Analysis of Weather Parameters for Three Hourly Intervals

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Abstract— Weather plays an important role in all phenomena such as air pollution and daily life. It has been found that weather and climate affect human health and well-being. A substantial mortality has been seen in the winter as well as summer season. Many cities have determined minimum and maximum temperature which is associated with total mortality in the city. Humidity affects the body's ability to cool itself by evaporation of perspiration. In the present study, four weather parameters viz. temperature, wind speed, wind direction and humidity have been studied with respect to three hourly intervals over the year 2012 for Mumbai city. Generally, weather parameters are analysed for continuous time series data for the period but in this case study, each particular eight intervals of three hours a day (8 intervals x 3 hours = 24 hours) for the year 2012 have been analysed. It helps to investigate the average pattern and variation of weather parameters over the year which influences the air pollution and other climatic impacts for each three hourly time interval. The statistical study has been done for this data set which includes minimum, maximum, average and standard deviation of each parameter for the year. Results show that temperatures of night time (23.30 to 8.30) have low variation than day time (11.30 to 20.30). Humidity takes large variation from day to night time, has higher variation from 11.30 to 20.30 than other times. The topographic region of Mumbai causes low wind speed as usual and many times calm is recorded when it does not give any wind data such as wind speed and direction. The variation in wind speed for particular time is marginal but maximum is found between 11.30 to 17.30. Wind is blowing from North, South, North-West and South-West direction. This analysis can help to investigate worst case scenario based on weather parameters which causes poor air quality and several health effects.

Index Terms— Weather parameter, Temporal scale, Dirunal changes, Standard variation.

1 Introduction

orrelations between weather and climate is a well researched field but there is some confusion between terminology [1], [2]. Weather is the combination of the condition of the atmospheric parameter in high temporal resolution for a particular place (i.e. from day to day or week to week), while climate is a combintation of average weather conditions over a longer period of time for a particular place. Climate reflects the weather pattern of a place over a long period because weather is subset of climate in fine resolution [3]. Climate is observed may be for 30 years or more to yield meaningful averages of meteorlogy. Climate change contributes to the extent and severe change of the global weather and recent outbreaks are strong evidence for that [4], [5]. To study climatic pattern due to variation of atmospheric parameters, long time period of data is required while for perspective point of air pollution, annual average weather paramaters are almost the same. Atmospheric parameteres are evaluated for understanding the trend in its variation associated with the dynamics of air pollution. Temperature, humidity, cloud cover, rain fall, wind speed and direction are atmospheric characteristics which represent weather for a small period. Temperature inversion makes low and high boundary layer height from the surface and varies the concentration of air pollutant. Lower value of relative humidity causes air pollution. Cloud

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which is also a factor of air pollution. Lower wind speed causes less dispersion and increased air pollution level. Many studies have been done to quantify and contrast the spatial and temporal variation for daily weather parameters [6]-[9]. The movement of the sun drives weather conditions and sunlight is dispersed and absorbed on water and land surfaces. The air masses move because of variation in temperature and pressure due to solar radiation. Weather change and increment of emission of carbon causes global warming in the built environment. A number of policies and regulations have been imposed in place to try and reduce the impact of CO₂ emissions to make a sustainable enviionment [10]-[12]. Most of these problems are driven by human behaviour that holds the key to reducing society's reliance on anthopogenic emission [13]. A meteorological model Weather Research and Forecasting was applied forair quality modelling [14], [15]. Meteorological parameters can be analyzed at weather scale as well as climatic scale. Air quality modelling is carried out with the help of emission and meteorological data to predict concentration in the region. In this modelling, uniform meteorological data is used over a region of 10 to 15 km radius. Therefore, monitored meteorological data can be representable for the region of 10 to 15 km radius.

In the present study, temperature, humidity, wind speed and wind direction have been analyzed for the year 2012. This data was analyzed in each particular three hours eight intervals of day and temporal variation and corelation have been found out.

2 Monitoring Site and Data Collection

The Indian Meteorological Department (IMD) is an agency of the Ministry of Earth Sciences of the Government of India.



Fig 1. Monitoring site Santacruz, Mumbai (India)

This agency has reponsibility for meteorological measurements, weather forecasting and seismology. The weather data is being collected by IMD continously for three hours temporal resolution at Santacruz, Mumbai. So, three hourly weather parameters were studied. The site location is given in Figure 1. The latitude and longitude are 19.12 and 72.85 with 14 m elevation. IMD monitors weather parameters in the temporal interval such as 2:30 - 5:30, 5:30 - 8:30, 8:30 - 11:30, 11:30 - 14:30, 14:30 - 17.30, 17:30 - 20:30, 20:30 - 23.30 and 23:30 - 2:30. All these parameters are monitered at a height of 10 m.

3 RESULTS AND DISCUSSION

Air, water and land system affect the temperature level in environment. These three factors cause heating and cooling in temperature at spatial and temporal scale in the region. The collected data from IMD was analyzed for the year 2012. Figure 1 shows each three hourly temperature over the year 2012. The eight intervals of three hours have been studied. The trend of temperature shows that from 11:30 to 5:30 of the day, there is low variation with respect to the time throughout the year which includes all different seasons. The variations in temperature have been found after 20:30 night and till 8:30 in the morning in that year. The minimum, maximum, average and standard deviation in temperature has been presented in Table 1. The minimum temperature from 2:30 to 8:30 is around 12oC and 13oC at mid-night and rest of the time it is 20 to 25oC. The maximum temperature is from 20:30 to 8:30 is 30 to 32 oC while rest of the time it is 35 to 38 oC. Also, average temperature was found to have almost similar pattern. The average temperature from 20:30 to 8:30 is 23 to 25 oC while rest of the time it is 27 to 31 oC. The variation in standard deviations is maximum from 23:30 to 8:30 while minimum are from 11:30 to 20:30.

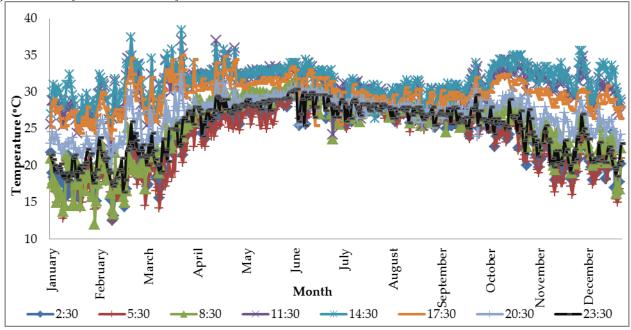


Fig 2. Variation of three hourly temperature over the year

Time	2:30	5:30	8:30	11:30	14:30	17:30	20:30	23:30
Min	13	12	12	22	26	24	19	16
Max	30	30	32	37	38	35	32	30
Average	24	23	25	31	31	30	27	25
Std Dev	4.1	4.3	4.3	2.4	2.2	2.1	2.4	3.5

Table 1. Minimum, maximum, average and standard deviation in temperature

Humidity is measured in terms of the amount of water that air can hold. When the humidity is high, it means that there is enough water in the air to create rain or snow. It is important for the formation of clouds because they are made from water and ice. Humidity changes a lot during the day. Figure 2 shows the variation of three hourly humidity in the year 2012. It varies a lot in a day from Januray to April and from mid October to December in the year for each interval. It has very low variation in a day from May to October. The maximum humidity for each interval is the same and more that 95% as shown in Table 2. The variation is low from 23:30 to 8:30 in a day and high in the rest of the intervals. The minimum humidity is between 13 to 21% from 11:30 to 20:30 and 28 to 36% from 23:30 to 8:30. The average humidity is between 78 to 82% from 23:30 to 8:30 (mid-night to morning) and 56 to 70% from 11:30 to 20:30 (from noon to evening time).

Wind is the movement of air across the earth's surface. The main factors that affect wind speed are air-pressure gradient, force and friction. Synoptic system, monsoons and thunderstorms influence the wind field. Cyclones in Mumbai are not observed. The wind speed of Mumbai is always low and causes low transport of atmospheric pollutants as well as other weather parameters. From this analysis, it has been found that wind speed is calm for maximum time of the period year 2012 for Mumbai city. Figure 4 shows variations of three hourly wind speeds over the year. The minimum wind speed is zero (calm condition) at each time interval in the year as shown in Table 3. It has very low standard deviation (4-5) in each interval of the wind speed throughout the year. The average wind speed in 3 to 5 km/h from 23:30 to 8:30 while 8 to 11 km/h for the rest of the interval. The maximum wind speed is 18 to 24km/h from 20:30 to 8:30 while 30 to 34 from 11:30 to 14:30.

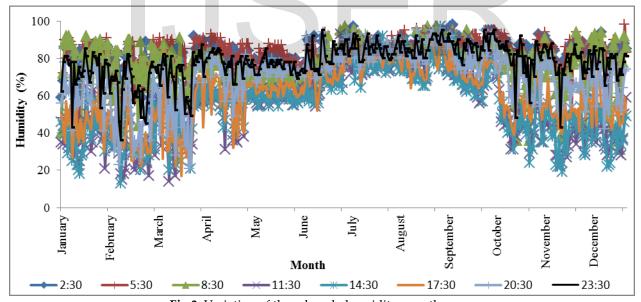


Fig 3. Variation of three hourly humidity over the year

Table 2. Minimum, maximum, average and standard deviation in humidity

Time	2:30	5:30	8:30	11:30	14:30	17:30	20:30	23:30
Min	36	33	28	14	13	17	21	36
Max	98	98	97	95	97	96	96	95
Average	82	82	76	56	55	60	70	78
Std Dev	9	11	13	19	18	17	14	10

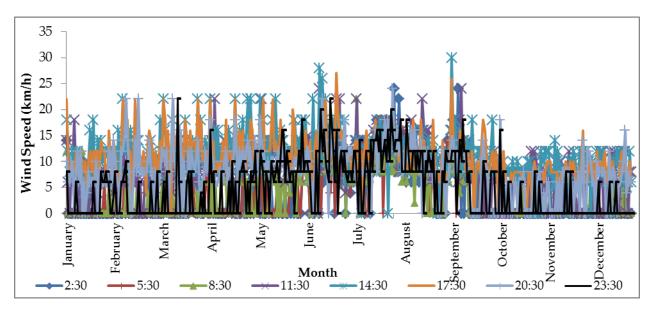


Fig 4. Variations of three hourly wind speeds over the year

Table 3. Minimum, maximum, average and standard deviation in wind speed

Time	2:30	5:30	8:30	11:30	14:30	17:30	20:30	23:30
Min	0	0	0	0	0	0	0	0
Max	24	18	22	34	30	27	24	22
Average	4	3	4	9	11	11	8	5
Std Dev	5	5	5	5	4	4	5	5

Wind direction is affected by the pressure-gradient force, the Coriolis force and frictional force which cause the wind to blow in different directions. In this study, the frequency of wind direction has been counted for each interval of the year. It has been observed that wind is calm from 23:30 to 8:30 for maximum time when observation cannot be recorded for wind direction. Also, the frequency is low for all directions in this period. The wind is blowing from North, North-west, Southwest and West direction at most of the time period. The highest frequency has been counted 132 for wind direction at an interval of 17:30 in North-west direction.

The daily averages of the temperature, humidity and wind speed have also been analyzed for the year as shown in Figure 6. A low variation has been found in daily average temperature and wind speed in the year while humidity has high variation in daily averages. Minimum, maximum, average and standard deviation of daily average temperature, wind speed and humidity have been shown in Table 4 for the year 2012. The minimum value of temperature, humidity and wind speed is 18oC, 25% and 0 km/h respectively while maximum is 33°C, 97% and 25 km/h respectively in the year 2012. The average temperature, humidity and wind speed is 27°C, 70% and 7 km/h respectively.

Table 4. Minimum, maximum, average and standard deviation of daily average temperature, wind speed and humidity for the year

Time	Temperature (°C)	Humidity (%)	Wind Speed (km/h)		
Min	18	25	0		
Max	33	97	25		
Average	27	70	7		
Std Dev	3	14	5		

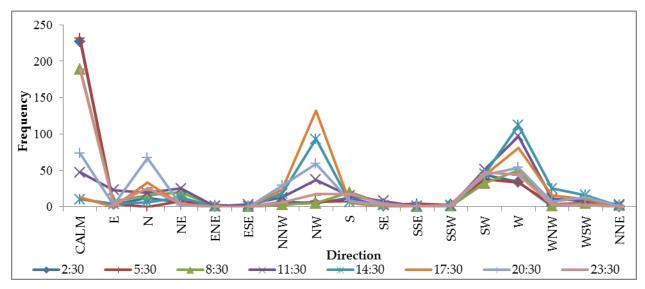


Fig 5. Freaquency of three hourly wind direction over the year

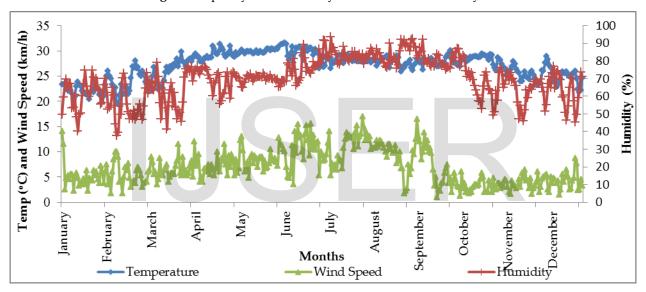


Fig 6. Variations of daily average temperature, wind speed and humidity for the year

4 Conclusions

The study about weather and climate needs to be done as it affects the environment as well as the well-being of the individuals. In this study, the eight intervals of three hours have been carried out for weather parameters like temperature, humidity, wind speed and direction. Temperature has lower in night than day time while humidity has higher value in night than day time. The wind is blowing from North, Northwest, South-west and West direction for maximum period of time. Statistical analysis of the weather parameters have also been done to calculate minimum, maximum, average and standard deviation. The daily average of temperature, humidity and wind speed have been studied where temperature and wind speed have low standard deviation while humidity has

high. Wind is calm for maximum time and it is difficult to record wind speed and direction for this condition. It may be because of topography and urban canopy of the region. The three hours interval of the day data can help to investigate various scenarios for management purposes. Many studies have been done for climate change where climate is for long period and weather is for small period. Climate change is important as its effects are seen globally but weather is as important since its effects are seen at a local scale. This study will be useful to investigate worst case scenarios of air pollution, climate change and health.

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