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**RESEARCH ARTICLE**

# A STUDY ON SHORT TERM SURFACE WEATHER ELEMENTS OVER KUTTAPULI COAST OF TAMIL NADU, SOUTHEAST COAST OF INDIA

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**ABSTRACT**

India has been identified as one among 27 countries which are most vulnerable to the impact of climatic changes and global warming relating to accelerated sea level rise. A mean sea level rise between 15 cm and 38 cm is projected by the mid 21st century along India's coast. Climate is continuously varying on time scales ranging from seasons to the lifetime of the Earth. In this background there is about 15% projected increase in intensity of tropical cyclones in the coastal regions of India. The present study highlights weather changes between the years 2007-2008 in atmospheric variability over Kuttapuli coast, South Tamil Nadu, Southeast Coast of India. During this period atmospheric data viz. atmospheric minimum and maximum temperature, pressure, relative humidity, wind speed, direction, sunshine hours and rainfall measurement were collected. During this study period drastic variation could be observed in air temperature, wind speed and direction and rainfall. Thus it is imperative that year to year variation has started to prevail in this coastal belt, which is forming a vital zone of Gulf of Mannar.



## INTRODUCTION

The current major focus for science is the prospect of global climate change. Presently weather change is one of the most important global environmental challenges facing humanity with implications for food production, natural ecosystem, fresh water supply, health etc. The Intergovernmental Panel on Climate & Change[1] predicts that the global mean temperature may increase between 1.4 and 5.8 degrees Celsius by 2100. In this background, this kind of climate change will lead to intrusion of seawater into the ground water and changes in temperature can reduce the agricultural and fishing income[2]. So it is essential to know the real time observation on recent surface weather changes over a coast (Kuttapuli coast). This will be much useful to understand the actual trend in weather changes. Any changes in the atmospheric variables of a coastal area can affect conditions in the sea in many ways[3]. Likewise, any changes in the sea will affect the coastal weather conditions. So coastal climate has intermediate climate and varies from both land and marine climate. Since 20th century the increase in air temperature has been 0.6 ± 0.2˚C. The last decade has been observed as the warmest in India and South East Asia experiencing frequent extreme climatic events[1]. The paper by the Barnett *et al.*[4] rightly points out that a major component of the global climate system is the ocean surface, covering roughly 72 percent of the planet's surface. The oceanic water bodies have the thermal inertia and heat capacity to help maintain and ameliorate weather variability. Hence a study on short term surface weather elements over Kuttapuli coast was undertaken to understand the changes of coastal surface weather elements over Kuttapuli. The study area is located on the banks of Gulf of Mannar in the eastern side and located very close to the Indian Ocean in the southern side. The data base of weather information will be much useful for further research to find the climatic changes and global warming. Kuttapuli is a coastal village in the southern part of Tamil Nadu in Tirunelveli District. It is located on the banks of Gulf of Mannar (Lat.08º.08'N, Log.77º.35'E) and 15 meter from the mean sea level (MSL) (Fig.1). When compared to the interior land area, significant variations of atmospheric temperature, wind speed, wind direction, relative humidity, air pressure, rain fall and sunshine hours were recorded. Weather data collected in the meteorological observatory was compiled and analysed for knowing changes in climate conditions over the period of 2007 and 2008. The main aim of this paper is to understand the recent trend in weather changes of Kuttapuli coast. Weather information recorded in the coast is imperative to know the coastal climatic changes and to predict the future changes.

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## MATERIALS AND METHODS

Kuttapuli is a coastal village in the southern part of Tamil Nadu in Tirunelveli District. It is located on the banks of Gulf of Mannar (Lat.08º.08'N, Log.77º.35'E) and 15 meter from the mean sea level (MSL) (Fig.1).


**Fig.1. Map showing the study area**

Atmospheric variables viz. air temperature, air pressure, wind speed, direction, relative humidity, rainfall, and sunshine hours were observed on a daily basis for the period of two years, from January, 2007 to December, 2008 and used in the present study. The daily observation was made at 0830 IST. Atmospheric temperatures of minimum and maximum were recorded by using the standard Celsius thermometer. Atmospheric pressure was observed by using the Aneroid barometer and relative humidity was measured with the help of wet and dry bulb thermometer. Wind speed and direction was recorded by using the anemometer and wind vane respectively. Rainfall was recorded with the help of standard FRB rain gauge and sunshine hours were measured by means of Campbell –Stokes sun shine recorder. Monthly mean data of atmospheric variables were studied in the present study.

## RESULT AND DISCUSSION

Observed weather parameter is given in (Table.1). In the present study, maximum mean temperature of 37.1˚C (Fig.2) was recorded in the month of June 2008 and minimum mean temperature of 19.9˚C (Fig.3) were observed in the month of December, 2008. Annual maximum mean temperature of 34.18˚C was recorded in 2007 and 34.47˚C was recorded in 2008. Annual minimum mean temperature of 23.31˚C was recorded in 2007 and annual minimum mean temperature of 23.4˚C was observed in 2008. It shows that means minimum temperature and means maximum temperature of 0.12˚C and 0.29˚C was increased from 2007 respectively. From these results, maximum mean temperature is increasing slightly faster than minimum mean temperature. The surface temperature over the Indian region shows increasing trend of about 0.4˚C/100 years. The increasing pattern of temperature is mainly contributed by the maximum temperature as the minimum temperature trend is less during the current century[5,6]. Similar pattern was studied by Pant. G.B[12]. During the study period 663.00 mm and 1367.10 mm annual rainfall were recorded in the year of 2007 and 2008 respectively (Fig.4). When compared to 2008, Kuttapuli coast receives half of rainfall during 2007. No rainfall was recorded during dry weather season (January, February, and March) during 2007. However, 44.01 mm of rainfall was recorded during dry season in 2008. Generally the coastal Tamil Nadu receives about 60 % of its annual rainfall during northeast monsoon[7] and the interior Tamil Nadu receives 40 - 50 % annual rainfall[7]. However, 62.24% of annual rainfall was received during (hot weather season) summer season. During the present study, more rainfall of 364.00 mm was recorded in summer monsoon than northeast monsoon. Murugan *et al* [8] observed that the most southern districts of Tamil Nadu and Kerala in the east and west coast of the Indian sub continent enjoying high and low rainfall respectively during Indian Summer Monson (ISM). The present study is in accordance with the findings of Murugan *et al,* that Indian Ocean brings much needed rain to the sub-continent during every summer.

Maximum atmospheric pressure of 1016 millibar was recorded in the month of November, 2007 and minimum of 1005.3 millibar was recorded during May, 2007 (Fig.5). Owing to the summer effect and high temperature, air pressure had decreased. During the present study, air pressure shows the decreasing trend during summer season and increasing trend of air pressure persist during northeast monsoon. Due to the rainfall and cooling effect it was found that pressure decreases during northeast monsoon.

**Table 1. Observed weather data from January 2007 to December 2008**

| Month | Rain fall (mm) | | Air temperature (°) | | | | Air pressure (Millibar) | | Relative humidity (%) | | Wind speed (km/hr) | | Wind direction (deg) | | Sun shine hours (Hours) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | | Maximum | | | | | | | | | | | |
| | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 |
| January | 0.00 | 0.00 | 20.1 | 20.4 | 32.8 | 33.9 | 1012.7 | 1012.3 | 82.0 | 86.0 | 5.0 | 5.0 | 40.0 | 65.0 | 6.15 | 6.20 |
| February | 0.00 | 125.7 | 20.8 | 20.5 | 33.0 | 33.6 | 1011.6 | 1011.6 | 80.0 | 88.0 | 4.7 | 4.0 | 55.0 | 50.0 | 6.45 | 6.30 |
| March | 0.00 | 314.4 | 21.3 | 21.4 | 33.6 | 34.3 | 1009.3 | 1010.4 | 72.0 | 84.0 | 5.4 | 4.0 | 30.0 | 70.0 | 7.00 | 7.15 |
| April | 12.70 | 107.5 | 22.4 | 22.3 | 35.1 | 35.4 | 1008.6 | 1009.0 | 68.0 | 78.0 | 4.0 | 5.0 | 310.0 | 350.0 | 8.10 | 7.50 |
| May | 400.00 | 0.00 | 26.3 | 26.8 | 36.8 | 36.9 | 1006.8 | 1007.4 | 66.0 | 60.0 | 13.0 | 8.0 | 275.0 | 280.0 | 9.30 | 9.20 |
| June | 115.00 | 4.60 | 26.1 | 26.9 | 36.6 | 37.1 | 1007.5 | 1008.3 | 64.0 | 68.0 | 12.0 | 14.0 | 270.0 | 265.0 | 9.15 | 9.30 |
| July | 4.20 | 63.3 | 25.8 | 26.4 | 35.9 | 36.4 | 1009.2 | 1009.5 | 65.0 | 70.0 | 12.0 | 12.0 | 245.0 | 250.0 | 9.00 | 8.50 |
| August | 18.80 | 90.8 | 25.1 | 25.3 | 34.5 | 34.3 | 1011.7 | 1010.0 | 72.0 | 74.0 | 11.0 | 13.0 | 220.0 | 225.0 | 7.50 | 7.40 |
| September | 63.6 | 0.00 | 25.3 | 25.8 | 33.9 | 34.0 | 1012.4 | 1010.6 | 78.0 | 70.0 | 9.0 | 11.0 | 260.0 | 270.0 | 7.30 | 7.20 |
| October | 22.0 | 399.4 | 24.1 | 23.5 | 33.2 | 33.7 | 1013.2 | 1011.8 | 82.0 | 88.0 | 8.4 | 6.0 | 330.0 | 15.0 | 7.30 | 6.45 |
| November | 22.0 | 246.4 | 22.6 | 21.9 | 32.7 | 32.1 | 1013.5 | 1012.5 | 86.0 | 85.0 | 15.0 | 8.0 | 45.0 | 45.0 | 6.45 | 6.50 |
| December | 4.70 | 15.0 | 20.9 | 20.8 | 32.1 | 32.0 | 1013.8 | 1013.8 | 88.0 | 86.0 | 4.60 | 8.0 | 85.0 | 90.0 | 6.30 | 6.10 |

Diurnal variation of pressure was observed during the study period. Minimum level was observed during summer months and maximum was observed during monsoon season. A close relationship exists between air temperature and pressure. The low pressure system (LPS) plays an important role in the distribution of rainfall during the period of summer season over India[9]. This concept is confirmed in the present study. Relative humidity is an important factor, which will decide the comfort of human beings. Changes in humidity are mainly depending on the temperature fluctuations. Maximum relative humidity was recorded during northeast monsoon in both the years (2007 and 2008) and low humidity observed during the summer season (Fig. 6). Maximum humidity was recorded during cold winter season and hot weather condition diminished the relative humidity. Labajo *et al*, [10] analyzed different empirical and semi empirical exponential relations between humidity and air temperature. A linear approach to real relation function between air temperature and humidity shows summer temperature soar from April to June. The relative humidity is high in the coastal areas. This appends more distress to the coastal community. However, sea breeze will start at after noon and relative humidity will become comfortable.

Maximum wind speed of 15 km/hr was recorded in the month of November, 2007 and minimum speed of 4 km/hr was recorded in April, 2007, February and March, 2008. Annual mean wind speed of 8.04 km/hr was observed during this study period (Fig.7). When compared with 2007, wind speed decreased in 2008. Changes in wind direction often bring changes in temperature and moisture conditions; therefore the ability to predict weather, the wind parameters is essential for forecasting[11]. Wind flow was observed mainly in the North of Northeast (NNE) direction during winter season while sometimes it flows in the southeast (SE) direction. During the summer months the wind flows from southeast direction. Wind flows in the southwest direction during June, July, August and September may be due to the southwest monsoon effect (Fig.8). Beyond September, the wind flows in the northeast direction. The same wind pattern prevailed in 2008 also. Monthly mean sun shine hour varied from 189.1 hours to 288.3 hours during the study period. Minimum mean sunshine recorded as 189.1 hours in the month of December, 2008 while maximum mean sunshine hour was recorded in the month of May, 2007 (Fig. 9). It has been found that stronger winds lead to longer sunshine duration[12]. Total sunshine hour in the study period was 5421.8 hours. Sunshine of 2739.65 and 2682.2 hours were recorded in 2007 and 2008 respectively. Recently it has been proved by many scientists that there is a steady decline in solar radiation across the globe, is observed ie, Global dimming [13-16]. In the present study about 11.55 hours decreased from 2007 ie. 0.96 h/ month in sunshine hours was observed for the two year period which may be due to the aerosols and suspended particles. Black aerosols may have dimmed the surface of the planet, while making it brighter at the top of the atmosphere[17]. The present study shows that the South Tamil Nadu is experiencing less sunshine hours. Similar solar dimming was reported by Kumari *et al*[18]. She stated that India is losing out on sunshine because a cloud of tiny air-borne particles released by the nation's industries hovers above the subcontinent, blocking light from the atmosphere[18]. Regular monitoring of sunshine hour observation in this area is required to understand the solar dimming scenario.

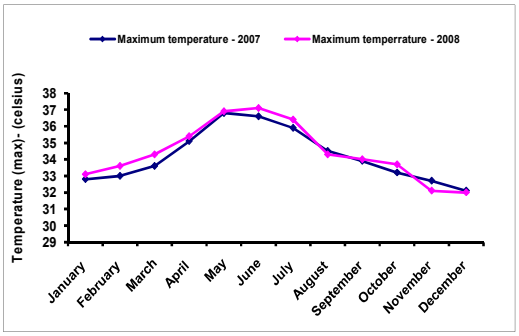


**Fig. 2. Monthly variation of Maximum Air temperature**

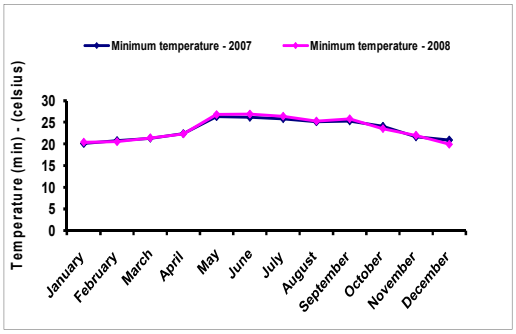


**Fig. 3. Monthly variation of Minimum Air temperature**

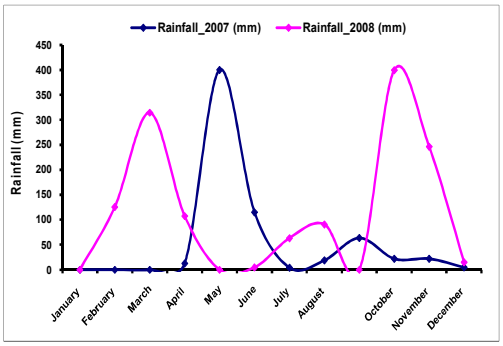


**Fig.4. Monthly variation of Rainfall**

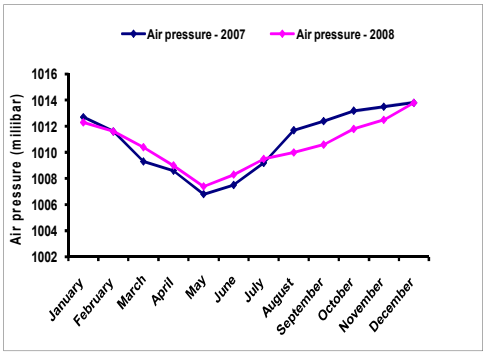


**Fig.5. Monthly variation of Air pressure**

## Statistical Analysis

Standard deviation for the rainfall, minimum temperature, maximum temperature, pressure, sunshine hour, wind speed, wind direction and relative humidity are 12.6148, 2.3971, 1.6072, 2.1412, 1.1173, 3.6482, 115.9648, and 8.8939 (Table.1).

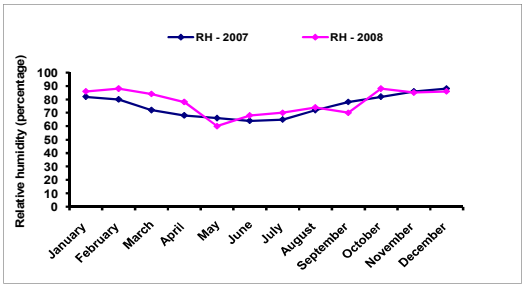


**Fig.6. Monthly variation of Relative humidity**

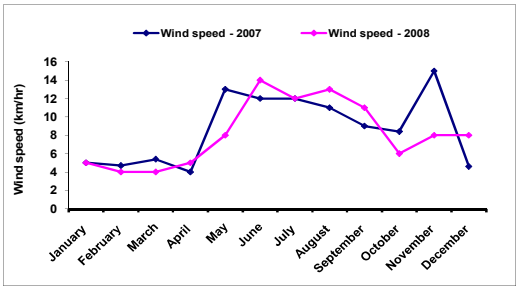


**Fig.7. Monthly variation of Wind speed**

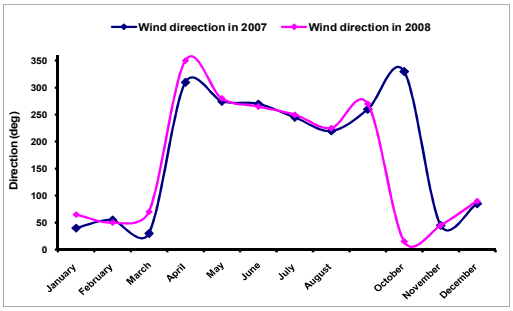


**Fig.8. Monthly variation of Wind direction**

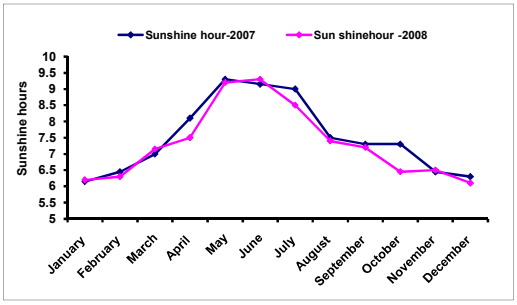


**Fig. 9. Monthly variation of Sun shine hours**

### a) Maximum temperature and Relative humidity

Correlation coefficient between maximum temperature is worked out to be -0.3050. It shows inverse relationship between maximum temperature and relative humidity. That is, as temperature increases the humidity falls. But the influence of maximum temperature on humidity is low.

### b) Relative humidity and Pressure

The influence of relative humidity on pressure is relatively high; as the correlation is 0.6567. Moreover the relationship between humidity and pressure is direct, that is, when humidity increases the pressure also increases but at lesser degree.

### c). Minimum temperature and Maximum temperature

The relationship between minimum temperature and maximum temperature is remarkably high. The influence of maximum temperature on minimum temperature is positive as the correlation coefficient is 0.7596.

### d). Sunshine hour and Maximum temperature

There is a high degree of positive correlation between sunshine hour and maximum temperature (r = 0.9360). This correlation coefficient is almost positively perfect. This means sunshine hour leads to direct and proportionate changes in maximum temperature.

### e). Maximum temperature and wind speed

The influence of temperature (maximum) on wind speed is relatively low. This correlation coefficient between maximum temperature and wind speed is 0.4260.

### f). Sunshine hour and relative humidity

Sunshine hour negatively influences the relative humidity. The correlation coefficient between sunshine hour and humidity is – 0.9005. It reveals that, sunshine hour and humidity are changing in opposite directions. In addition, the degree of changes between them is almost perfectly positive.

### g). Relative humidity and rainfall

Normally rainfall is not influenced by humidity. This is proved beyond doubt in this case also. The correlation coefficient between humidity and rainfall is 0.1697. This means that, the influence of humidity on rainfall is virtually zero.

### h). Air pressure and wind speed

The impact of pressure on wind speed is negative. This correlation coefficient is – 0.0784. This means that both the variables are changing in opposite directions. That as the pressure increases wind speeds falls and vice versa.

### i). Maximum temperature and pressure

The coefficient of correlation between temperature and pressure is – 0.5541. It reveals that changes in temperature lead to opposite changes in pressure. However, the quantum of changes is less than proportional

## Conclusion

The present study reveals that the annual mean maximum and minimum temperature are found to be increased by 0.3 degree Celsius and 0.1 degree Celsius respectively from 2007 to 2008. Though maximum rainfall was received in the year 2008, mean maximum temperature is slightly higher in that year. Northeast rainfall recorded in 2007 and 2008 are 5.31 mm and 660 mm respectively. However 400 mm of rainfall was recorded during the month of May 2007. Air pressure has slightly decreased during the study period. When compared to other seasons, low pressure persists during summer seasons in both the years. Wind speed is high in southwest monsoon and

low speed was recorded in winter season. The wind direction observed during the study period did not very much varied. In the present study, it has been observed that duration of sunshine hours was decreased from 2007 to 2008. Continuous monitoring of sunshine hour data is required to understand the solar dimming phenomenon is persists in the coastal districts of Southern Tamil Nadu.

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