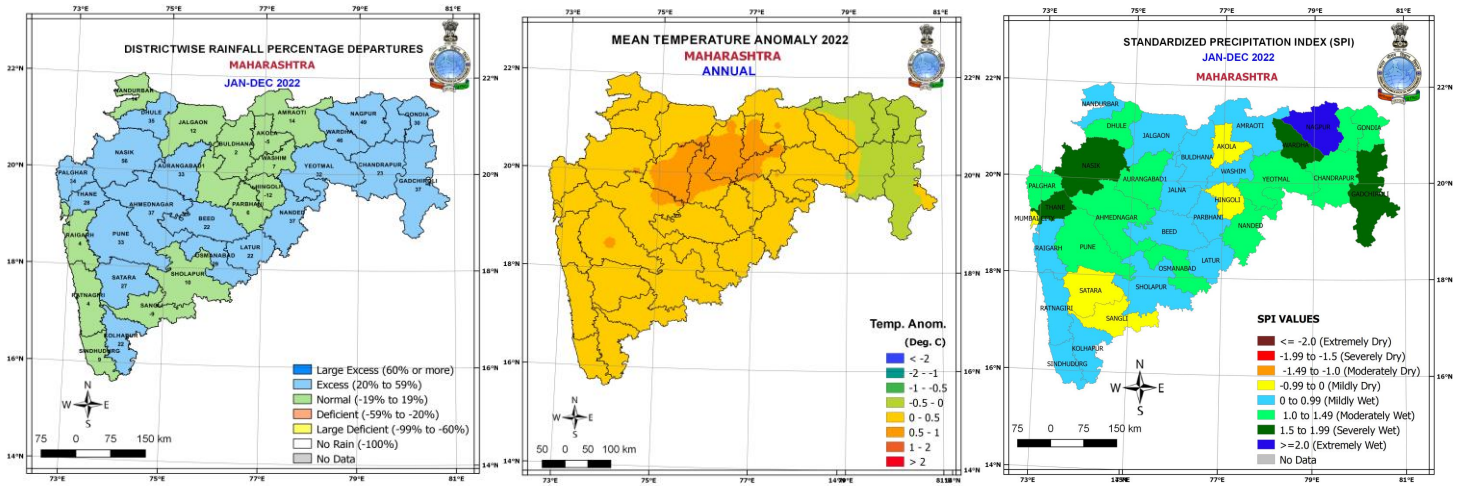




Government of
Maharashtra

भारत सरकार
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



महाराष्ट्र राज्य के लिए जलवायु पर वक्तव्य: २०२२

STATEMENT ON CLIMATE FOR THE STATE OF MAHARASHTRA: 2022

JOINTLY PREPARED BY
India Meteorological Department and Government of Maharashtra

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
भारत मौसम विज्ञान विभाग / India Meteorological Department

पुणे 411005 / Pune 411005

महाराष्ट्र राज्य के लिए जलवायु पर वक्तव्य: २०२२
Statement on Climate for the state of Maharashtra: 2022

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

Preamble:

It gives me immense pleasure to share this scientific document titled, "Statement on Climate for the state of Maharashtra for 2022" jointly prepared by office of Climate Research and Services, India Meteorological Department, Pune (Ministry of Earth sciences) and the Government of Maharashtra. 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 2022 (122 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 parallely with relevant global and regional scientific directives or advisories in the coming time.

This statement on climate of 2022 also includes the inputs like loss and damage data due to severe weather and other weather-related factors from the Government of Maharashtra. 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 2023

HIGHLIGHTS

The Maharashtra State averaged annual mean land surface air temperature (25.9 °C) during 2022 was 0.3°C warmer than its Long Period Average (LPA) for the period 1981-2010 thus making it the 14th warmest year on record for the state since 1901.

The annual maximum temperature averaged over the state during the year 2022 was 0.1°C above its LPA, while annual minimum temperature was relatively warmer by +0.5°C (10th warmest since 1901).

Out of 36 districts of the state, 20 received excess rainfall (20% to 59% of its 1971-2020 period LPA) and 16 districts received normal rainfall (-19% to +19% 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 2022. 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 2022.

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 2022 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 2022 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 2022.

Temperature

The monthly, seasonal and annual maximum, minimum and mean temperature anomalies averaged over the State of Maharashtra for the year 2022 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 August and December months and the Pre-monsoon (March to May) season as a whole were relatively warmer for the state. The annual maximum temperature averaged over the state during the year 2022 was slightly warmer than average with anomaly of 0.1°C, while annual minimum temperature was warmer than average by 0.5°C (10th warmest

since 1901). The mean temperature for the state was +0.3°C warmer than the average (14th warmest year on record since 1901).

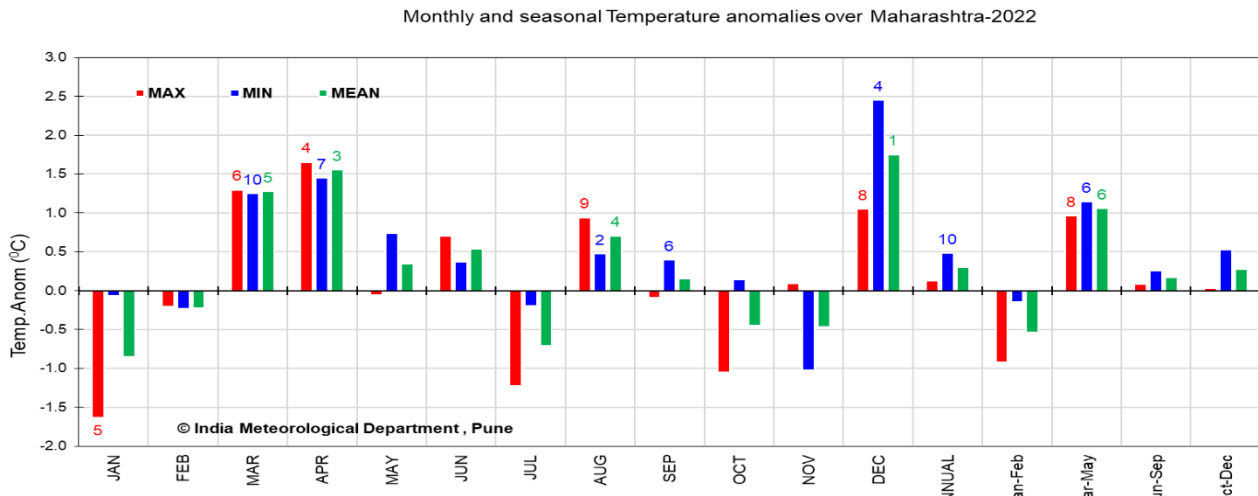


Fig. 1: Monthly and Seasonal Maximum, Minimum and Mean Temperature anomalies averaged over Maharashtra during 2022. The anomalies were computed from the LPA base period of 1981-2010. The numbers above/below the bar indicate top 10 warmest/coolest ranking since 1901.

The Spatial pattern of Annual Maximum, Minimum and Mean Temperature anomalies over Maharashtra during 2022 given in Fig 2. The temperature anomalies were within ±0.5°C over most parts of the state. However, over central parts of Maharashtra, minimum temperature anomalies were between 0.5 to 1°C.

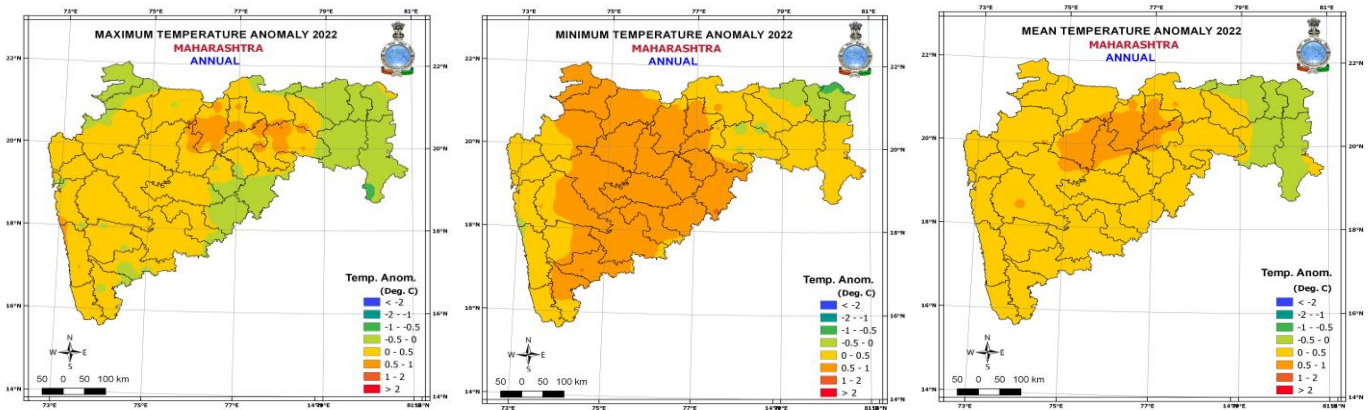


Fig. 2: Spatial pattern of Annual Maximum, Minimum, and Mean Temperature anomalies over Maharashtra during 2022. The anomalies were computed from LPA for the base period of 1981-2010.

The time series of variation of annual maximum, minimum and mean land surface air temperature anomalies averaged over the State for the period 1901-2022 is given in Fig 3. A significant increasing trend of 0.58 °C/100 years is observed in the State averaged annual mean temperature during 1901-2022. It was more significant in respect of maximum temperature (+0.74°C/100 years) and relatively less significant (+0.42°C/100 years) in respect of minimum temperature. The five warmest years on record in order for Maharashtra are 2019 (anomaly+0.515°C), 1941(+0.492°C), 2015(+0.469°C), 2016(+0.450°C) and 1979(+0.448°C).

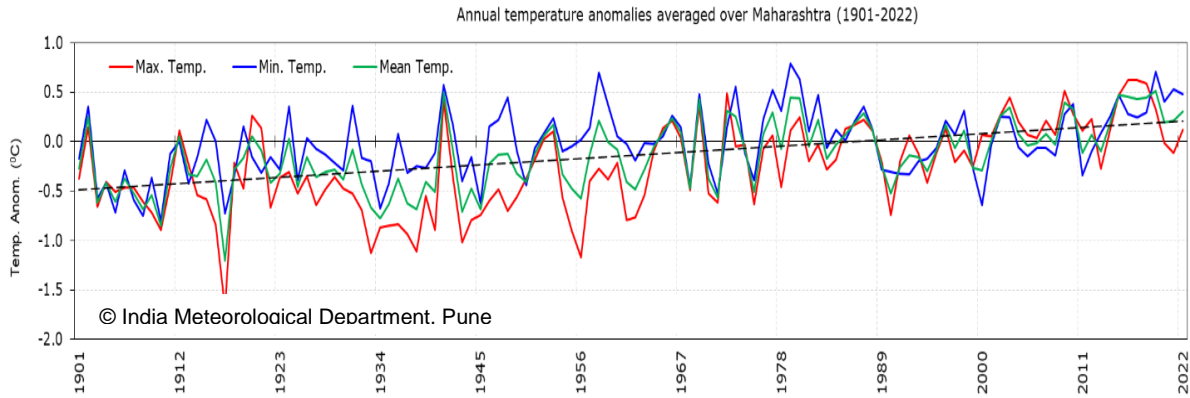


Fig. 3: Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Maharashtra for the period 1901-2022. The anomalies were computed with respect to the base period of 1981-2010. The dotted black line indicates the linear trend in the annual mean temperature time series.

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 warmer both in respect of minimum and maximum temperature during March, April and December months of the year. While January, July and October months were relatively less warm in respect of maximum temperature.

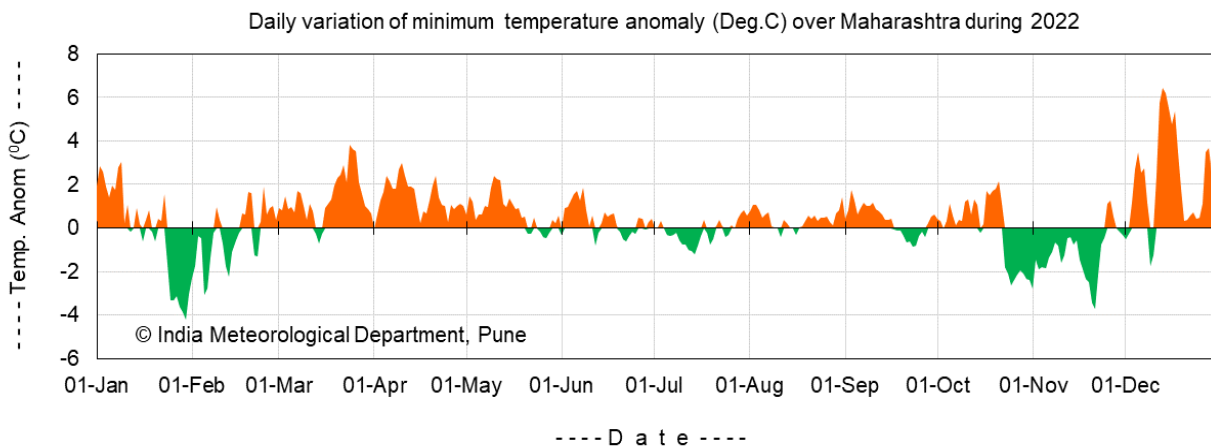


Fig. 4(a): Daily variation of minimum temperature anomaly (°C) over Maharashtra during 2022

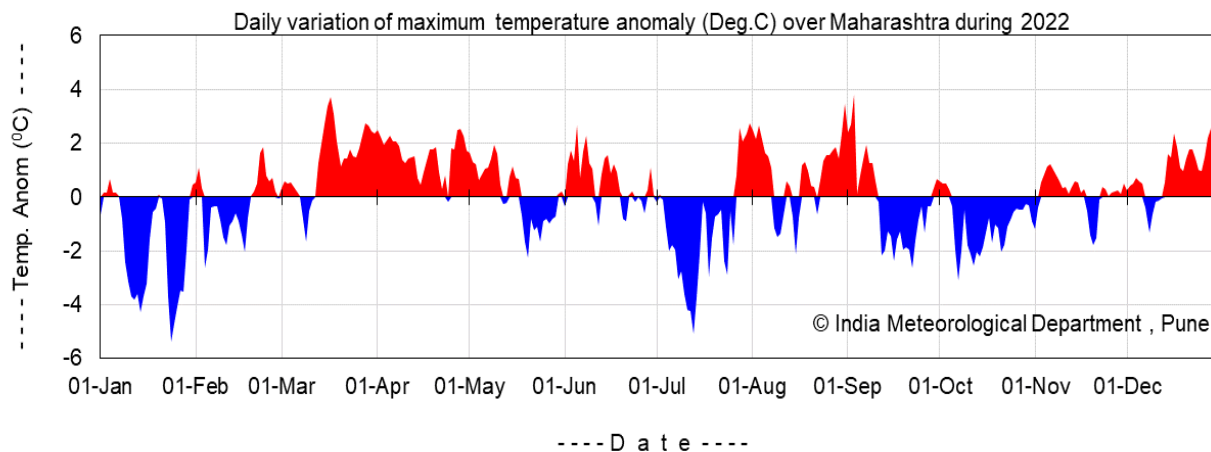


Fig. 4(b): Daily variation of maximum temperature anomaly (°C) over Maharashtra during 2022

Rainfall

Based on 1971-2020 climatology, Maharashtra state as a whole receives 0.7 % of its annual rainfall during the winter season (Jan-Feb), 2.3% during the Pre-Monsoon season (Mar-May), 88.4 % during the southwest monsoon season (Jun-Sept) and 8.6 % during the Post-Monsoon season (Oct-Dec). Thus, the Southwest monsoon season is the principal rainy season for the state. **Fig. 5** shows the annual departure of rainfall over different districts of Maharashtra during 2022. The anomalies were computed based on the 50 year LPA for period of 1971-2020. Out of 36 districts of the state, 21 received excess rainfall (20% to 59% of its LPA) and 15 districts received normal rainfall (within -19% to +19% of its LPA).

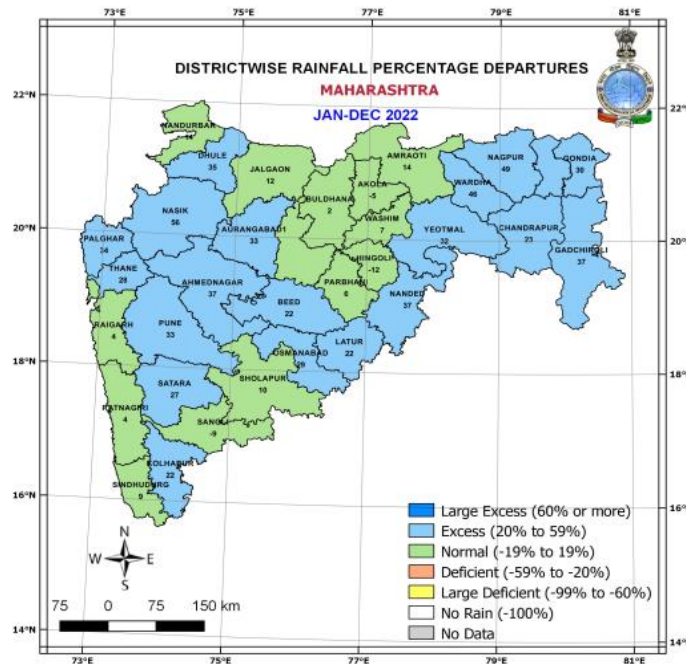


Fig. 5: District-wise annual rainfall percentage departures

The daily variation of rainfall (mm) during the year for the state is shown in **Fig. 6(a)**. The state received below normal rainfall on many days in June and above normal rainfall on many occasions during July, August, September and October months.

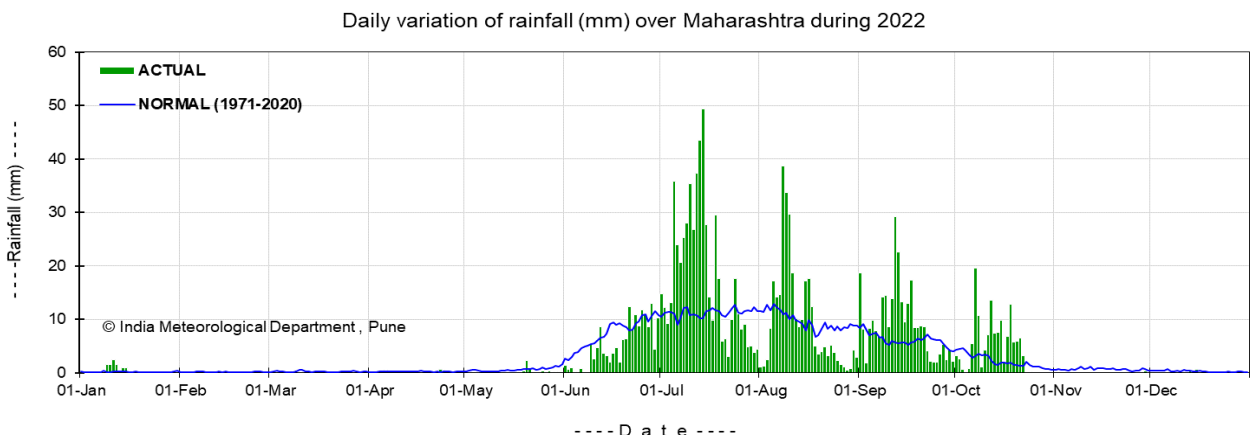


Fig. 6(a): Daily variation of rainfall (mm) averaged over Maharashtra during the year.

The time series of variation of % departure of seasonal and annual rainfall for the state for the period 1901-2022 are shown in **Fig. 6(b) and 6(c)** respectively. The departures are calculated with respect to the LPA base period of 1971-2020. For the monsoon season and the year 2022, the state received 123 % and 122 % of its LPA rainfall respectively.

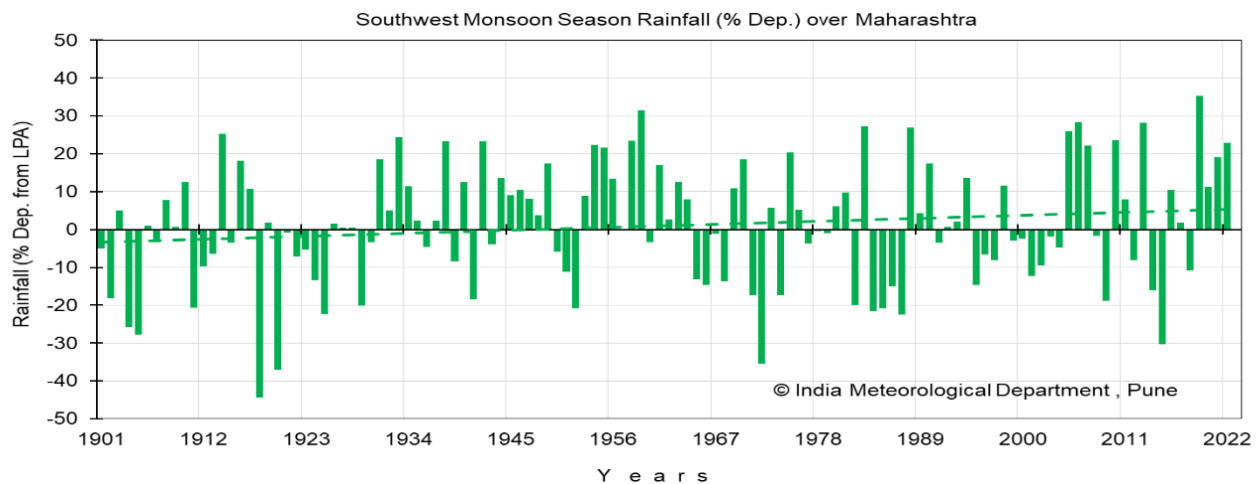


Fig. 6(b): Time series of % departure of southwest monsoon rainfall averaged over Maharashtra (1901-2022).

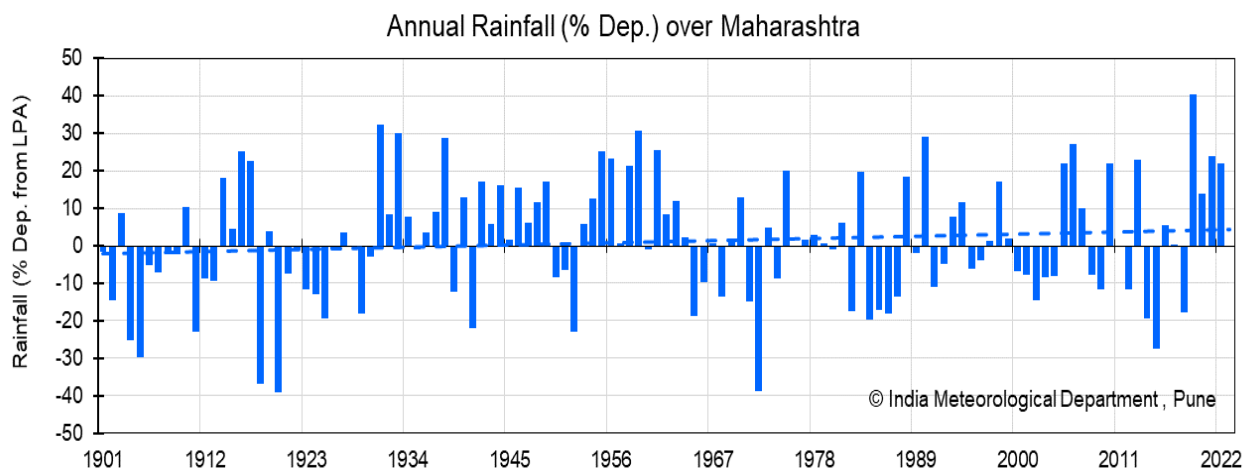


Fig. 6(c): Time series of % departure of annual rainfall averaged over Maharashtra (1901-2022).

Table 1 shows the monthly, seasonal and annual rainfall statistics for the state for the year 2022. The state as a whole received excess rainfall during the winter, monsoon, post monsoon seasons and year as a whole. However, during the pre-monsoon season it received large deficient rainfall.

TABLE 1

MONTH / SEASON	ACTUAL (mm)	NORMAL (mm)	% DEP.	CATEGORY
JANUARY	9.2	4.6	100.0	LE
FEBRUARY	0.3	3.2	-91.6	LD
WINTER SEASON	9.5	7.8	21.4	E
MARCH	1.3	6.2	-78.2	LD
APRIL	3.0	5.6	-46.6	D
MAY	5.3	14.4	-63.5	LD
PRE-MONSOON SEASON	9.6	26.2	-63.4	LD
JUNE	146.1	209.8	-30.3	D
JULY	528.0	324.2	62.9	LE
AUGUST	279.8	280.2	-0.1	N
SEPTEMBER	265.9	180.3	47.5	E
MONSOON SEASON	1219.8	994.5	22.7	E
OCTOBER	132.3	74.0	78.8	LE
NOVEMBER	0.3	17.8	-98.5	LD
DECEMBER	1.1	4.6	-75.5	LD
POST-MONSOON SEASON	133.7	96.4	38.7	E
ANNUAL	1372.5	1124.9	22.0	E

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 rainfall trends for annual rainfall for the period 1901-2021 is given in **Fig 7**. It is seen that among all the districts of the state, Aurangabad and Parbhani show significantly decreasing trend, Palghar shows significantly increasing trend while rest of the districts shows non-significant trend.

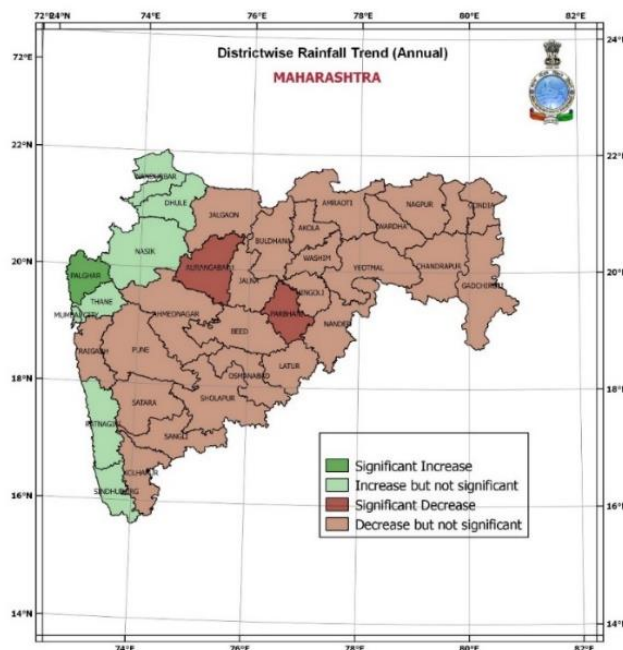


Fig. 7: District-wise annual rainfall Trend for Maharashtra (period of study 1901-2021)

Standardized Precipitation Index (SPI)

The district wise Annual SPI Map for the state for the year 2022 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. Mildly wet to Moderately wet conditions were observed over many districts of the state. Extremely wet conditions were observed over parts of Nagpur district, while severely wet conditions were observed over parts of Thane, Nasik, Wardha and Gadchiroli districts. Mildly dry conditions were observed over some districts of the state viz. Mumbai city, Satara, Sangli, Akola and Hingoli.

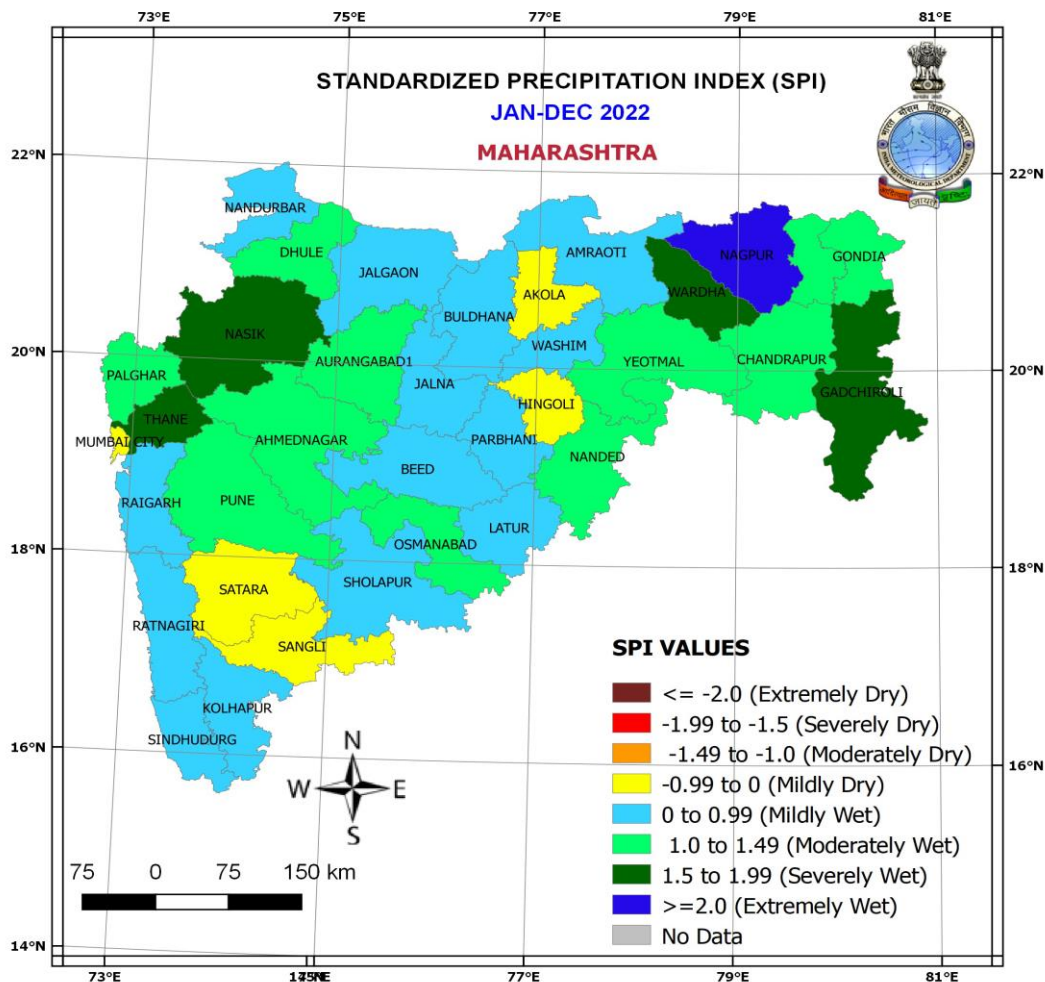


Fig. 8: District wise Annual SPI Map for Maharashtra for the year 2022

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 Maharashtra. **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.

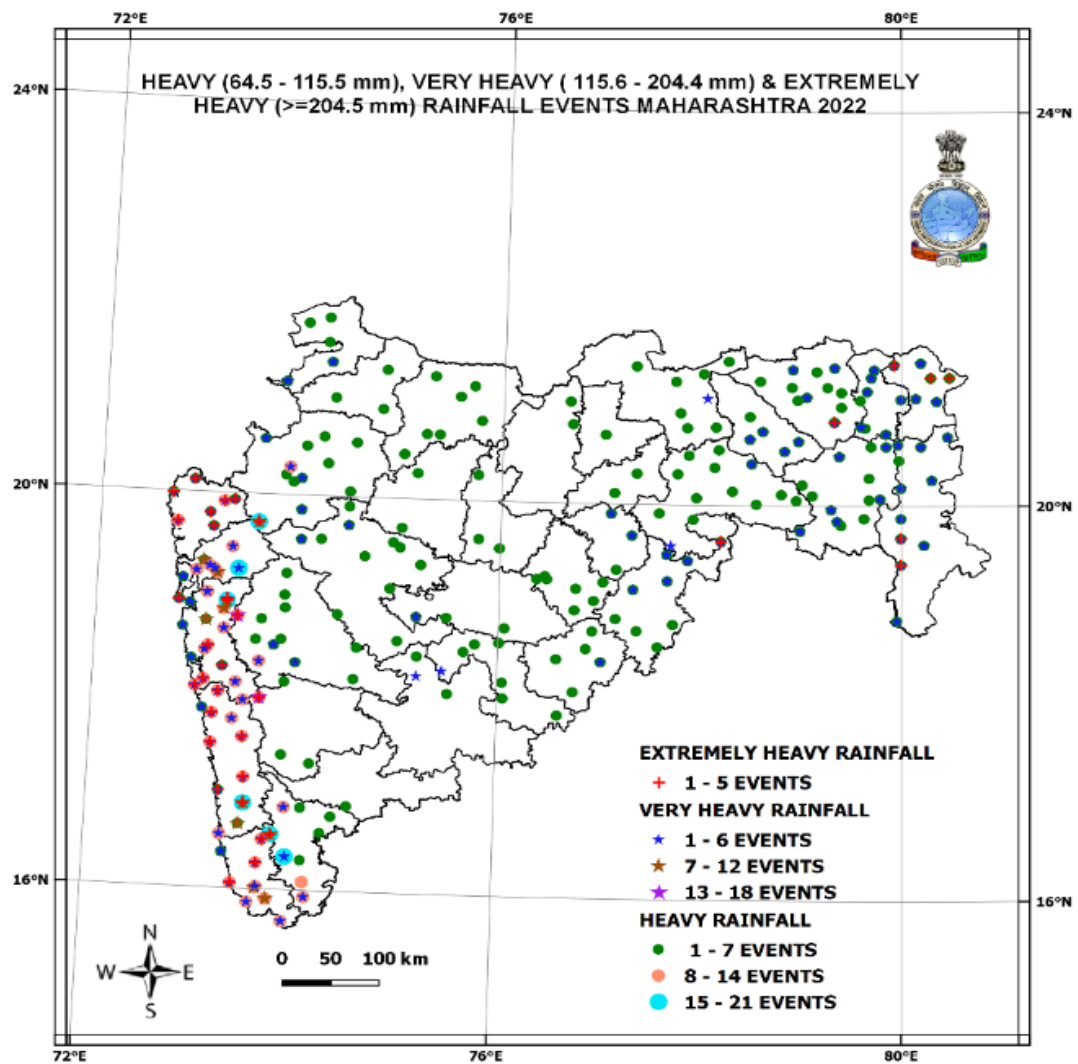


Fig. 9: Location and frequency of Heavy Rainfall, Very Heavy Rainfall and Extremely Heavy Rainfall events reported over stations of Maharashtra during the period January to December 2022.

Table 2

Extremely heavy rainfall # (> 204.4 mm) recorded over some stations of Maharashtra during January – December 2022

DATE	STATION NAME	RAINFALL (mm)	DATE	STATION NAME	RAINFALL (mm)
21-Jun	PALGHAR_AGRI	207.4	14-Jul	DAHANU - IMD OBSY	225.7
26-Jun	SHRIWARDHAN	207.0		JAWHAR	237.7
	LANJA	275.0		PALGHAR_AGRI	224.0
	RATNAGIRI - IMD OBSY	222.0		TALASARI	275.3
1-Jul	COLABA - IMD OBSY	227.8		VIKRAMGAD	255.0
5-Jul	MANGAON	230.0		WADA	242.0
	TALA	245.0		LONAVALA_AGRI	232.0
	LANJA	342.0	MAHABALESHWAR- IMD OBSY	294.2	
	MANDANGAD	205.0	15-Jul	KARJAT_AGRI	206.8
	SANGAMESHWAR DEVRUKH	210.0		MATHERAN	354.2
	MALVAN	225.0		JAWHAR	222.0
	6-Jul	VAIBHAVWADI	230.0	LONAVALA_AGRI	205.2
GAGANBAWADA		259.0	7-Aug	KANKAVLI	218.0
8-Jul	DAPOLI_AGRI	224.0		VAIBHAVWADI	270.0
	8-Jul	MAHABALESHWAR- IMD OBSY	213.4	8-Aug	MHASLA
MATHERAN		210.2	SHRIWARDHAN		245.0
10-Jul	LANJA	214.0	CHIPLUN		205.0
	IGATPURI	240.0	DAPOLI_AGRI		220.0
12-Jul	MULCHERA	205.8	GUHAGAR		205.0
	JAWHAR	285.0	LANJA		290.0
	MOKHADA - FMO	273.2	UMRER	207.2	
	TALASARI	260.0	9-Aug	TALA	210.0
	MAHABALESHWAR- IMD OBSY	253.0		LANJA	334.0
13-Jul	AHIRI	209.4	10-Aug	MAHABALESHWAR- IMD OBSY	215.6
	MATHERAN	217.0		TIRORA	222.9
14-Jul	KINWAT	210.0	11-Aug	MAHABALESHWAR- IMD OBSY	225.4
	MATHERAN	243.6	15-Aug	AMGAON	222.0
		SALEKASA		235.9	

(#: 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 Maharashtra during the year 2022 is shown in **Fig 10**. The state experienced flood, heatwave, cold wave, lightning/thunderstorms during the year 2022. The district-wise affected area (in Hectares) for Kharif crop by flood and heavy rains from June to September 2022 is given in **Fig 11**.

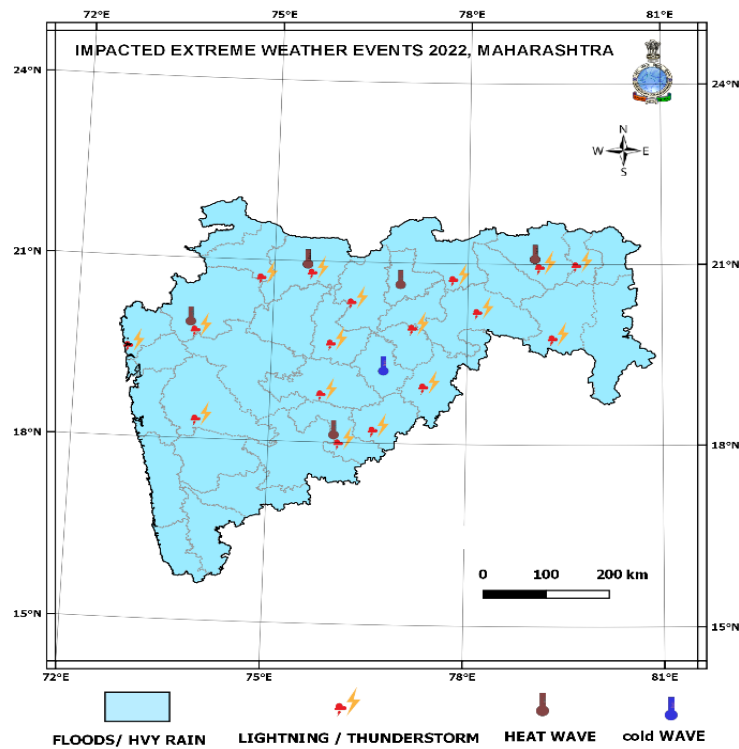


Fig.10: Locations of impact occurred associated with Major Extreme Weather Events occurred during 2022 (details provided in the Table 3).

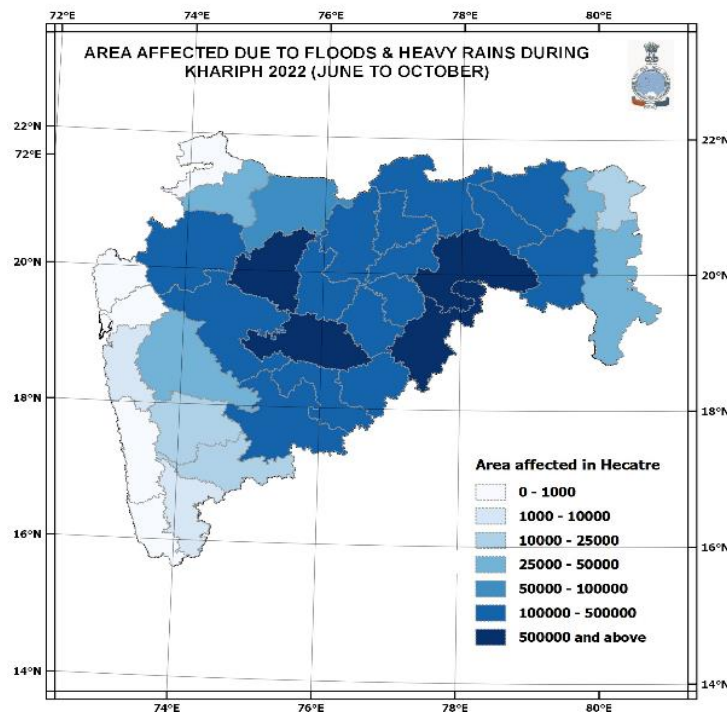


Fig.11: Shows the district-wise area affected (in Hectares) by flood and heavy rains during the Kharif season (June-Oct 2022) (Source: Maharashtra Government)

Table 3

Major extreme weather events during 2022 which caused loss of human lives*
in Maharashtra

Event	Number of casualties & Date	Season	Affected districts
Lightning & Thunderstorm	64 (12 Jan.; 7 to 9 Mar.; 6 & 22 Apr.; 20 & 31 May; 8, 11, 12, 18, 19, 20, 21, 23, 24 Jun.; 9, 30 Jul.; 30 Aug.; 8, 10, 11, 12, 16, 21, 28 Sep.; 5, 18, 20 Oct.)	Winter (January & February), Pre-Monsoon (March to May), Monsoon (June to Sept.), Post-Monsoon (Oct to Dec)	Amravati, Aurangabad, Beed, Bhandara, Buldhana, Chandrapur, Dhule, Jalgaon, Jalna, Latur, Nagpur, Nanded, Nashik, Osmanabad, Palghar, Pune, Washim, Yavatmal
Flood & Heavy Rains	116 (24 Jun.; 6, 9 to 14, 18 & 19 Jul.; 4 to 14, 17 Aug.; 11 to 14, 16, 20, 21 Sep.; 5, 17 to 20 Oct.)	Monsoon (June to Sept.), Post-Monsoon (Oct to Dec)	Akola, Amravati, Aurangabad, Beed, Bhandara, Gadchiroli, Gondia, Mumbai City, Mumbai Suburban, Nagpur, Nanded, Nashik, Palghar, Pune, Raigad, Ratnagiri, Sindhudurg, Thane, Washim, Yavatmal
Heat Wave	13 (29 to 31 Mar.; 1, 6, 26, 28, 30 Apr.; 10 May)	Pre-Monsoon (March to May)	Akola, Jalgaon, Nagpur, Nashik, Osmanabad
Cold Wave	1 (21 Nov.)	Post-Monsoon (Oct to Dec)	Prabhani

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

Summary

The Statement on Climate for the state of Maharashtra for 2022 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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