Urban Heat Island Effect over Ahmedabad city: A Study Using temperature Trend

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***Abstract*:-**The local temperature is one of the major climatic elements to record the changes in the atmospheric environment brought about by industrialization, increasing vehicle, increasing population and massive urbanization. The present study deals with the annual and seasonal temperature trends and differences for maximum, minimum and mean temperatures of Ahmedabad city for the past few decades and their association with the development through urbanization processes and vehicle numbers increase. The annual mean maximum temperature did not show any specific trend; however a consistent increasing trend was seen in the annual mean minimum temperatures indicating an overall warming trend over Ahmedabad city especially after 1990. However, the temperature trends in annual mean minimum temperatures reported in various countries (USA, Turkey, Italy, etc.) across the world showed warming trends to be associated to the urbanization process of the cities also. The current warming trends in temperature in Ahmedabad city based on the annual mean minimum temperatures have thus been supported by the trends in other parts of the world and could be utilized to infer the development process in city. The urbanization pattern and unbalanced transportation system within Ahmedabad is reflected by the trends of differences in annual mean minimum temperature of city. The significance of the warming trends of the annual minimum temperature for the urban heat island effect is also discussed.

IndexTerms:- **Urban Heat Island, Temperature Trends, Urbanization, Ahmedabad city, Increase Vehicle numbers**

I.INDRODUCTION

"Urban Heat island" is an area specific phenomenon where the temperature of urban/developed area is higher than that of the surrounding rural or undeveloped areas. Urban Heat Island (UHI) is considered as one of the major problems in the 21st century posed to human beings as a result of industrialization and urbanization [1].

At the local scale, especially in urban areas, waste heat produced by human activities, including heat generated by vehicle combustion and industrial processes, the conduction of heat through building walls or emitted directly into the atmosphere by air-conditioning systems, and the metabolic heat produced by humans all combine to cause local air temperatures to raise, especially in urban areas. This phenomenon is known as 'urban heat islands' (UHI).With increase in the population, the demand for residences has also increased which has escalated growth of slum areas and haphazard planning in suburban. [2-5].

The deterioration of the living environment, increase in the cooling energy requirements [6], elevation in the ground level ozone [7] and even an increase in the mortality rates [8] are some of the few ill effects of urban heat islands.

Cayan and Douglas [10] studied the urban influences on surface temperatures in the South -Western United States for the period 1930-1980 and concluded that urban warming appears to be predominantly a night time phenomenon, with minimum temperatures displaying considerably more increase than the maximum temperature. India has witnessed tremendous industrialization in the last five decades. This has led to migration of masses from rural areas towards cities for jobs and businesses.

Urbanization gives comfort and easy life style which attract humans to live in urban area.so population of urban area increasing rapidly as result of this land use and planning was mostly not proper.

In urban area people have more source of income and last 2decades change whole scenario before years 1family had may be 1 or 2 vehicle but in now days every person have its own vehicle sometime family have more number of vehicle than family members number.

Result of vehicle number and population are increase unsatisfied tarnsportation, conjection, low parking facilities, etc. All this increase vehicle emission which is directly related to temperature, visibility and discomfort.

Transportation as major source of UHI. Direct vehicle exhaust is a dominant source of air pollution in Ahmedabad Vehicles, especially two-wheelers and diesel-based trucks, account for over 20% of PM10 pollution in Ahmedabad.

Two-wheeler motor vehicles including mopeds, scooters and motorcycles, all with a mix of two and four stroke engines have grown rapidly in Ahmedabad and make up the largest number of passenger kilometers travelled as well as the most rapidly

growing fleet of vehicles. An estimated 30-40% of two-wheelers in Ahmedabad have two-stroke engines, which are considered to be less fuel efficient than four-stroke models. As in most Indian cities, Ahmedabad bans heavy-duty vehicles during daytime hours. However, the number of light-duty vehicles on the roads during the day and number of heavy duty vehicles in the night have increased rapidly.

The present study deals with temperature trends of annual mean maximum and minimum, annual mean, seasonal mean maximum and minimum temperatures; as well as temperature anomalies at different time periods during 1958-2018 in Ahmedabad city in India. Seasonal and annual temperature trends and anomalies are studied for mean, minimum and maximum temperatures and their association to Urban Heat Island is discussed.

There has been accelerated growth of the city Ahmedabad in past few decades especially since 1988 and there is no systematic study undertaken that could highlight the impact of this rapid development and number of vehicle increase on the atmospheric environment. For the change in Ahmedabad city analyze long term data of temperature (40-70yr).

II Study Area

The study area for the present study is Ahmedabad city of India as shown in Figure 1.

Figure: 1 Ahmedabad (Study area)

Ahmedabad is the fifth largest city and the former capital of Indian state Gujarat with a population of more than 7.3million (2017). Ahmedabad situated on 23.03°N, 72.58°E according to geographic–coordination system. It is situated on the western part of India near Sabarmati river passes near the Ahmedabad. It spreads in area of 464 km².

Climatic condition of the Ahmedabad city is semi-arid and hot because it receives less rainfall during monsoon season. It is having three seasons of year, summer, monsoon & winter. Apart from the monsoon season, climate of Ahmedabad city is very extreme dry and hot from March to mid-June. Average maximum and minimum temperature of summer recorded are 42ºC and 28ºC, respectively.

Maximum and minimum average temperatures of winter are 30ºC and 15ºC, respectively. Ahmedabad is situated on dry and sandy soil. So it is responsible for extra heating of the city because it absorbs the heat during day time and releases during night time.

III Methodology for Trend Analysis

Seasonal and annual temperature trends and anomalies are studied for mean, minimum and maximum temperatures. For seasonal analysis, the monthly data was further averaged with respect to the season.

For trend analysis, polynomial trend line of order 5 was used that is selected based on trial and error method for various orders of polynomial fitting and the resulting correlation coefficients.

Temperature anomaly was calculated by the formula $\Delta t = T0 - Tavg$ where Δt is the temperature anomaly, T0 is the annual average temperature (either maximum or minimum as the case may be) and Tavg is the overall average of the temperature for the study period for maximum or minimum. Mean temperature is based on the average of the mean minimum and mean maximum temperatures.

Significance test at 95% confidence level was performed to assess the usability of the trends in data.

IV Data Collection and Sources of Data

Meteorological data collected from NOAA (National Oceanic and Administration U.S.Department of Commerce) year 1958-2018 for Ahmedabad city. The National Oceanic and Atmospheric Administration (NOAA) is an American scientific agency within the U.S.Department of Commerce that focuses on the conditions of the oceans, major waterways and the atmosphere. NOAA is give most accurate data of metrology and other environmental. Most of meteorological software also conducts NOAA data as base data.

For analyze temperature trends of Ahmedabad city calculate Annual and Seasonal temperature (1958-2018).Seasonal and annual temperature trends and anomalies are studied for mean, minimum and maximum temperatures.

VI Result and Discussion

It is concluded from various studies discussed in section 1 of this paper that urban warming appears to be pre-dominantly a night time phenomenon, with minimum temperatures displaying considerably more increase than the maximum temperature. Further, it was shown that increasing trend in urban temperatures was more conspicuous in the minimum temperatures rather than in the maximum temperatures.

It is noted from the significance test (at 95% confidence level) that there is presence of trend in minimum temperatures while no specific trend in the maximum and mean temperatures exist. The significance test showed autocorrelation coefficients between 0.561 to 0.623 for the minimum temperatures for the four stations while that for maximum temperatures and mean temperatures these values are low and ranged from 0.131 to 0.354 and 0.084 to 0.413 respectively.

Therefore further discussion considers all trends based mostly on minimum temperatures. Furthermore, due to the availability of complete data as long time series of Ahmedabad city.

Seasonal analysis of Ahmedabad city as per Indian Meteorological Department. In Figure:-2 describe the annual mean minimum temperatures along with the trend line which calculate month January and February.

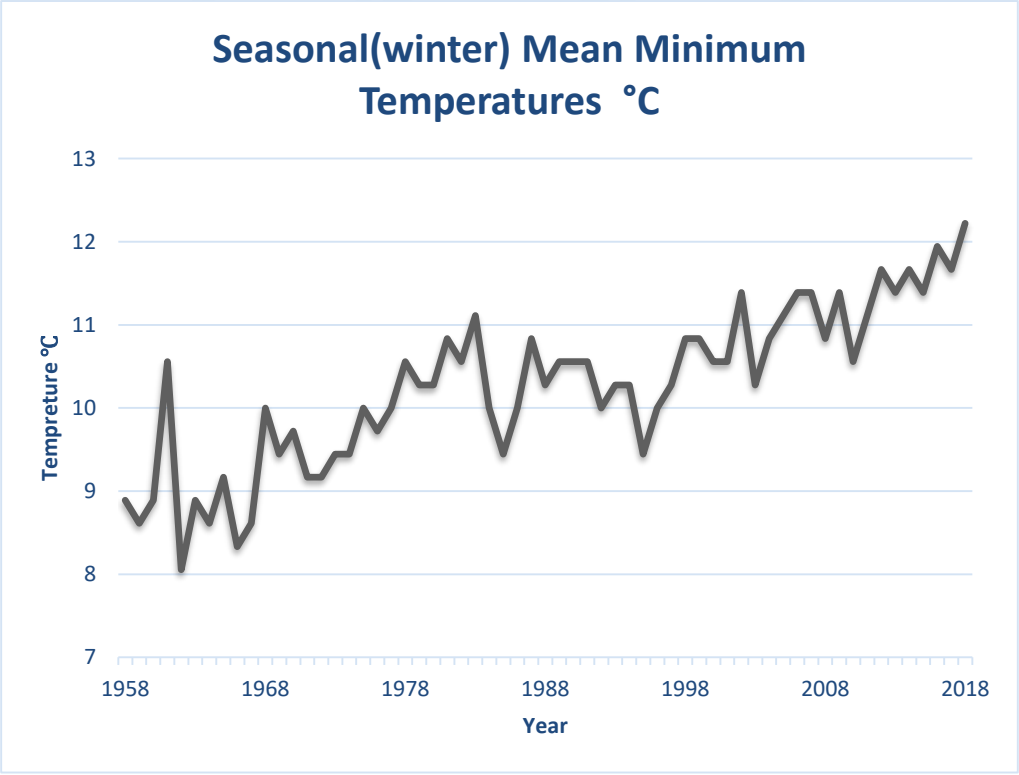

Figure 2 Seasonal (winter) Mean Minimum Temperatures at Ahmedabad during 1958 - 2018

Result of figure 2 the Seasonal (Winter) mean minimum Temperature trend indicates, in general, warming trend since 1968 and it's continuously increase with years. It means lowest temperature of winter in Ahmedabad is continuously go high which is very dangerous for atmosphere.

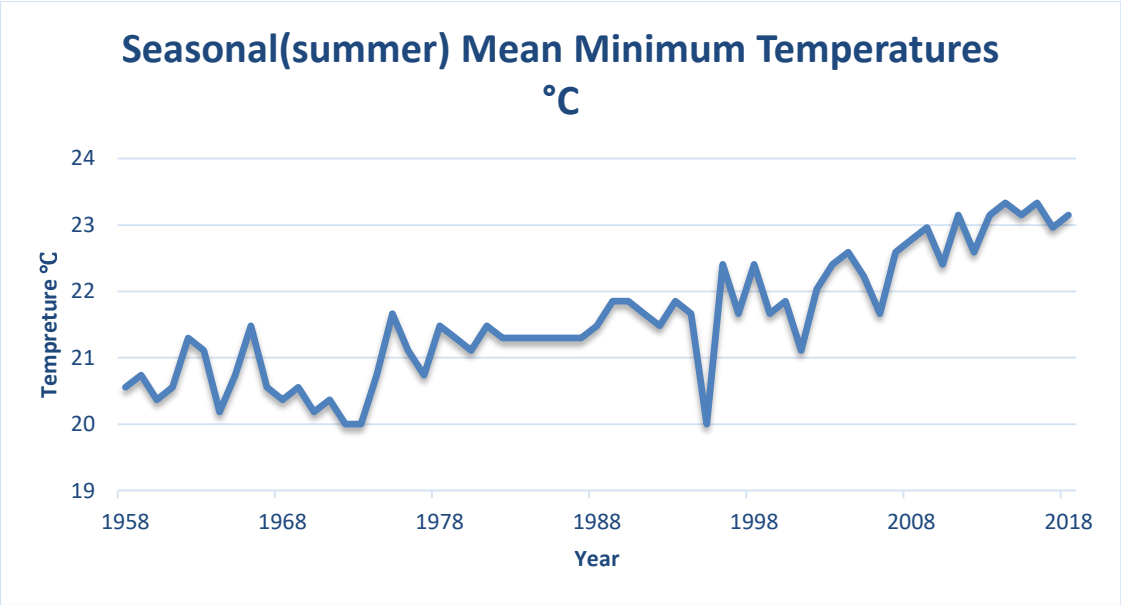

Figure 3 Seasonal (summer) Mean Minimum Temperatures at Ahmedabad during 1958 - 2018

Result of figure 3 the Seasonal (summer) Mean minimum Temperature trend indicates, in general, warming trend since 1975 and it's continuously increase with years. For summer analyze month March, April and May. After 2010 Ahmedabad summer temperature is rise too much and summer temperature in Ahmedabad city rapidly almost 2 to 3ºC which is harmful and increase UHI in city area.

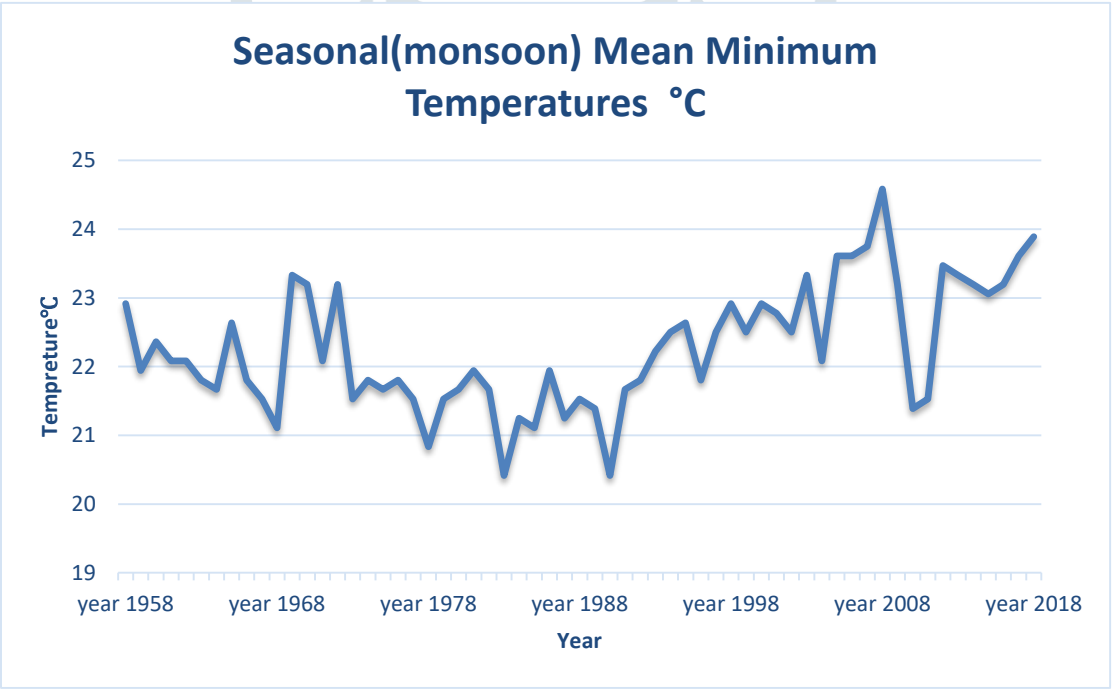

Figure 4 Seasonal (Monsoon) Mean Minimum Temperatures at Ahmedabad during 1958 - 2018

Result of figure 4 the Seasonal (Monsoon) Mean minimum Temperature trend indicates, not perfect trend. Monsoon temperature is too varying with time which means rain fall pattern may vary and temperature also not make trend. For monsoon June, July, august and September in analyze as per Indian Meteorological Department.

Result of figure 5 the Seasonal (Post-Monsoon) mean minimum Temperature trend indicates, temperature trend is increase with year by year. For post-monsoon analyze October, November and December. In October 2010, Ahmedabad had Heat wave which make it too hot and temperature rise after that time in post-monsoon almost every year city have Heat wave which is not good for Human Health.

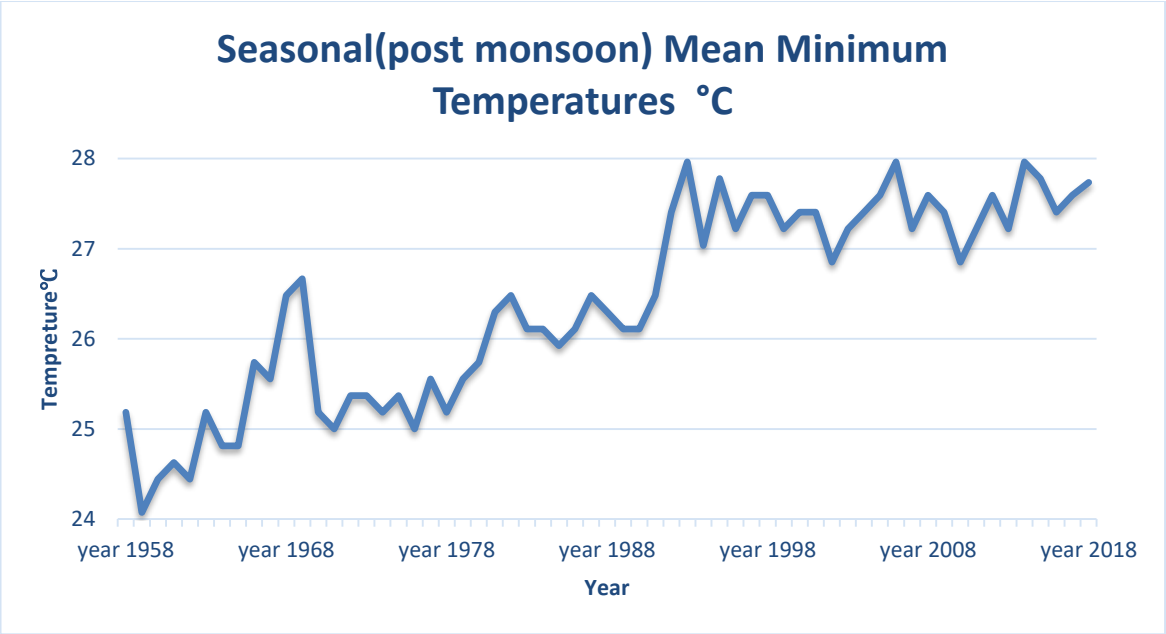

Figure 5 Seasonal (Post-Monsoon) Mean Minimum Temperatures at Ahmedabad during 1958 - 2018

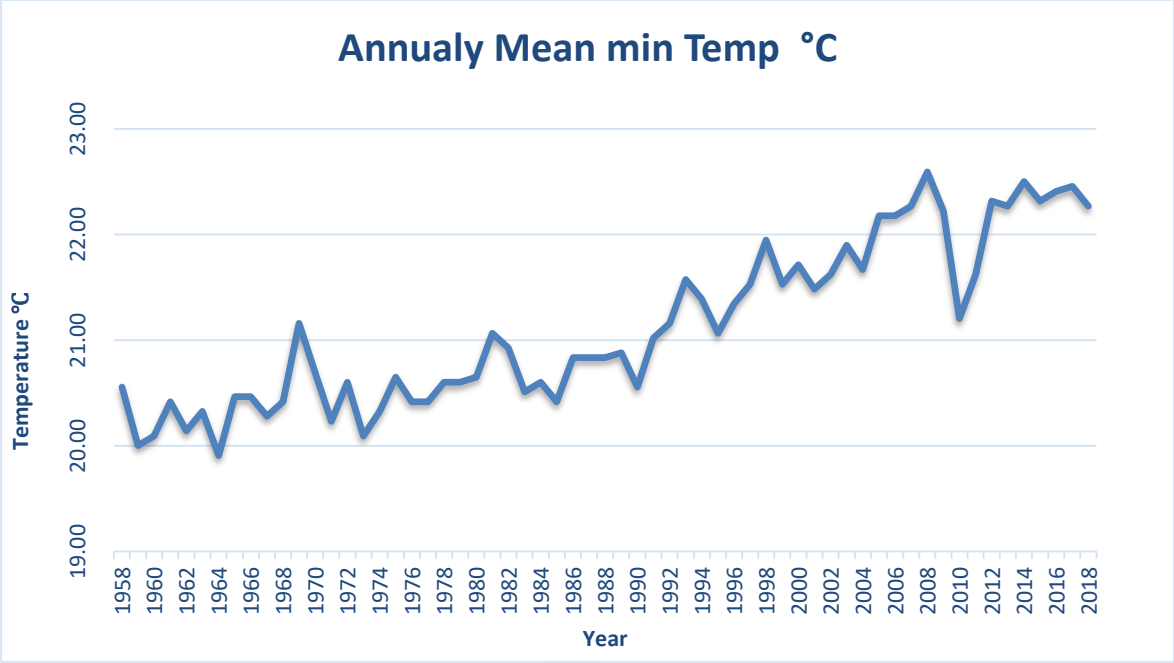

Figure 6 Annual Mean Minimum Temperatures at Ahmedabad during 1958 – 2018

Result of figure 6 the Annual mean minimum Temperature trend indicates, that temperature is rise after 1988.

V.Acknowledgement

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