

Climatological variation of meteorological parameters over Daman

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Abstract— The report is the analysis of the variation of observed and recorded data of various meteorological parameters such as maximum temperature, minimum temperature and average rainfall (Jun-Sep) of Daman over past 31 years 1991-2021. The effect of system formation (D, CS, SCS) over Arabian sea and its neighbouring coastline for the analysis of climate over Daman.

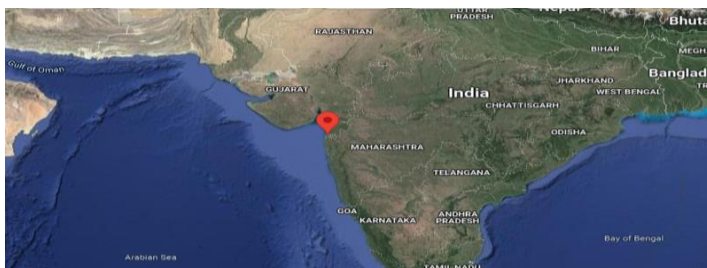
Index Terms— Averaging, Moving average, Linear Trend Method

1 INTRODUCTION

Daman, formerly (Portuguese) Damão, town, capital of Dadra and Nagar Haveli and Daman and Diu union territory, western India. The town, together with numerous villages in the surrounding area, forms an enclave in south-eastern Gujarat state and is situated on the Gulf of Khambhat (Cambay) of the Arabian Sea.

Known as Damão, the town was part of Portuguese India. The town was sacked and burned by the Portuguese in 1531. It was subsequently rebuilt, and in 1559 it was again taken by the Portuguese, who made it a permanent settlement. Damão became a flourishing port, but its importance waned with the decline of Portuguese sea power. The settlement remained under Portuguese rule until it was taken over by India in December 1961, at which time it became part of the union territory of Goa, Daman, and Diu. In 1987, after Goa became a state of India, the town was designated the capital of the union territory of Daman and Diu. It became the capital of Dadra and Nagar Haveli and Daman and Diu union territory, when Dadra and Nagar Haveli union territory merged with Daman and Diu union territory in 2020.

Fig 1: The GPS coordinates of Daman [1] is 20° 23' 50.5428" N and 72° 49' 58.0872" E.



Weather and climate [5] of a place are described by the composite effect of atmospheric factors like maximum temperature, minimum temperature, rainfall, humidity, clouds, visibility etc. These interrelated factors are termed as elements of weather and climate. Weather of a place at a given time is the instantaneous effect of these elements. Climate of the place is the average weather conditions obtained by averaging the elements over a long period of time (usually 30 to 50 years).

2 STEVENSON SCREEN

Stevenson screens are also known as a cotton region shelter, an instrument shelter, a thermometer shelter, a thermoscreen, or a thermometer screen. Its purpose is to provide a standardised environment in which to measure temperature, humidity, dewpoint, and atmospheric pressure. It is white in color to reflect direct solar radiation. The common type of Stevenson screen has a maximum and minimum thermometer for daily readings.

The traditional Stevenson screen is a box shape, constructed of wood, in a double-louvered design. However, it is possible to construct a screen using other materials and shapes, such as a pyramid. The World Meteorological Organization (WMO) agreed standard for the height of the thermometers is between 1.25 and 2 m (4 ft 1 in and 6 ft 7 in) above the ground. It consists of four thermometers i.e. Dry Bulb, Wet Bulb, Maximum and Minimum fixed inside the Thermometer screen (Stevenson screen).

Maximum Temperature: The highest temperature of the air indicated by the Maximum thermometer in the SS screen since its last setting.

Minimum Temperature: The lowest temperature of the air indicated by the minimum thermometer in the Stevenson Screen (SS) since its last setting.

3 METHODOLOGY

The statistical method of averaging, moving average, linear trend analysis of the observed and recorded data is undertaken for following parameters over the year 1991-2021 for the station, Daman.

- Maximum Temperature (Throughout the Day)
- Minimum Temperature (Throughout the Day)
- Average Rainfall (01 Jun - 30 Sep) - as per recorded no. of values

3.1 Averaging

Simple averaging technique is determined by dividing the sum total of all the values by the number of values in the set, Example. (If we have total value for year say 31 years (1991-

2021) is x, total number of values is 31, then average is $x/31$).

Averages are used to represent a large set of numbers with a single number. It is a representation of all the numbers available in the data set. For quantities with changing values, the average is calculated and a unique value is used to represent the values.

3.2 Moving Average

Moving Average (MA) is a widely used technical indicator that smooths out value trends by filtering out the “unwanted noise (e.g., Effect of system)” from the observed and recorded data.

The most common applications of moving averages are to identify trend direction and to determine, understand and analyse the variability of observed and recorded data.

3.3 Linear Trend Method

Linear trend estimation is a statistical technique to aid interpretation of data. It can be undertaken by use of Trend analysis software available online. In this case linear trend estimation expresses data as a linear function of time, and can also be used to determine the significance of differences in a set of data linked by a categorical factor.

The linear trend model tries to find the slope and intercept that give the best average fit to all the past data, and unfortunately its deviation from the data is often greatest at the very end of the time series.

4 MAXIMUM TEMPERATURE

The maximum temperature is generally observed during the month of March, April and May. It has risen up from 35°C during early decadal years to 41°C from past few years. Also, 11-year moving average technique on maximum temperature indicate an increasing trend from 1991-2021.

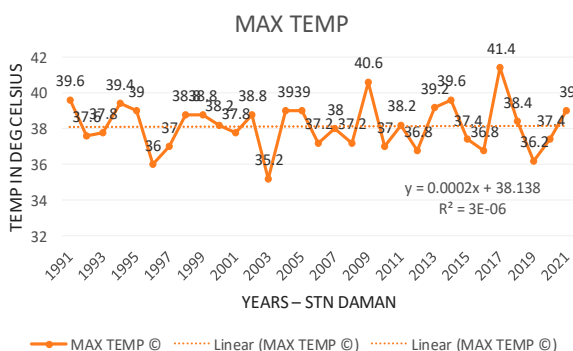


Fig. 4.1 Max Temp variation for years 1991-2021

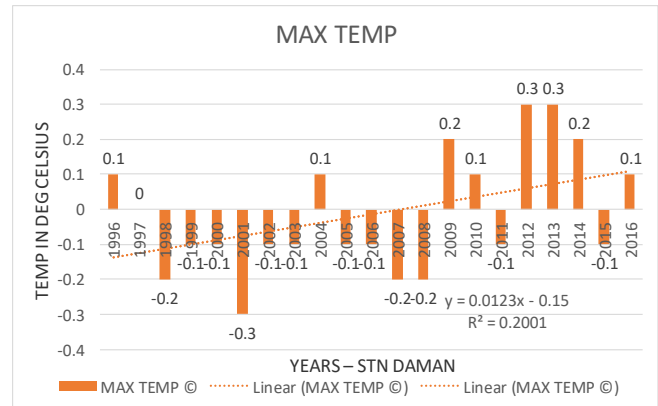


Fig 4.2 Moving average technique on Max Temp for years 1991-2021

5 MINIMUM TEMPERATURE

The Minimum temperature is generally observed during the month of Jan. It is risen up from 07°C during early decadal years to 13°C from past few years. Also, 11-year moving average technique on minimum temperature also indicate an increasing linear trend from 1991-2021.

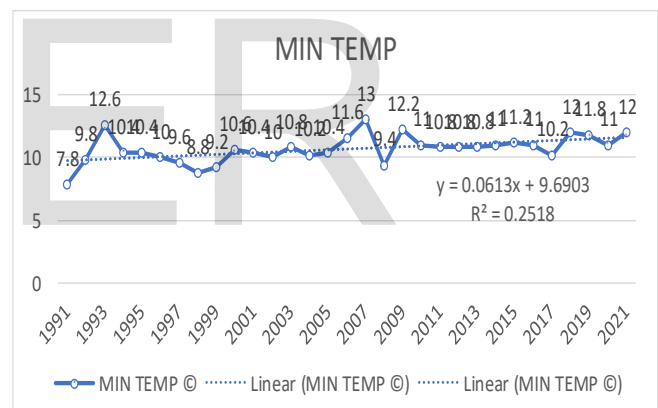


Fig 5.1 Min Temp variation for years 1991-2021

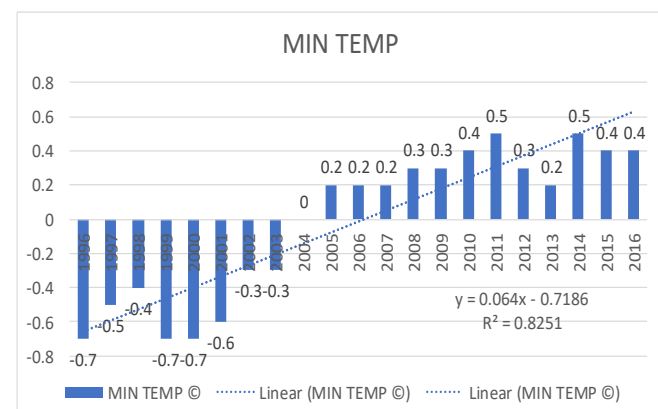


Fig 5.2 Moving average technique on Min Temp for years 1991-2021

6 RAINFALL AVERAGE

June to September are main rain showering months for Daman. During this period, it receives almost 80-85% rain of its annual rainfall. As per the onset of SW monsoon and formation of systems prior/during onset effect the rainfall pattern over Daman. Also, 11-year moving average technique on **average rainfall** also indicate an increasing linear trend from 1991-2021.

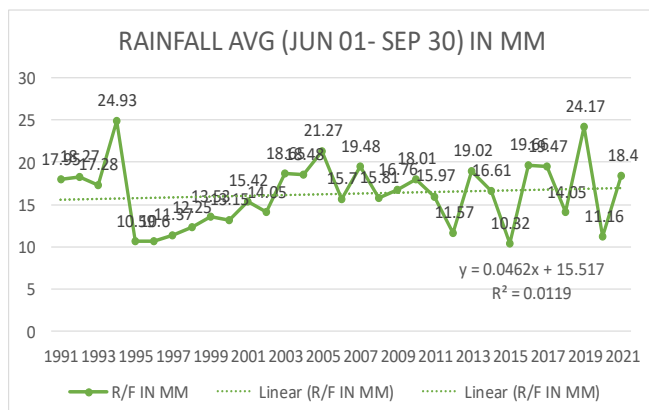


Fig 6.1 Average Rainfall variation (01 Jun-30 Sep) for years 1991-2021

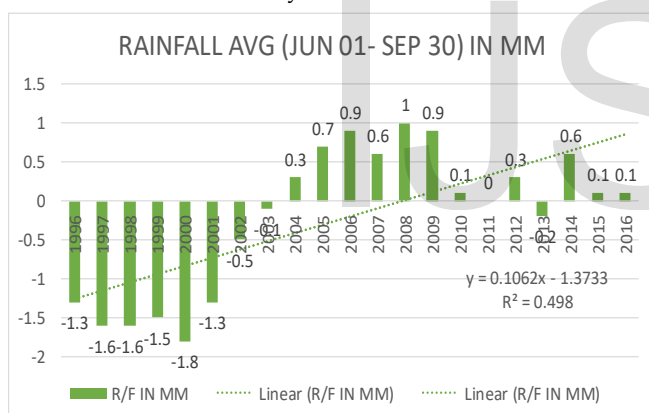


Fig 4.6 Moving Average technique on rainfall (01 Jun – 30 Sep) for years 1991-2021

7 DETAILS OF SYSTEM FORMATION

Ser.	Month	D	CS	SCS	Remarks
(a)	Jan	Nil	Nil	Nil	00
(b)	Feb	Nil	Nil	Nil	00
(c)	Mar	01	Nil	Nil	01
(d)	Apr	Nil	Nil	Nil	00
(e)	May	02	03	06	11
(f)	Jun	08	04	06	18
(g)	Jul	Nil	Nil	Nil	00
(h)	Aug	Nil	Nil	Nil	00
(i)	Sep	02	01	04	07
(j)	Oct	05	06	06	17
(k)	Nov	06	01	06	13
(l)	Dec	06	01	01	08
Total		30	16	39	75

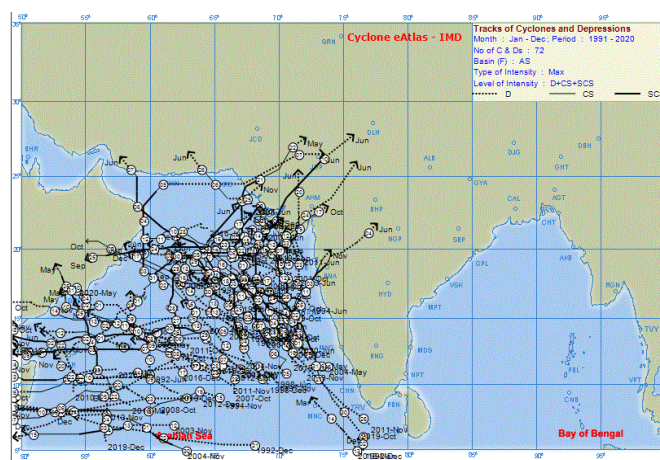


Fig 7.1 Tracks of systems formed in Arabian Sea [4] from 1991-2020

The track indicates that most of the system formation took place during post monsoon months (Quantity>45 %). It is also observed that these systems have formed and took tracked within 14° 48' 50.5428" N to 24° 48' 50.5428" N and 65° 49' 58.0872" E to 74°50' 58.0872" E. Occurrence of maximum no. of systems formation is observed in the lateral decadal years i.e., 2011-2021. The observed change of various meteorological parameters from past 31 years is the major contributor for climatological change over Daman. These changes occurred due to increase of human interference with respect to utilization and consumption of natural resources which has widely supported incremental effect of global warming over the region from past few years.

8. CONCLUSION

The sixth assessment report of IPCC [2] (Intergovernmental Panel on Climate Change). The Intergovernmental Panel on Climate Change (IPCC) [3] is an intergovernmental body of the United Nations responsible for advancing knowledge on human-induced climate change. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) and later endorsed by United Nations General Assembly with headquarters in Geneva, Switzerland, it is comprised of 195 member states.

It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe. Human influence is main driver of hot extremes, which have become more frequent and more intense. Ocean warming and ocean acidification has impacted changes in the frozen areas of the planet.

9 ACKNOWLEDGMENT

I hereby have the honour to submit the analysis report of variation of observed and recorded meteorological parameters over Daman using data from 1991-2021, performed under the guidance and supervision of Dr Ramesh Kripalani, Retired

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- [4] <http://14.139.191.203/AboutEAtlas.aspx>
- [5] <https://mausam.imd.gov.in/>

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