

# Study and Comparison of Rainfall in Muthukur and Nellore Urban Before and After Power Plants Installed near Muthukur

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**Abstract**—The effect of rainfall in Muthukur village and SPSR Nellore district is studied and compared before and after the installation of two major thermal power plants at Muthukur. Data was taken from the CPO (Chief Planning Office), and the rainfall data from January 1976 to December 2022 was analysed.

## I. INTRODUCTION

The people of Bharat worship the rain god Varunadeva. Once, he became angry with Lord Krishna and caused heavy rainfall upon Lord Krishna and his people in Brindavanam. Lord Krishna saved his people by holding up the Govardhana Parvatham (mountain) with the little finger of his left hand. The great scientist Sri Krishna knew at what point the centre of gravity of the Govardhan mountain existed, meaning he could easily calculate the stability of the mountain [1].

Dr. Rajendra Gode clearly explains how power plants function [2]. Arora Ranjuna investigated a 227 KW industrial rooftop power plant [3]. Sorabh Gupta et al. simulated coal crushing in a thermal power plant [4]. Bandi Dayasagar et al. explain how to improve thermal power plant efficiency [5]. Anjali T. et al. focused on the efficiency of a power plant [6], and Gimble S. et al. effectively discuss the Evolution and Second Law of Thermodynamics [7].

Muthukur village is 21 km from Nellore. Two main power plants are installed near Muthukur:

1) Sembcorp Gayatri Power Complex, which started in February 2016, with a capacity of 800 MW.

2) Sri Damodaram Sanjeevaiah Thermal Power Station, which started in December 2014 [8]. Its capacity is  $3 \times 800 = 2400$  MW.

The total capacity of the two plants is  $2400 + 800 = 3200$  MW.

The rainfall data from January 1976 to December 2023 is now compared.

## The Factors Affecting Rainfall

The factors affecting rainfall and their comparison for Nellore Urban and Muthukur are described as follows:

- 1) Temperature
- 2) Humidity
- 3) Movement of Wind
- 4) Topography and Geography
- 5) Aerosols

How these factors change the rainfall is discussed below.

### 1) Temperature

Temperature affects the average rainfall: if the temperature is higher, the atmosphere holds more moisture; when it cools and condenses, raindrops fall from the clouds.

The average yearly temperature of Muthukur is 28-29 degrees centigrade, and the average yearly temperature of Nellore is 28.3 degrees centigrade. There is no abnormal variation in the average yearly temperature, but due to the higher humidity, the chance of rainfall in Muthukur is greater than in Nellore Urban.

### 2) Humidity

Due to its proximity to the seashore, evaporation of water is greater, increasing moisture, and wind breezes are stronger in Muthukur, which leads to precipitation forming more easily in clouds. The humidity of Nellore Urban is lower compared to the water sources in Muthukur. Therefore, Muthukur has more rainfall than Nellore Urban.

### 3) Movement of Wind

The movement of wind causes seasonal variations. The moist air at the seacoast of Muthukur is abundant; therefore, air currents produce precipitation more easily. Hence, there is a greater chance of rainfall at Muthukur than at Nellore Urban.

### 4) Geography and Topography

Increased evaporation near large water bodies, such as coastal seashores, leads to a greater chance of rainfall than in other places. In this respect too, Muthukur has a greater chance of rainfall than Nellore Urban.

### 5) Aerosols

Aerosols are tiny particles present in the atmosphere that cause the nucleation of raindrops. Generally, in cities, pollution is caused by factories, building construction, etc., so more aerosols are produced in cities than in villages. On this basis, we would expect more rainfall in Nellore; however, since Krishnapatnam Port is near Muthukur, the transportation of goods such as coal and iron ore increases aerosols, which leads to more rainfall in Muthukur. Shipping pollution is also greater here, and palm oil factories and other industries near the

seashore increase coastal pollution abnormally. Because Krishnapatnam Port is close to Muthukur, this pollution makes it difficult for people to live near the port. From all these effects, aerosols are more abundant in Muthukur village compared to Nellore Urban, so there is a greater chance of rainfall in Muthukur than in Nellore Urban.

From all these causes, it is expected that rainfall in Muthukur village would be greater than in Nellore Urban. The CPO data taken over 39 years shows that rainfall in Nellore Urban was greater than in Muthukur village in 22 years, and less in the remaining years. During this period, there was a special case: in 1988, rainfall in Muthukur was zero. The India Meteorological Department (IMD) explains that a subtropical anticyclone in April and May 1988 led to dry conditions in southern India, while severe floods occurred in Haryana, Punjab, and Himachal Pradesh. Due to this, a severe drought occurred in Muthukur, resulting in zero rainfall being recorded there.

The average rainfall per year from January 1976 to December 2022 at Muthukur and Nellore Urban, along with the difference in rainfall, is tabulated in Table 1 below.

Table - 1

| S.NO. | YEAR | NELLORE<br>RURAL | MUTHUKUR<br>VILLAGE | DIFFERENCE IN<br>RAIN FALL |
|-------|------|------------------|---------------------|----------------------------|
| 1     | 1976 | 1774.5           | 1678.5              | + 96                       |
| 2     | 1977 | 705.1            | 805.8               | - 100.7                    |
| 3     | 1978 | 974.4            | 955.4               | + 19                       |
| 4     | 1979 | 1195             | 1439.1              | - 244.1                    |
| 5     | 1980 | 800.6            | 1092.3              | - 291.7                    |
| 6     | 1981 | 1160.7           | 966.2               | + 194.5                    |
| 7     | 1982 | 833.5            | 683.2               | + 150.3                    |
| 8     | 1983 | 1212.3           | 283                 | + 929.3                    |
| 9     | 1984 | 1283.4           | 1023.2              | + 260.2                    |
| 10    | 1985 | 872.7            | 739.8               | + 132.9                    |
| 11    | 1986 | 1124.1           | 652                 | + 472.1                    |
| 12    | 1987 | 1465.1           | 851.2               | + 613.9                    |
| 13    | 1988 | 737.7            | 0.0                 | + 737.7                    |
| 14    | 1989 | 682.2            | 667.6               | + 14.7                     |
| 15    | 1990 | 1352.3           | 1225                | + 127.3                    |

|    |      |        |        |          |
|----|------|--------|--------|----------|
| 16 | 1991 | 1528.6 | 1832.2 | - 303.6  |
| 17 | 1992 | 1058.6 | 923.5  | + 135.1  |
| 18 | 1993 | 1431.3 | 1180.2 | + 251.1  |
| 19 | 1994 | 1294.2 | 1597.4 | - 303.2  |
| 20 | 1995 | 1401.6 | 1395.4 | + 6.2    |
| 21 | 1996 | 1663   | 1857.4 | - 194.41 |
| 22 | 1997 | 1524.1 | 1903.2 | - 379.1  |
| 23 | 1998 | 911.2  | 932.5  | - 21.3   |
| 24 | 1999 | 1268   | 1617.4 | - 349.4  |
| 25 | 2000 | 922.4  | 954.8  | - 32.4   |
| 26 | 2001 | 1326.2 | 1673.9 | - 347.7  |
| 27 | 2002 | 1119   | 1119   | 0.00     |
| 28 | 2003 | 954.2  | 942.3  | + 11.9   |
| 29 | 2004 | 1076.2 | 1169.6 | - 93.4   |
| 30 | 2005 | 1280.6 | 1401.8 | - 121.2  |
| 31 | 2006 | 1419.8 | 1254.6 | + 165.2  |
| 32 | 2007 | 3228.3 | 2478.2 | + 750.1  |
| 33 | 2008 | 2500.6 | 2514.8 | - 14.2   |
| 34 | 2009 | 1079.6 | 893.2  | + 186.4  |
| 35 | 2010 | 2520.4 | 2596.9 | - 76.5   |
| 36 | 2011 | 1240.6 | 1316.6 | - 76     |
| 37 | 2012 | 1423.2 | 734    | + 689.2  |
| 38 | 2013 | 1000   | 974.2  | + 25.8   |
| 39 | 2014 | 545.5  | 535.6  | + 9.9    |
| 40 | 2015 | 1411.2 | 1539.3 | - 128.1  |
| 41 | 2016 | 453.3  | 464.6  | - 11.3   |
| 42 | 2017 | 759.3  | 668.7  | + 90.6   |
| 43 | 2018 | 353.3  | 545.2  | - 191.9  |
| 44 | 2019 | 776.1  | 1154.4 | - 378.3  |
| 45 | 2020 | 1196.2 | 1696.1 | - 499.9  |
| 46 | 2021 | 922.2  | 1502   | -579.8   |
| 47 | 2022 | 1237.4 | 1384.9 | - 147.5  |

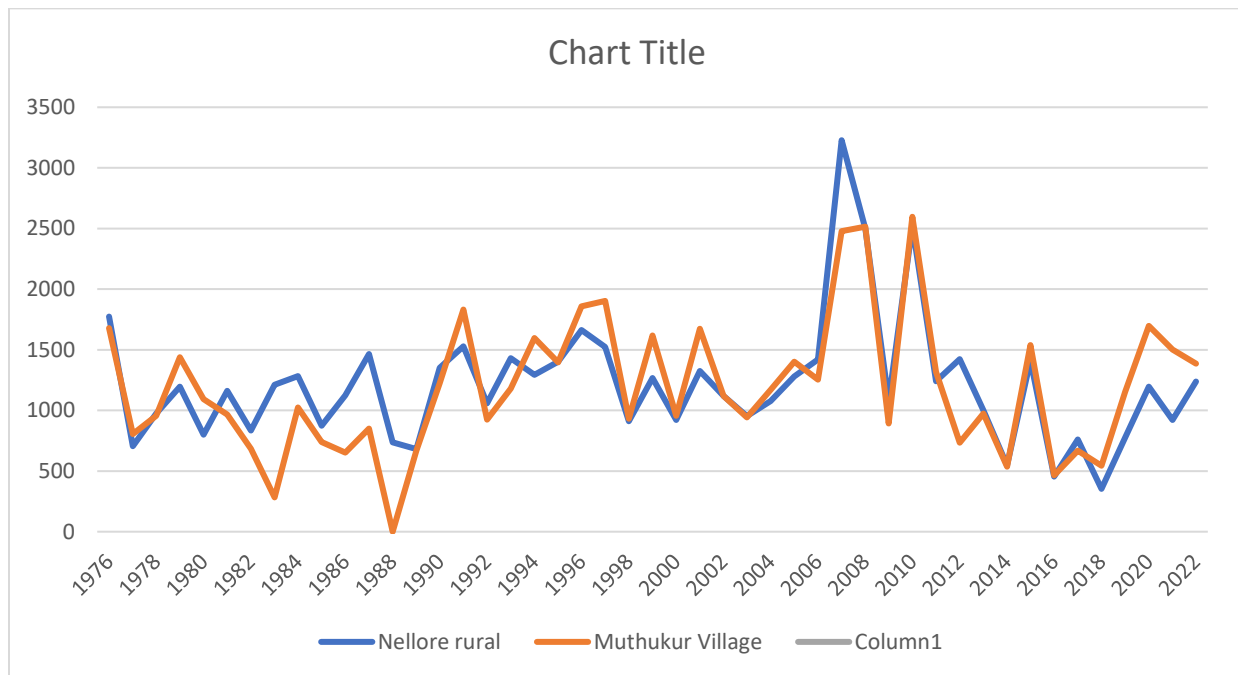
#### Explanation of Table

In Table 1, a positive sign indicates that the rainfall in Nellore Urban was greater than in Muthukur village, and a negative sign indicates that the rainfall in Nellore Urban was less than in Muthukur village. Before the

thermal power plants were installed, rainfall in Muthukur was lower than in Nellore Urban. However, after the thermal power plants started operating, from 2015 onwards, except for 2017, rainfall in Nellore Urban was less than in Muthukur village.

From this data, we note that before the power plants started, out of 39 years, rainfall in Nellore was greater in 22 years and less in the remaining years. In 2002, the same average rainfall value was recorded in Nellore and Muthukur. Therefore, out of 39 years, 22 years showed a positive rainfall difference and 16 years showed a negative rainfall difference. However, after the thermal power plants started operating, from

2015 to 2022, except for 2017, the rainfall difference was negative, indicating that rainfall in Nellore Urban decreased compared to Muthukur village. In 2002, the rainfall difference between Nellore Urban and Muthukur village was zero because both rainfalls were the same. In 1988, Muthukur village had zero rainfall due to subtropical anticyclone conditions.



Graph – 1

#### Analysis of Graph

The blue line indicates the rainfall in Nellore Rural, and the red line represents the rainfall in Muthukur village. From the graph, we conclude that before the thermal power stations were installed, the rainfall difference was mostly positive; after the thermal power stations started, except in 2017, the rainfall difference between Nellore Urban and Muthukur village was negative, indicating that rainfall in Nellore Urban decreased after the thermal power plants were installed.

#### Causes of Decrease of Rainfall in Nellore Urban

##### 1) Thermal power plants near Nellore Urban:

a) Continuous coal burning increases the temperature around the thermal power plants, and the direction in which this heat travels prevents raindrop formation in Nellore.

b) Pollution released into the air increases aerosol density.

c) Muthukur village is near the seashore.

d) Because of the large water resources, humidity increases.

##### 2) Factories near the seashore:

a) The palm oil factory near the seashore increases pollution; the number of aerosols in the air near the seashore increases, so rainfall increases.

b) Nanda Chemicals Private Limited and Lucky Fruits are some other factories present near the Nellore seashore.

## II. CONCLUSION

The rainfall data from 1976 to 2022 was taken and analysed in two steps: 1) before, and 2) after the start of the thermal power stations near Muthukur village.

The first stage of the Sembcorp Gayatri Power Complex started in March 2014, and the second stage started in February 2016. The first stage of the Sri Damodaram Sanjeevaiah Thermal Power Station started in March 2014, and the second stage started in December 2014.

Rainfall data analysis before the thermal power plants  
The period before the thermal power plants is taken from 1976 to 2014, because the major stages of the power plants started in September 2015. Before the thermal power plants were placed near Muthukur, rainfall was mostly greater in Nellore Urban compared to Muthukur.

Rainfall data analysis after the thermal power plants  
This period is taken from 2015 to 2022. Except for 2017, rainfall in Nellore Urban was lower compared to Muthukur village, because nearly all the important factors determining rainfall were increasing in Muthukur village. Pollutants released into the air from the palm oil factory and other factories near the seashore increase aerosol density, which is responsible for the increased rainfall in Muthukur; all these effects together decrease rainfall in Nellore Urban.  
From all the rainfall data before and after the installation of power plants in Muthukur, the data show that before the installation of the power plants, rainfall was greater in Nellore than in Muthukur, except in 1988, due to subtropical anticyclone conditions. After the installation of the power plants, rainfall in Nellore decreased due to the heat effect of the thermal power plants.

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