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### Study on extreme weather events in different districts of Mahanadi basin area of Chhattisgarh state

Megha Sahu and Anshulata Xalxo

Student, Department of Agrometeorology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

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Corresponding Author: Megha Sahu

#### Abstract

The study entitled “Study on extreme weather events in different districts of Mahanadi basin region of Chhattisgarh” was carried out in department of Agrometeorology during 2021-22. RClimDex 1.0 software was used to find out extreme rainfall and temperature events in different districts of Mahanadi basin area. Mahanadi is one of major peninsular river of India, originates from Pharsiya village in Dhamtari district of Chhattisgarh and travels a distance of 851 km, consider as a lifeline of major part of Chhattisgarh and Odisha. The Mahanadi basin extends over an area of 141,589 km<sup>2</sup>. The annual rainfall of Mahanadi Basin area is 1158 mm. In the years 2003, 2008, 2011 and in 2014 the basin has experienced major floods due to heavy rainfall. The outcome of rainfall extremes indicates that, the 1- and 5-day monthly maximum rainfalls status exhibit significantly decreasing trends, while SDII shows significantly decreasing trend in major districts. Concurrent decrease in dry spells and increase in wet spells were also observed over the basin. The increase in frequency and magnitude of extreme rainfall and temperature in the basin area has been attributed to the increasing trend in warm days and decreasing in cool nights. Higher value of consecutive wet day has a high chance of flooding. Numbers of heavy precipitation days had been increasing in slow pace in most of the districts.

**Keywords:** Mahanadi basin, extreme rainfall, RClimDex1.0 software, weather, extreme temperature

#### Introduction

Mahanadi is one of the major rivers of India, it originates from Pharsiya village in Dhamtari district of Chhattisgarh and travels a distance of 851 km and meets Bay of Bengal (India- WRIS, 2016) <sup>[1]</sup>. It is considered as a lifeline of major part of Chhattisgarh and Odisha state of India. The Mahanadi basin extends over an area of 141,589 km<sup>2</sup> with annual rainfall of 1158 mm. In changing climatic scenario the quantum, intensity and distribution of rainfall and temperature in basin area are going to alter drastically and need to be studied. It is expected to be the worst affected basin in India in terms of increase in flood intensity due to climate change.

#### Methodology

The long-term (1989-2019) temperature and rainfall data

has been collected for 21 districts of the Mahanadi basin part of Chhattisgarh district. After collecting the data it was systematically arranged and the quality of the data was checked for further computation in WeatherCock15 software and RClimDex 1.0 software. The RClimDex 1.0 was developed and maintained by Xuebin Zhang and Feng Yang at the Climate Research Branch of the Meteorological Service of Canada. RClimDex (1.0) was designed to compute 27 weather elements of climate extremes with user defined threshold. In this present study, 16 temperature and 11 rainfall weather elements were computed for 21 districts of Mahanadi Basin region of Chhattisgarh. Linear regression method was used which was used to investigate trends in data over time.

**Table 1:** Details of the weather elements used in this study:

ID	Indicator name	Details	UNITS
FD0	Frost days	Annual count when TN(daily minimum)<0 °C	Days
SU25	Summer days	Annual count when TX(daily maximum)>25 °C	Days
ID0	Ice days	Annual count when TX(daily maximum)<0 °C	Days
TR20	Tropical nights	Annual count when TN(daily minimum)>20 °C	Days
GSL	Growing season Length	Annual (1 <sup>st</sup> Jan to 31 <sup>st</sup> Dec in NH, 1 <sup>st</sup> July to 30 <sup>th</sup> June in SH) count between first span of at least 6 days with TG>5 °C and first span after July 1 (January 1 in SH) of 6 days with TG<5 °C	Days

TXx	Max Tmax	Monthly maximum value of daily maximum temp	°C
TNx	Max Tmin	Monthly maximum value of daily minimum temp	°C
TXn	Min Tmax	Monthly minimum value of daily maximum temp	°C
TNn	Min Tmin	Monthly minimum value of daily minimum temp	°C
TN10p	Cool nights	Percent of days when TN<10 <sup>th</sup> percentile	Days
TX10p	Cool days	Percent of days when TX<10 <sup>th</sup> percentile	Days
TN90p	Warm nights	Percent of days when TN>90 <sup>th</sup> percentile	Days
TX90p	Warm days	Percent of days when TX>90 <sup>th</sup> percentile	Days
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90 <sup>th</sup> percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10 <sup>th</sup> percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	°C
RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	Mm
Rx5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	Mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year	Mm/day
R10	Number of heavy precipitation days	Annual count of days when PRCP>=10mm	Days
R20	Number of very heavy precipitation days	Annual count of days when PRCP>=20mm	Days

## Results

The probability of heavy precipitation was highest in the district of Korea. While seasonal drought can be seen in the districts like Balod, Balodabazar, Bemetra, Dhamtari, Gariaband, Mungeli and Surajpur. On the other hand, chances of flooding can be seen in the Dhamtari, Kanker, Rajnandgaon, Sarguja and Raigarh districts. Jashpur, Korba, Korea, Raigarh Sarguja, and Surajpur districts reported

significantly significant positive trend for warm days. A significantly increasing trend on the hottest days was observed while significantly decreasing in cool nights. Bemetra, Durg, Korba, Korea, Mungeli, Raigarh, Rajnandgaon, Sarguja and Surajpur districts observed a significantly decreasing trend of very wet days. There were no significant changes observed in frost day, ice day, growing season length, and summer days

**Table 1:** Trend of temperature under various weather elements in different districts of Chhattisgarh.

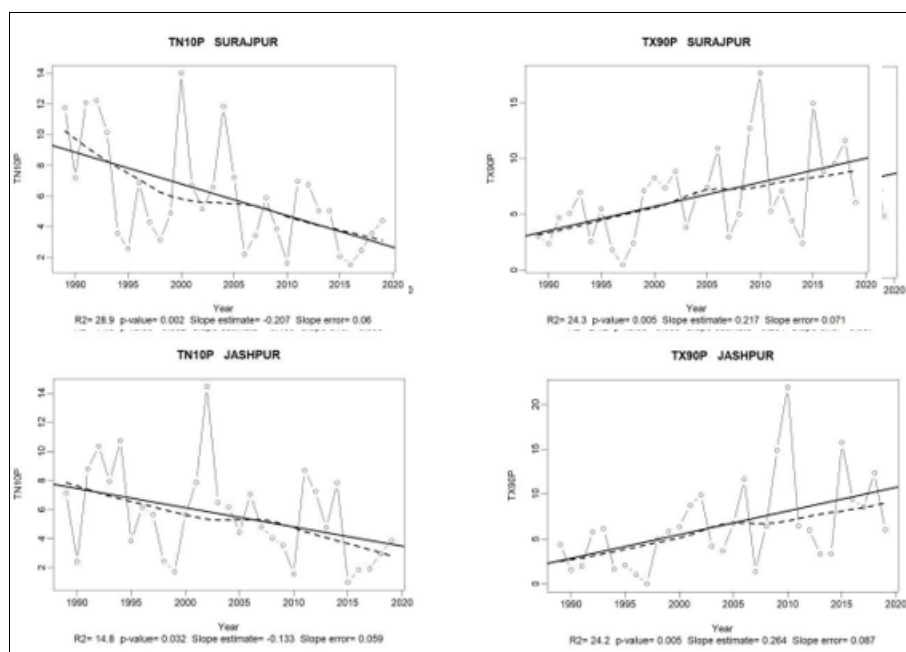
S. No	District	TXx	TNx	TXn	TNn	TN10P	TX10P	TN90P	TX90P	WSDI	CSDI	DTR
1	Balod	0.035	0.028	0.326	0.338	0.08	0.157	0.157	0.204	0.056	0.157	0.093
2	Balodabazar	0.014	0.265	0.251	0.099	0.411*↓	0.065	0.212	0.351	0.14	0.075	0.041
3	Bemetra	0.054	0.062	0.128	0.314	0.363*↓	0.226	0.183	0.264	0.036	0.28	0.01
4	Bilaspur	0.035	0.048	0.326	0.21	0.194	0.157	0.164	0.209	0.056	0.084	0.002
5	Dhamtari	0.035	0.028	0.326	0.338	0.08	0.157	0.08	0.209	0.056	0.157	0.095
6	Durg	0.054	0.062	0.128	0.314	0.363*↓	0.226	0.183	0.264	0.036	0.28	0.01
7	Gariaband	0.084	0	0.143	0.069	0.315	0.291	0.004	0.132	0.044	0.02	0.098
8	Jan-Champa	0.073	0.095	0.185	0.106	0.339	0.221	0.147	0.348	0.193	0.071	0.046
9	Jashpur	0.134	0.217	0.127	0.151	0.384*↓	0.137	0.259	0.492**↑	0.213	0.014	0.087
10	Kabirdham	0.042	0.106	0.096	0.385*↓	0.214	0.08	0.014	0.231	0.086	0	0.153
11	Kanker	0.034	0.028	0.326	0.338	0.08	0.157	0.156	0.209	0.056	0.157	0.095
12	Kondagaon	0.067	0	0.146	0.153	0.06	0.168	0.056	0.05	0.274	0.182	0.267
13	Korba	0.061	0.048	0.216	0.21	0.194	0.086	0.164	0.395*↑	0.074	0.084	0.053
14	Korea	0.00	0.166	0.332	0.22	0.525**↓	0.017	0.232	0.427*↑	0.163	0.142	0.11
15	Mahasamund	0.073	0.095	0.185	0.106	0.339	0.221	0.147	0.348	0.193	0.071	0.046
16	Mungeli	0.042	0.106	0.096	0.385*↓	0.214	0.08	0.014	0.237	0.086	0	0.156
17	Raigarh	0.077	0.01	0.05	0.122	0.355*↓	0.198	0.141	0.415*↑	0.137	0.014	0.124
18	Raipur	0.054	0.062	0.097	0.314	0.363*↓	0.228	0.183	0.266	0.036	0.28	0.014
19	Rajnandgaon	0.079	0.00	0.061	0.393*↓	0.215	0.239	0.042	0.336	0.017	0.047	0.24
20	Sarguja	0.134	0.217	0.127	0.151	0.385*↓	0.137	0.259	0.492**↑	0.213	0.014	0.087
21	Surajpur	0.00	0.144	0.264	0.221	0.537**↓	0.028	0.288	0.493**↑	0.186	0.003	0.062

**Note:** \*\*, \* significant 1percent, 5percent level respectively

**Table 2:** Trend of rainfall under various indices in different districts of Chhattisgarh

S. No	District	RX1DAY	RX5DAY	SDII	R10	R20	Rnn	CDD	CWD	R95P	R99P	PRCPTOT
1	Balod	0.034	0.03	0.349	0.037	0.069	0.000	0.378*↓	0.229	0.077	0.017	0.03
2	Balodabazar	0.186	0.106	0.215	0.223	0.05	0.058	0.385*↓	0.255	0.134	0.121	0.005
3	Bemetra	0.539**↓	0.562**↓	0.605**↓	0.037	0.511**↓	0.264	0.659**↓	0.052	0.562**↓	0.526**↓	0.435*↓
4	Bilaspur	0.169	0.194	0.107	0.007	0.169	0.000	0.048	0.185	0.171	0.124	0.081
5	Dhamtari	0.237	0.246	0.246	0.08	0.276	0.264	0.410*↓	0.681**↓	0.304	0.306	0.259
6	Durg	0.334	0.235	0.536**↓	0.007	0.440*↓	0.000	0.068	0.197	0.391*↓	0.31	0.25
7	Gariaband	0.01	0.157	0.24	0.083	0.117	0.000	0.446*↓	0.168	0.131	0.109	0.112
8	Jan-Champa	0.143	0.048	0.097	0.002	0.107	0.000	0.142	0.302	0.075	0.033	0.033
9	Jashpur	0.06	0.056	0.098	0.282	0.133	0.000	0.257	0.165	0.095	0.037	0.258
10	Kabirdham	0.115	0.317	0.419*↓	0.005	0.296	0.000	0.024	0.457**↑	0.335	0.22	0.123
11	Kanker	0.054	0.068	0.04	0.007	0.124	0.061	0.058	0.377*↓	0.104	0.017	0.004
12	Kondagaon	0.101	0.136	0.047	0.169	0.32	0.000	0.260	0.186	0.309	0.108	0.148
13	Korba	0.357*↓	0.332	0.580**↓	0.278	0.278	0.061	0.487	0.226	0.472**↓	0.313	0.141
14	Korea	0.619**↓	0.610**↓	0.727**↓	0.534**↓	0.535**↓	0.000	0.601**↓	0.633**↑	0.382*↓	0.191	0.02
15	Mahasamund	0.112	0	0.102	0.017	0.095	0.000	0.109	0.067	0.014	0.004	0.007
16	Mungeli	0.466**↓	0.437*↓	0.591**↓	0.151	0.197	0.000	0.414*↓	0.184	0.532**↓	0.541**↓	0.051
17	Raigarh	0.305	0.186	0.445*↓	0.302	0.360*↓	0.000	0.157	0.408*↑	0.377*↓	0.245	0.188
18	Raipur	0.135	0.159	0.072	0.054	0.048	0.061	0.009	0.048	0.12	0.065	0.072
19	Rajnangaon	0.344	0.131	0.509**↓	0.031	0.412*↓	0.000	0.076	0.646**↑	0.411*↓	0.298	0.183
20	Sarguja	0.457**↓	0.416*↓	0.648**↓	0.03	0.462**↓	0.061	0.118	0.594**↑	0.557**↓	0.458**↓	0.389*↓
21	Surajpur	0.540**↓	0.413*↓	0.565**↓	0.189	0.193	0.264	0.404*↓	0.232	0.546**↓	0.520**↓	0.254

Note: \*\*, \* significant 1percent, 5percent level respectively



## Conclusion

In general it was observed that increasing trends on hottest days and decreasing trends in the coldest nights on the major districts of the Mahanadi basin area. The results showed that the concurrent decrease in dry spells and increase in wet spells are also observed over the basin. Chances of flooding can also be seen in the Chhattisgarh plain zone.

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