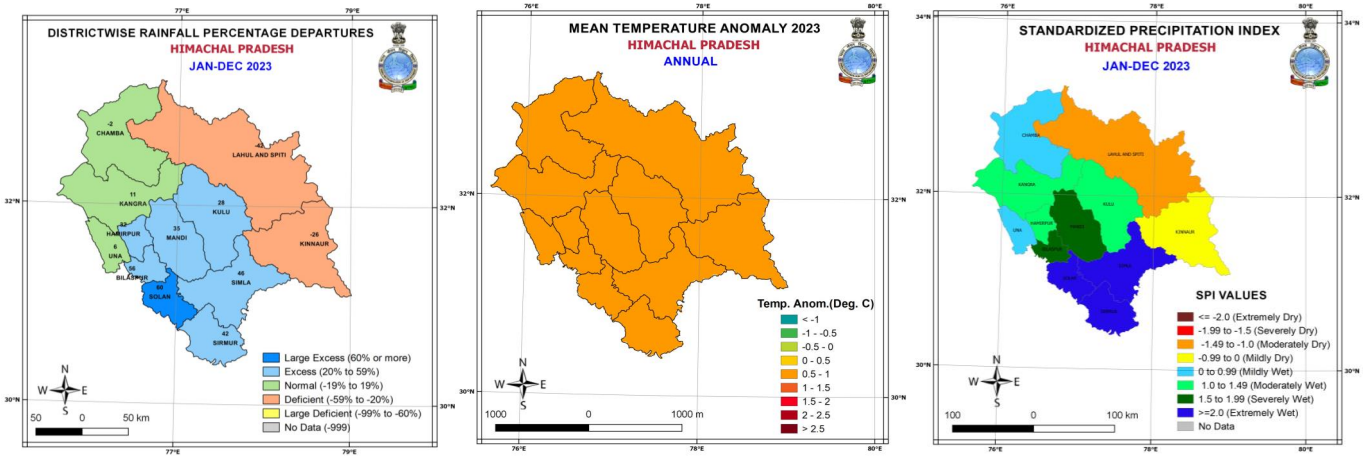
Government of India
पृथ्वी विज्ञान मंत्रालय (एम. ओ. ई. एस.)
Ministry of Earth Sciences (MoES)
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
जलवायु अनुसंधान एवं सेवाएँ
CLIMATE RESEARCH AND SERVICES



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STATEMENT ON CLIMATE FOR THE STATE OF HIMACHAL PRADESH: 2023

JOINTLY PREPARED BY
India Meteorological Department and Government of Himachal Pradesh

द्वारा जारी / ISSUED BY
जलवायु निगरानी और प्रागुक्ति समूह / Climate Monitoring and Prediction Group
जलवायु अनुसंधान एवं सेवाएँ का कार्यालय / Office of Climate Research and Services
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हिमाचल प्रदेश राज्य के लिए जलवायु पर वक्तव्य: २०२३

Statement on Climate for the state of Himachal Pradesh: 2023

जलवायु अनुसंधान एवं सेवाएँ का कार्यालय
O/o Climate Research and Services,
India Meteorological Department,
Pune 411 005

Preamble:

It gives me immense pleasure to share this scientific document titled, "Statement on Climate for the state of Himachal Pradesh for 2023" jointly prepared by office of Climate Research and Services, India Meteorological Department, Pune (Ministry of Earth sciences) and the Government of Himachal Pradesh. The statement of climate is attempting to capture the regional climate variability of the state especially with reference to weather parameters like; temperature and rainfall which has huge impact on various sectors like Agriculture, Health, Power, Water Management and many other critical domains. The information on severe weather analysis is also presented in this along with statistics which could be, one of the important inputs for state for its Planning Purpose, Disaster managements issues and over all the economic sustainability and growth. With the continuous projections of climate scientists globally, indicating the possibility of increase in the severe weather events along with its severity, both at global and regional level, this Annual Update will be very useful to all concerned. The data used in this analysis is from 1901 to 2023 (123 years). I am sure this yearly update with climatological perspectives, will create more awareness among all the stake holders, users in the state about the climate of the state and would enable to move parallelly with relevant global and regional scientific directives or advisories in the coming time.

This statement on climate of 2023 also includes the inputs like loss and damage data due to severe weather and other weather-related factors from the Government of Himachal Pradesh. I wish that such joint ventures and integrated approach will yield more benefits to the society, state and in turn to our Nation.

Looking forward for your feedback and will work together.

K. S. Hosalikar
Head, Climate Research and Services,
India Meteorological Department,
Pune.

February 2024

HIGHLIGHTS

The Himachal Pradesh State averaged annual mean land surface air temperature (17.13 ^{0}C) during 2023 was +0.70^{0}C warmer than its Long Period Average (LPA) for the period 1981-2010 thus making it the 7th warmest year on record for the state since 1901.

The annual maximum temperature averaged over the state during the year 2023 was warmer by +0.64^{0}C (9th warmest year since 1901), while annual minimum temperature was warmer +0.76^{0}C (8th warmest year since 1901).

Out of 12 districts of the state, 1 district received large excess rainfall (+60 % or more of its 1971-2020 period LPA), 6 received excess rainfall (+20% to +59% of its LPA), 3 received normal rainfall (-19% to +19% of its LPA) and remaining 2 districts received deficient rainfall (-59% to -20% of its LPA).

Objective

The objective of this brief report is to provide the analysis of state's temperature, rainfall and extreme weather events that occurred during 2023. This report will be useful for various stakeholders and general public who are interested on the latest weather and climate conditions and its impact in 2023.

Introduction

India Meteorological Department (IMD) is the official agency responsible for providing operational weather and climate services required for the country in various sectors. IMD provides climate services through its office of the Climate Research and Services (CRS) situated in Pune. As part of its climate monitoring activities, CRS office in coordination with IMD's state Meteorological Centers and state governments have decided to issue the statement of annual climate 2023 for each individual state in line with the annual statement of climate issued for the country. The present statement contains, important information about the monthly, seasonal and annual State averaged temperature, rainfall and Standardized Precipitation Index (SPI) for the year 2023 and as well as long term trend for some of the parameters. This statement also includes State specific information related to various extreme weather and climate events experienced during 2023.

Temperature

The monthly, seasonal and annual maximum, minimum and mean temperature anomalies averaged over the State of Himachal Pradesh for the year 2023 is given in the **Fig. 1**. The anomalies were computed based on the LPA for the period 1981-2010. Top 10 warmest/coolest months/seasons are marked on the graph. It may be mentioned that the pre-monsoon (March to May) season as a whole was relatively cooler for the state while, the winter, monsoon and post monsoon seasons were relatively warmer. The annual maximum and minimum temperature averaged over the state during the year 2023 were warmer by +0.64^{0}C (9th warmest year since 1901) & +0.76^{0}C (8th warmest year since 1901)

respectively. The mean temperature for the state was +0.70^{0}C warmer than the average (7th warmest year on record since 1901).

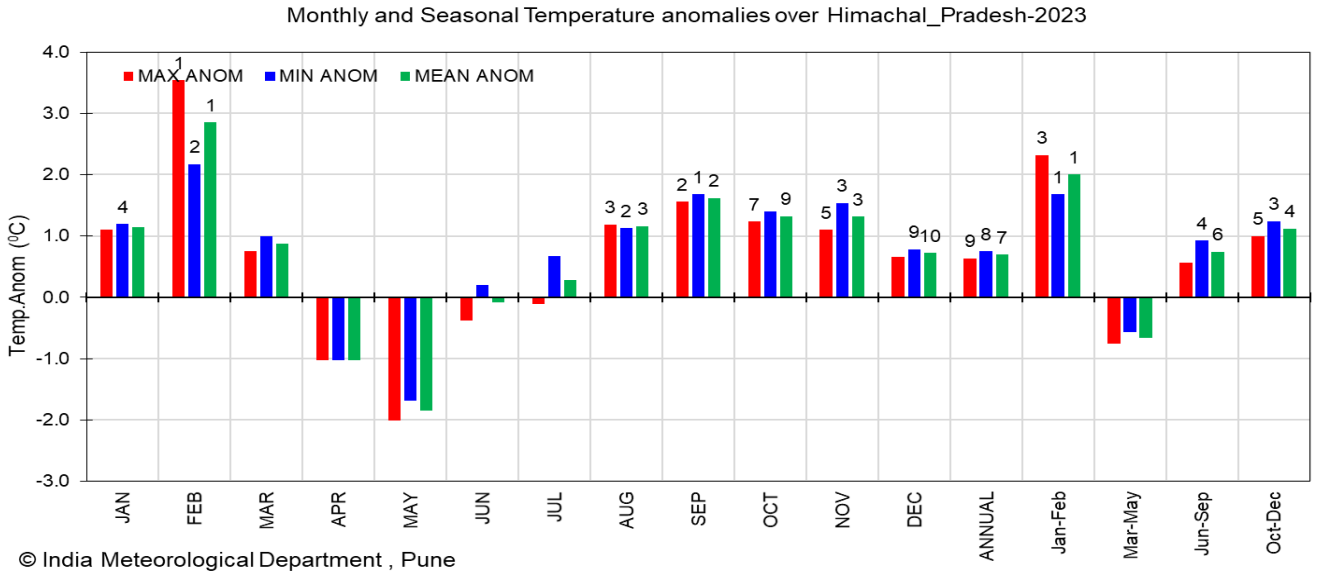
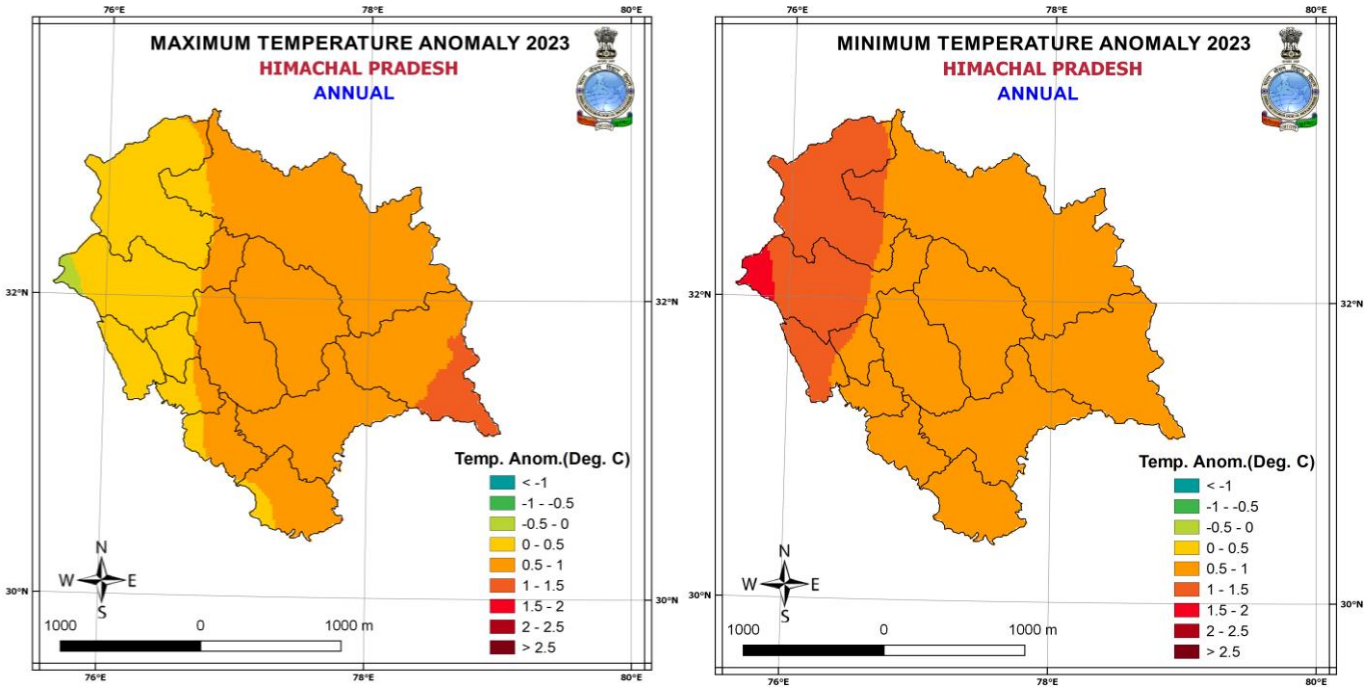


Fig. 1: Monthly and Seasonal Maximum, Minimum and Mean Temperature anomalies averaged over Himachal Pradesh during 2023.The anomalies were computed from the LPA base period of 1981-2010 The numbers above/below the bar indicate top 10 warmest/coolest ranking since 1901

The Spatial pattern of annual maximum, minimum and mean temperature anomalies over Himachal Pradesh during 2023 is given in **Fig 2**. The temperature anomalies were within +0.5^{0}C to +1^{0}C over most parts of the state. However, over northwest parts of the state, minimum temperature anomalies were between +1 to +2 ^{0}C.



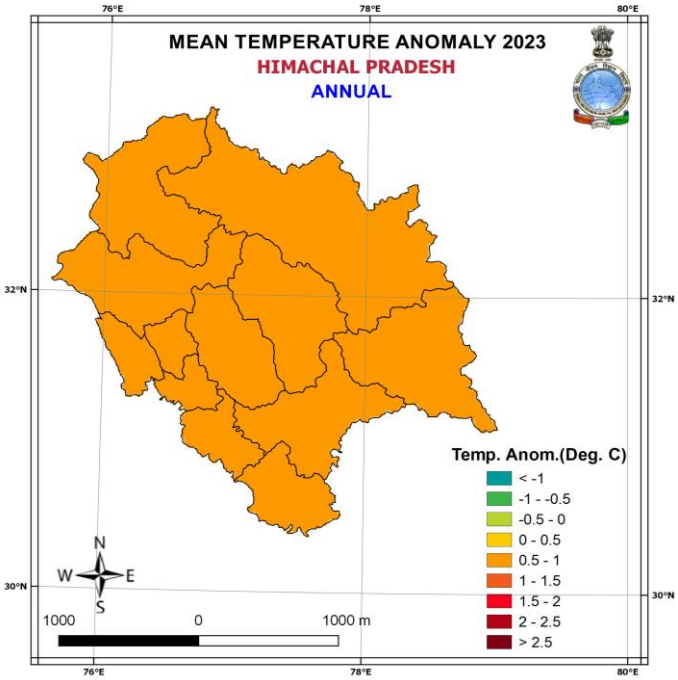


Fig. 2: Spatial pattern of Annual Maximum, Minimum, and Mean Temperature anomalies over Himachal Pradesh during 2023. The anomalies were computed from LPA for the base period of 1981-2010

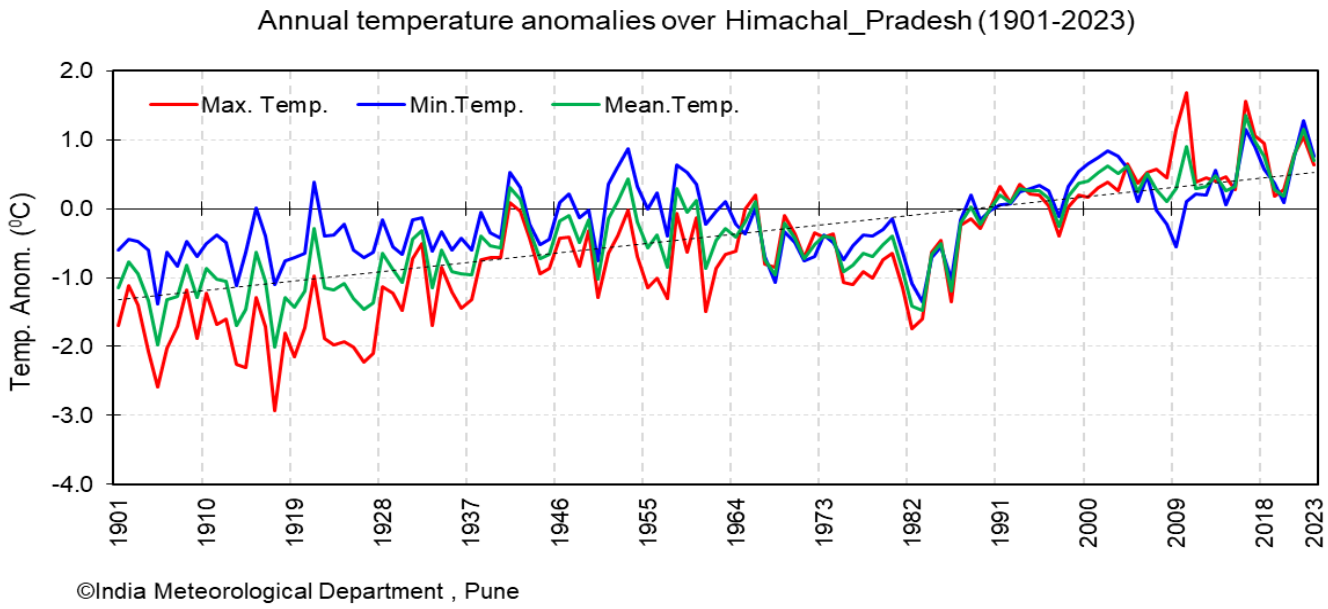


Fig. 3: Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Himachal Pradesh for the period 1901-2023. The anomalies were computed with respect to the base period of 1981-2010. The dotted black line indicates the linear trend in the annual mean temperature time series

The time series of variation of annual maximum, minimum and mean land surface air temperature anomalies averaged over the State for the period 1901-2023 is given in **Fig 3**. A significant increasing trend of +1.51 ^{0}C/100 years is observed in the state averaged annual mean temperature for the period 1901-2023. It was more pronounced in terms of maximum temperature (+2.18 ^{0}C/100 years) and relatively less pronounced (+0.84^{0}C/100 years) in terms of minimum temperature. The five warmest

years on record in order for Himachal Pradesh are 2016(anomaly+1.361°C), 2022(+1.159°C), 2017(+0.983°C), 2010(+0.896°C) and 2021(+0.777°C).

Fig. 4(a and b) shows daily variation of minimum and maximum temperature anomaly during the year respectively. The anomalies were computed with respect to the base period of 1981-2010. State was relatively cooler both in respect of both minimum and maximum temperature during the second fortnight of April and first and last week of May. January, February, March and June to December were warmer in respect of minimum temperature while February, first fortnight of March and August to December months were warmer in respect of maximum temperature.

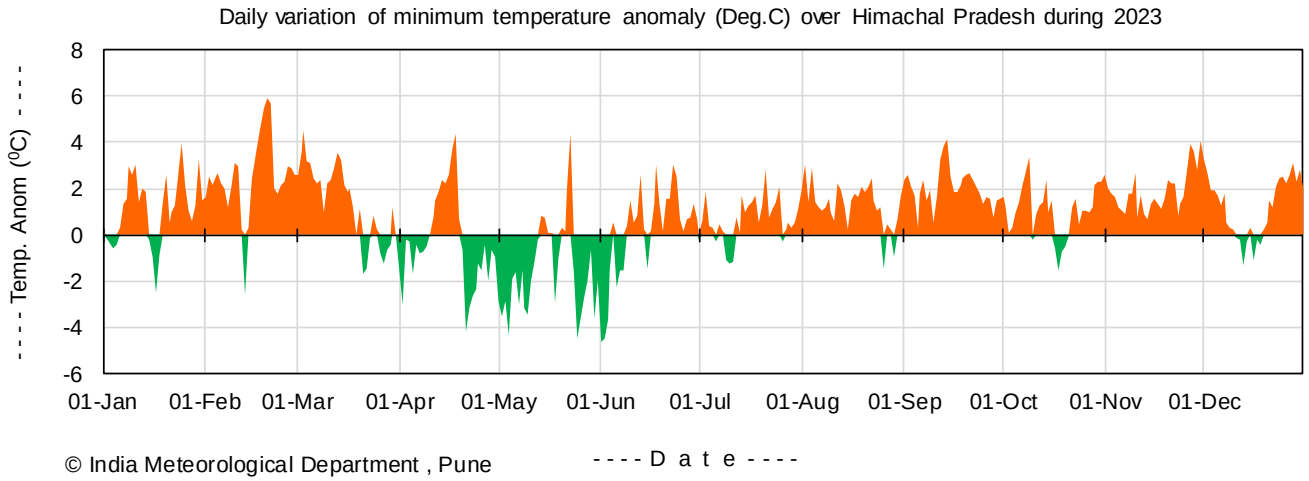


Fig. 4(a): Daily variation of minimum temperature anomaly (^{0}C) over Himachal Pradesh during 2023

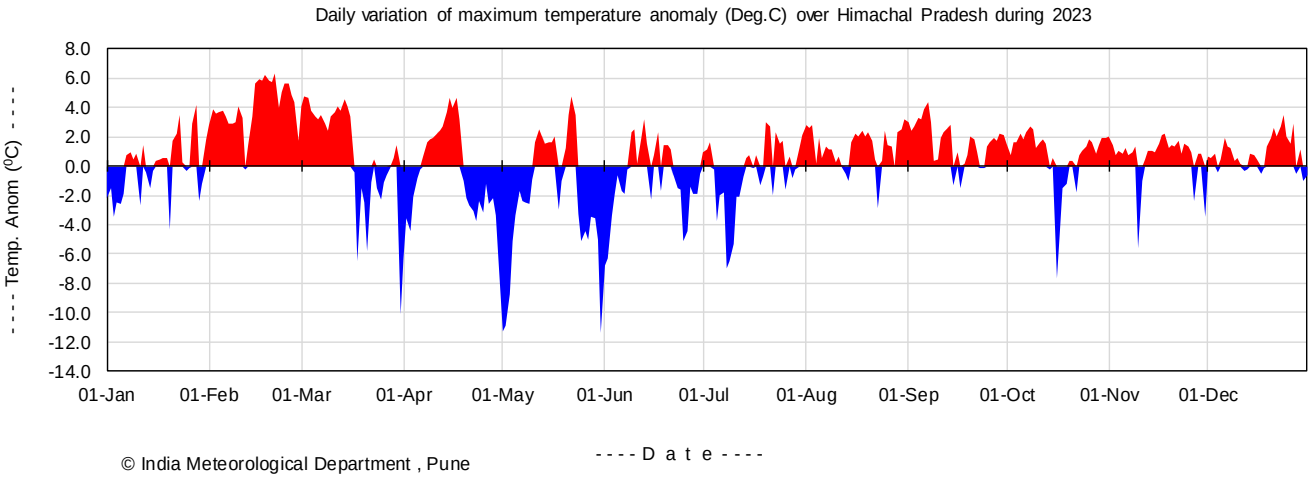


Fig. 4(b): Daily variation of maximum temperature anomaly (^{0}C) over Himachal Pradesh during 2023

Rainfall

Based on 1971-2020 climatology, Himachal Pradesh state as a whole receives 15 % of its annual rainfall during the winter season (Jan-Feb), 19.3% during the pre-monsoon season (Mar-May), 59 % during the southwest monsoon season (Jun-Sept) and 6.7 % during the post-monsoon season (Oct-Dec). Thus, though the southwest monsoon season is the principal rainy season for the state, the

state receives considerable amount of rainfall during the winter and pre-monsoon seasons also. **Fig. 5** shows the annual percentage departure of rainfall over different districts of Himachal Pradesh during 2023. The anomalies were computed based on the 50 year LPA for the period 1971-2020. Out of 12 districts of the state, 1 district viz. Solan received large excess rainfall (+60 % or more of its LPA), 6 received excess rainfall (+20% to +59% of its 1971-2020 period LPA), 3 received normal rainfall (-19% to +19% of its LPA) and remaining 2 districts from north east region of the state received deficient rainfall (-59% to -20% of its LPA).

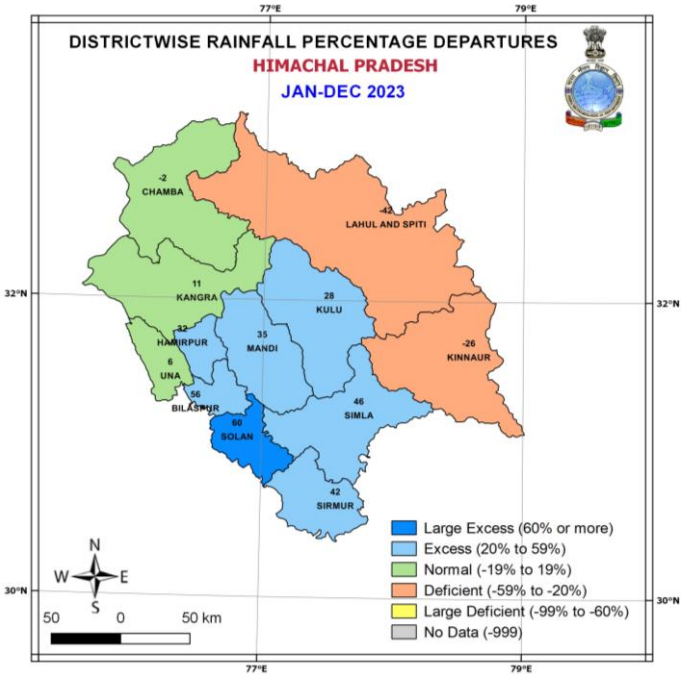


Fig. 5: District-wise annual rainfall percentage departures

The daily variation of rainfall (mm) during the year for the state is shown in **Fig. 6(a)**. The state received above/near normal rainfall on many days from last week of June to second week of August. On three consecutive days of July (9 to 11 July), it received substantially above normal rainfall (103.4mm, 92.4mm and 48.10 mm respectively). However, during September, the state received below normal rainfall on many days at a stretch.

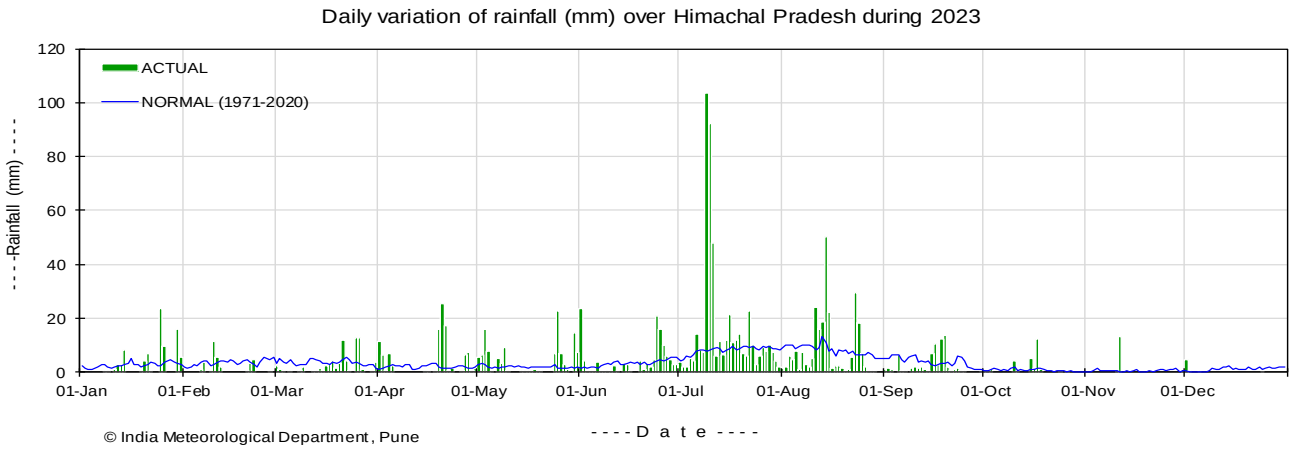


Fig. 6(a): Daily variation of rainfall (mm) averaged over Himachal Pradesh during the year

The time series of variation of % departure of seasonal and annual rainfall for the state for the period 1901-2023 are shown in **Fig. 6(b) and 6(c)** respectively. The departures are calculated with respect to the LPA base period of 1971-2020. During the monsoon season and the year as a whole, the state received 120 % and 107 % of its LPA rainfall respectively.

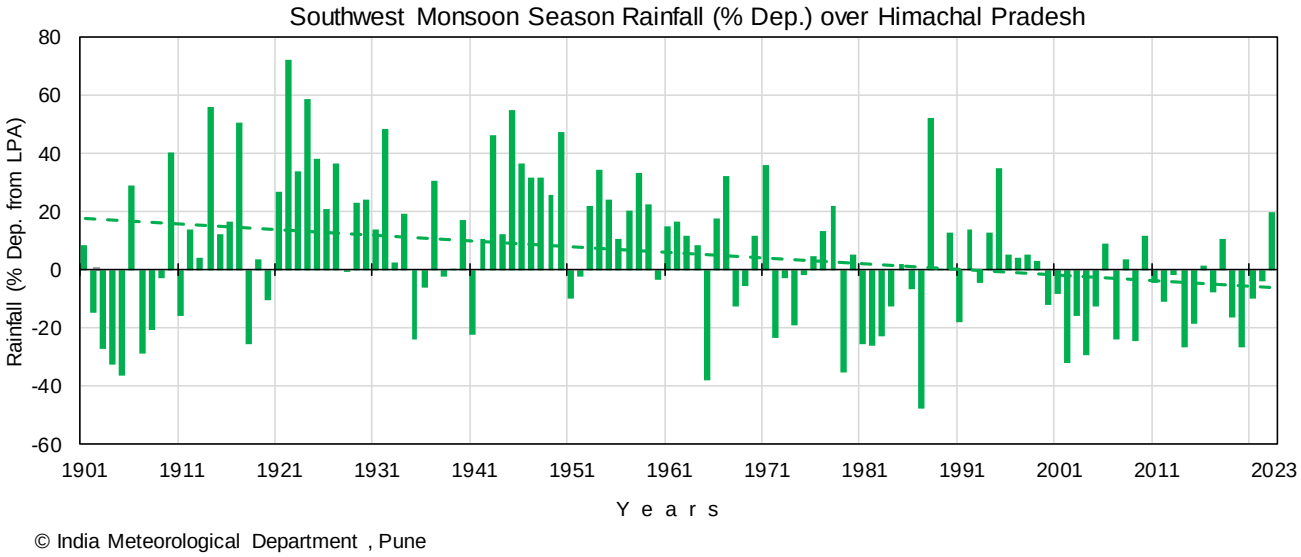


Fig. 6(b): Time series of % departure of southwest monsoon rainfall averaged over Himachal Pradesh (1901-2023)

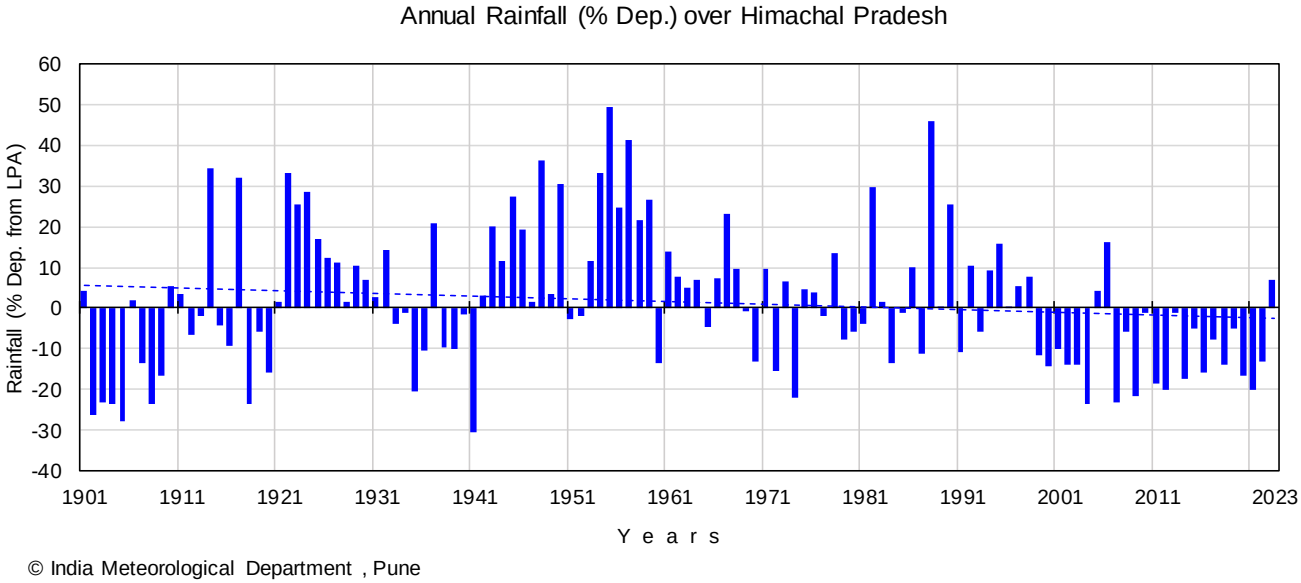


Fig. 6(c): Time series of % departure of annual rainfall averaged over Himachal Pradesh (1901-2023)

Table 1 shows the monthly, seasonal and annual rainfall statistics for the state for the year 2023. The state received deficient rainfall during the winter and post monsoon seasons. However, due to reception of excess rainfall during the pre-monsoon and monsoon seasons, overall the state received normal rainfall by the end of year 2023.

TABLE 1

MONTH / SEASON	ACTUAL (mm)	NORMAL (mm)	% DEP.	CATEGORY
JANUARY	86.8	85.3	1.7	N
FEBRUARY	29.5	101.8	-71.0	LD
WINTER SEASON	**116.3**	**187.1**	**-37.8**	**D**
MARCH	66.7	113.4	-41.2	D
APRIL	103.5	64.0	61.7	LE
MAY	118.2	63.3	86.7	LE
PRE-MONSOON SEASON	**288.3**	**240.7**	**19.8**	**E**
JUNE	120.7	101.1	19.4	N
JULY	447.5	255.9	74.9	LE
AUGUST	246.4	256.8	-4.0	N
SEPTEMBER	67.1	120.6	-44.4	D
MONSOON SEASON	**881.8**	**734.4**	**20.1**	**E**
OCTOBER	27.2	25.1	8.6	N
NOVEMBER	11.7	19.7	-40.4	D
DECEMBER	5.7	38.1	-85.0	LD
POST-MONSOON SEASON	**44.7**	**82.9**	**-46.1**	**D**
ANNUAL	**1331.1**	**1245.1**	**6.9**	**N**

CATEGORY		
	LARGE EXCESS [LE]	+60 % OR MORE
	EXCESS [E]	+20 % TO +59 %
	NORMAL [N]	-19 % TO +19 %
	DEFICIENT [D]	-59 % TO -20%
	LARGE DEFICIENT [LD]	-99 % TO -60 %
	NO RAIN [NR]	-100%

The district-wise trend in annual rainfall for the period 1951-2022 is given in **Fig 7**. It is seen that out of 12 districts of the state, 6 districts viz. Lahul and Spiti , Kinnaur, Simla, Kangra, Solan and Sirmur districts are showing significant decreasing trend while rest of the districts did not show any significant increasing / decreasing trend.

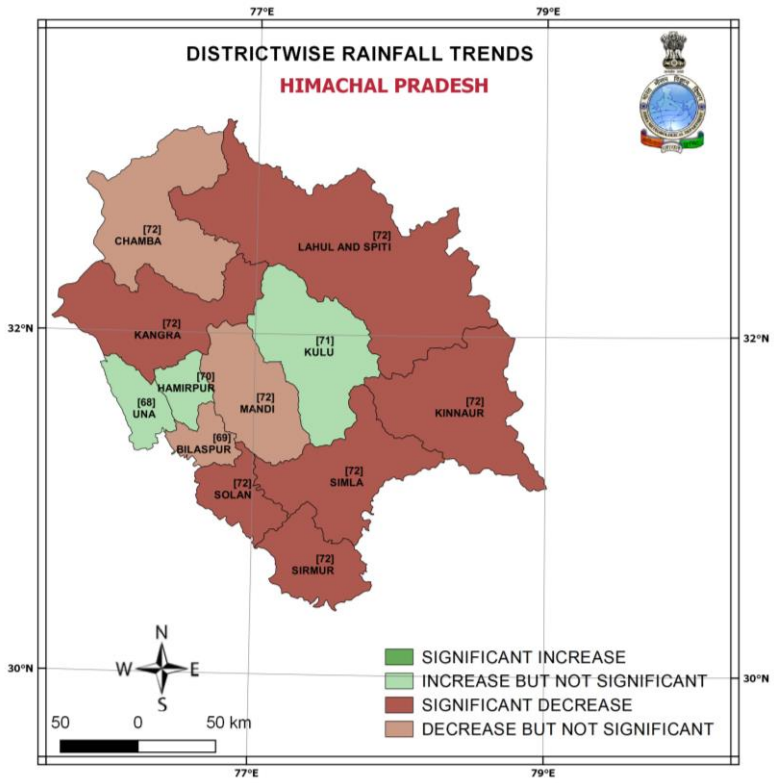


Fig. 7: District-wise annual rainfall Trend for Himachal Pradesh
[Numbers in the bracket for each district indicates the number of years up to 2022 used to calculate the trend]

Standardized Precipitation Index (SPI)

The district wise Annual SPI Map for the state for the year 2023 is shown in **Fig. 8**. The SPI is based on precipitation and is used for measuring drought. This index is negative for drought and positive for wet conditions. As the wet and dry conditions become more severe, the index becomes more positive or negative. Wet conditions of different intensity were observed over many districts of the state. In contrast, over two districts of the state viz. Kinnaur and Lahul and Spiti, mildly dry and moderately dry conditions were observed respectively.

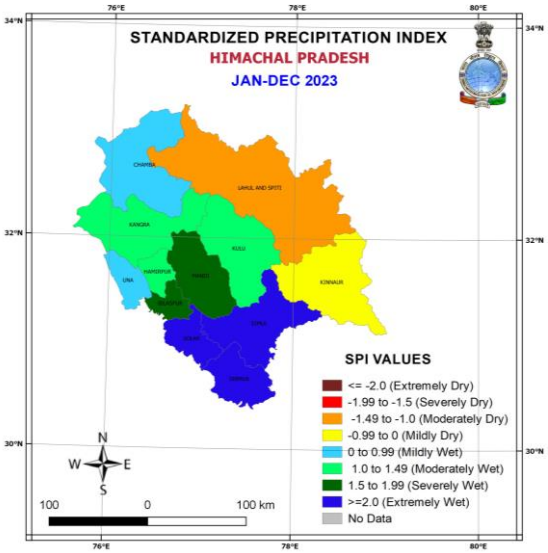


Fig. 8: District wise Annual SPI Map for Himachal Pradesh for the year 2023

Extreme Weather Events

Heavy (64.5-115.5mm), Very heavy (115.6-204.4 mm) and extremely heavy (more than 204.4 mm) rainfall events were recorded over some stations of Himachal Pradesh. **Fig. 9** shows the location and frequency of occurrence of such events during the year. **Table 2** shows the extremely heavy rainfall values with the date of its occurrence and the location.

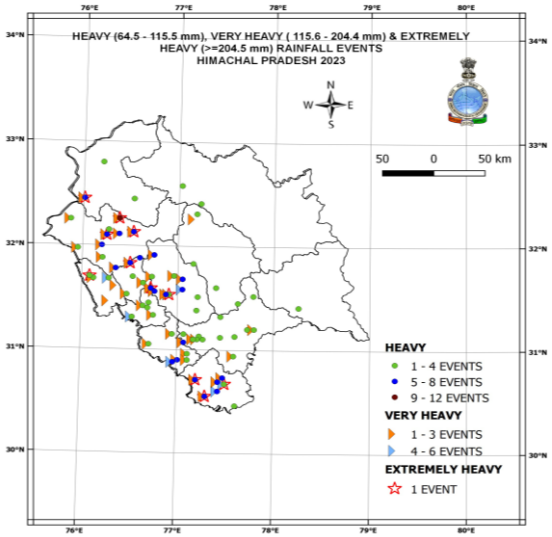


Fig. 9: Location and frequency of heavy, very heavy and extremely heavy rainfall events reported over stations of Himachal Pradesh during the period January to December 2023

Table 2

Extremely heavy rainfall (>= 204.5 mm) or Very heavy (115.6-204.4 mm) recorded over some stations of Himachal Pradesh during January – December 2023 #

DATE	STATION NAME	RAINFALL (mm)
24-JUN	KANGRA AERO	143.5
	KASAULI	145.0
9-JUL	BARTHIN	148.6
	KAHU	171.5
	NAINA DAVI	162.8
	R L BBMB	224.0
	CHUARI	160.1
	MEHRE (BARSAR)	170.2
	NADAUN	160.5
	DEHRA GOPIPUR	175.4
	GHAMROOR	166.0
	GULER	145.0
	NAGROTA SURIAN	154.2
	ROHRU	185.0
	SANGRAHA	180.0
	ARKI	150.0
	KASAULI	172.0
	BANGANA_R	172.0
	UNA	166.2
	UNA RAMPUR AWS	228.5
10-JUL	NAINA DAVI	198.4
	CHUARI	193.0
	MEHRE (BARSAR)	145.8
	ROHRU	160.0
	PACHHAD	220.3
	RENUKA / DADHAU	160.0
	SANGRAHA	150.0
	ARKI	170.0
	DHARAMPUR	140.4
	UNA	169.2
11-JUL	NAINA DAVI	188.2
	ROHRU	150.0
	JATTON BARRAGE	238.0
	NAHAN	250.0
	RAJGARH	117.0
	RENUKA / DADHAU	192.0
	SANGRAHA	190.0
	KASAULI	198.0

DATE	STATION NAME	RAINFALL (mm)
14-JUL	SALONI	124.0
16-JUL	PALAMPUR	151.0
21-JUL	PALAMPUR	147.0
22-JUL	JATTON BARRAGE	150.4
	RENUKA / DADHAU	195.0
23-JUL	NALAGARH	140.0
26-JUL	JATTON BARRAGE	156.0
7-AUG	NAINA DAVI	162.6
	R L BBMB	139.0
11-AUG	BILASPUR SADAR	160.8
	NADAUN	164.0
13-AUG	SUJANPUR TIRA	145.5
	SUNDARNAGAR	166.1
14-AUG	CHUARI	234.0
	SUJANPUR TIRA	254.0
	DHARMSALA	250.2
	GULER	191.0
	KANGRA AERO	273.4
	NAGROTA SURIAN	175.8
	PALAMPUR	220.0
	JOGINDARNAGAR	178.0
	PANDOH	166.0
	SARKAGHAT	180.8
	SUNDARNAGAR	168.4
	BANGANA_F	175.3
	BANGANA_R	174.3
23-AUG	BARTHIN	180.2
	BILASPUR SADAR	180.8
	KAHU	213.6
	BALDWARA	143.5
	PANDOH	178.0
	DHARAMPUR	162.4
	KANDAGHAT	159.0
	KASAULI	148.0
	BANGANA_F	151.3
	BANGANA_R	150.4
24-AUG	JOGINDARNAGAR	154.0
19-SEP	AMB	147.0

(**#:** Rainfall figures are for past 24 Hrs. ending on 8:30 Hrs. IST of the date)

The location of impact occurred due to major extreme weather events in Himachal Pradesh during the year 2023 is shown in **Fig 10**. The state experienced flood/heavy rain, snowfall, lightning & Hail storm events during the year 2023.

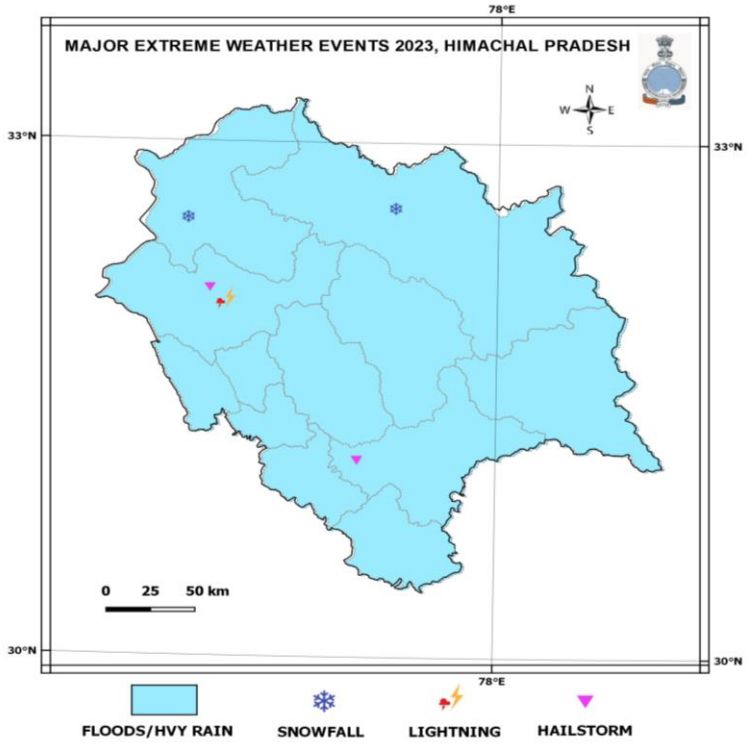


Fig.10: Locations of impact occurred associated with Major Extreme Weather Events during 2023 (details provided in the Table 3)

Table 3

Major extreme weather events during 2023 which caused loss of human lives* in Himachal Pradesh

Event	Number of causalities & Date	Season	Affected districts
Lightning	**2** (15 Sep.)	Monsoon (June to September)	Kangra
Floods and Heavy Rain	**123** (24 & 25 Jun.; 6, 9 to 11, 16, 18, 22 Jul.; 9, 11, 13, 14, 15, 23 Aug.)	Monsoon (June to September)	Chamba, Hamirpur, Kangra, Kullu, Lahaul & Spiti, Mandi, Shimla, Sirmaur, Solan & Parts of Himachal Pradesh
Snowfall	**2** (5 Feb.)	Winter (January & February)	Lahaul & Spiti

*(* : Based on the media reports and the reports from Disaster Management Authorities of the government)*

Summary

The Statement on Climate for the state of Himachal Pradesh for 2023 is prepared based on the real-time meteorological observation across the state at the district/block level in different seasons and taking reference of more than 100 years of past climate data for the state. So, the observation made in this report are very important for different sectors like agriculture, health, power, disaster management and water, etc. This joint report is prepared by the India Meteorological Department with the crucial inputs from the state government, which we expect in future as well. It is suggested that with the demanding need at global and regional level related to the climate change for sustainable development, this type of joint reports/ventures would be a path breaking for the society. By saying so, following are the submitted:

(i) The report may please be circulated to all the concerned ministries/departments of the state government and other relevant stakeholders in the state.

(ii) Based on the feedback, further course of actions in different climate sectors can be planned, like holding workshops, pilot studies, and any other joint ventures.

Apart from this annual climate statement, India Meteorological Department, Pune comes out regularly with climate updates which are shared on the public domain for the users' benefit. It is suggested to check for these updates regularly on the India Meteorological Department (IMD), Pune website: **https://www.imdpune.gov.in/.**

Contact

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