

Effect of Urban Heat Island Measured in Anand city, Gujarat

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ABSTRACT

The reason behind surge in urban temperature, dangerous heat events and high risk of heat exposure in cities is global heating. This study examined how different locations in an urban area and its surrounding contributes the urban heat island (UHI) in the city Anand, Gujarat, India. The various preliminary methods were adopted to observe temperature rise, urban growth and land use rise in the city in past few decades. On field measurements were taken during two different seasons: winter and summer in the year 2020. Based on the collected data, the UHI intensity were identified. and found positive in urban areas in Anand City. Based on the study, key reason for UHI intensity were rapid urban sprawl, lack of green space and haphazard development in the city area. Various remedies were also suggested to mitigate UHI.

Keywords

Urban heat Island; Land use; Land cover; Intensity

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Introduction

The Earth's climate is changing continuously throughout the history. Energy consumption acquired by our globe is higher because of developed physical infrastructures. It elevates temperature and generates greenhouse gases (GHGs) which results into global warming.

The GHGs generation are more in cities because of more industries, population and vehicles. Thus, they face high temperature fluctuations through out the day. Normally, in city region temperatures are higher than rural region, this phenomenon is known as Urban Heat Island (UHI). The Wagner et al. [6] (2013) study shows that, the best solution for minimizing temperature is to develop Green space, which also will help in generating oxygen.

The earth surface reflects sunlight to the atmosphere. The city region generates various GHGs which creates an atmosphere which not only retain more heat near ground level but also revert less outside the atmosphere level. Whereas rural area does not face this problem to the extreme level. These changes between city area and rural area has resulted in the development of vast temperature difference between them and this is known as UHI effect. Voogt & Oke (2003) [5] have investigated urban climate within different urban climate scales and concluded that urban

effects are scale dependent and depends on, from where they are measured.

Objective Of The Study

The objective of the study is to evaluate UHI Effect in the Anand city with the help of on field temperature measurement.

Methodology

A. Land use land cover information (LULC)

Land use term indicates the area of land used by human beings for building some of the infrastructures, industries and other constructed units. Land cover term defines the area of land covered with vegetation, bare soil and water bodies in the locality.

LULC details can be gathered from Google Earth Pro [3]. It is a geospatial software application that displays a virtual globe, which offers the ability to analyses and capture geographical data. It captures image of globe from the satellite and shows on the virtual globe.

Here, Google Earth Pro is used to gather details of land use of Anand city from 1984 to 2019. The satellite images for Anand city for the year of 1984, 2000 and 2019 are in Figure 1.

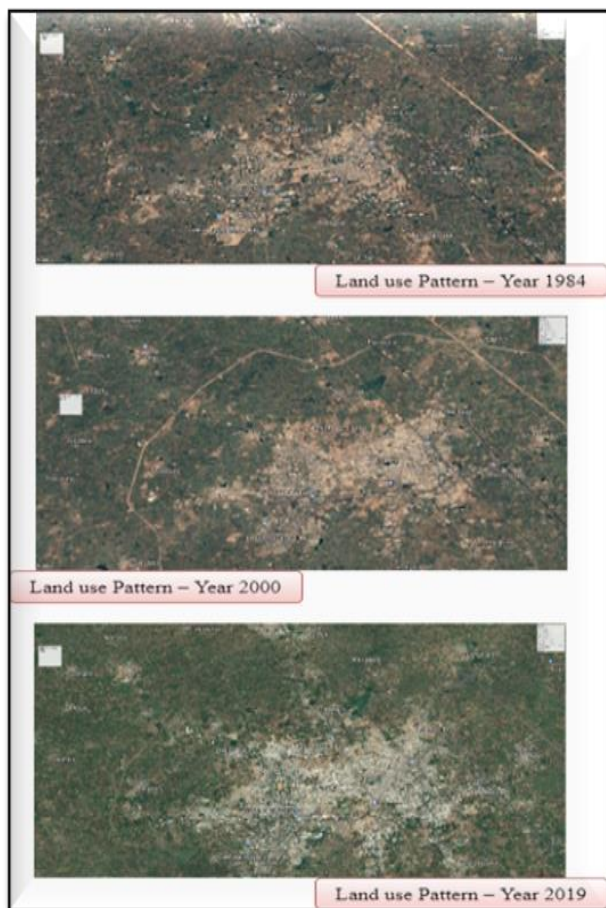


Figure 1 Land use land cover of Anand city in the year 1984, 2000 and 2019
Source: Google Earth Pro

B. Urban Sprawl in Anand city

The gradual growth pattern of Anand is observed from the images. The city has spread in all the direction. In this duration, city has acquired about 3 times area than that was in 1984. However, the major expansion was seen between year 2000 to 2019.

Urban sprawl in Anand city for 1940 to 2013 and anticipated sprawl for 2013 to 2023 were gathered from Draft Development Plan of the city [2] and is as per Figure 2.

During 1940 to 1960, the staggered sprawl was observed in Anand. In 1960 to 1980, the sprawl was observed near to the location developed between previous two decades.

However, in year 1990 to 2010, More sprawl was there in north part of the city which linked previously developed two major regions of the city. The anticipated sprawl in 2013 to 2033 is towards south-east side of the city. A small grown is also forecasted in extreme west side of the city, hence in future, the area between anticipated location towards west

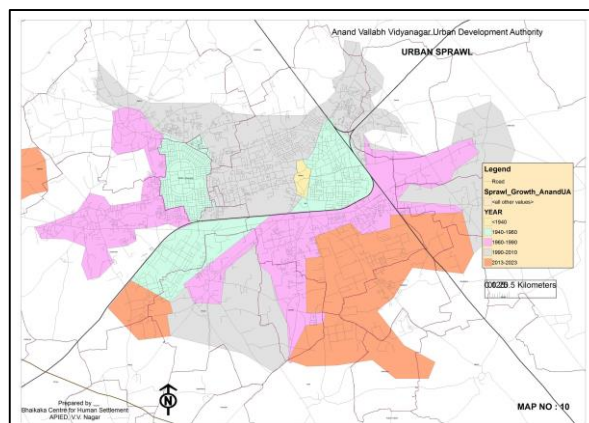
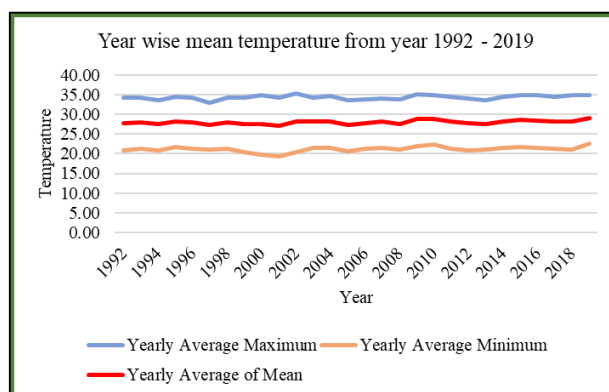


Figure 2 Urban Sprawl in Anand City
Souce: Draft Development plan, Anand

C. Temperature data of Anand from 1992 to 2019

Temperature data were gathered from <https://www.accuweather.com/> [4] for duration of 1992 to 2019. It is a US based organization working since 1962. It deals with various weather-related data and provide service to various multi national companies for weather forecasting.

From the website, daily temperature data were collected in three parts viz. daily maximum temperature, daily minimum temperature and daily mean temperature. From the collected data, year wise average maximum temperature, minimum temperature and mean temperature were calculated and is plotted in the Chart 1.



side and sprawl in west side between 1990-2010 may also be grown.

Chart 1 Yearly average temperature from the year 1992 to the year 2019

Temperature fluctuations are observed since 1992 to till now. However, an interesting observation was that the mean daily temperature was slightly increasing for most of the years in this duration. It is about to reach 30 degree Celsius in 2019.

D. On Field data collection of surface temperature

The actual UHI was evaluated from the onsite temperature measurement A temperature measurement gun was used to measure surface temperature and it was manufactured by Ishnee. The gun was able to measure object temperature and body temperature in degree Celsius and degree Fahrenheit unit. It had accuracy of ± 0.5 degree Celsius.

The strategy adopted for measurement of temperature is shown in Figure 3. Two months, January and March were

selected for temperature measurement. Former month was considered in winter season and the later one was considered in summer season.

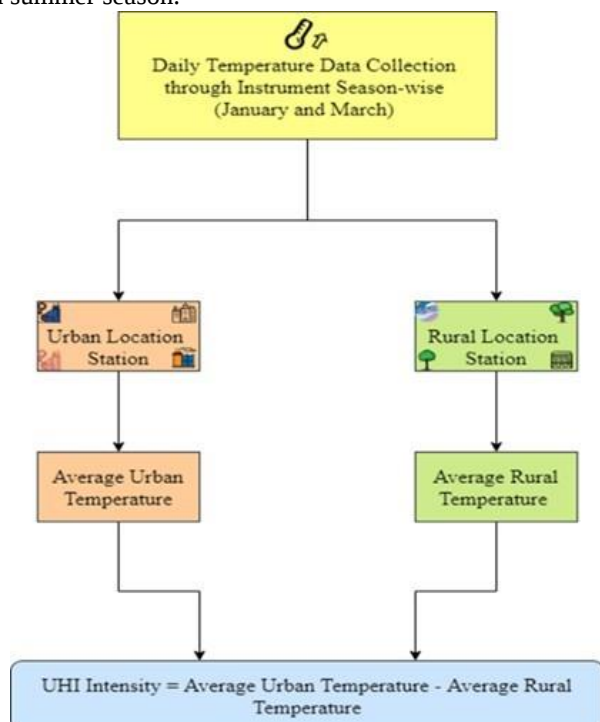


Figure 3 Strategy for on field temperature measurement

The strategy was to select two rural or semi rural location and two urban or semi urban locations. It was then decided to measure temperature all all selected location on the same time on all days. As the gun was used for on field measurement, it was not possible to measure temperature at same time at all locations hence, stations were need to be selected in such a way that temperatures of difference locations shall be taken in very less time difference.

The UHI intensity for this path in January and March were to be evaluated by difference between average temperature of urban region and rural region.

Accordingly, one path was selected with 4 locations namely Grid cross road – Anand, Area near to Zydus hospital – Anand, Vaishali Nagar – Bakrol gate and Vinayak Institute – Vadtal road. From these locations, Grid cross road and Vaishali Nagar areas were surrounded by concrete jungles and hence considered as urban stations. Whereas rest two were surrounded by green space and hence considered as rural locations for the study. The distance between first station and last station was about 6 km. The path is shown in Figure 4.

During winter season, the time decided to measure surface temperature was about 12:00 noon and complete all the measurements till 12:30 PM. The readings were taken at 12 noon at Grid cross road, 12:10 PM at location near Zydus, 12:20 PM at Vaishali Nagar and 12:30 PM at Vinayaka Institute.

In March month, summer season, the temperature measurement work was initiated on 8:00 AM in the morning and completed on 8:30 AM. The readings were taken at 8:00 AM at Grid cross road, 8:10 at location near Zydus, 8:20 AM at Vaishali Nagar and 8:30 AM at Vinayaka Institute

It was decided to measure temperature of a surface near to the existing bituminous road, since the bitumen temperature is misleading some time. For urban area, the road. For both, urban and rural areas, road bank temperature were taken and they were mostly earthen.

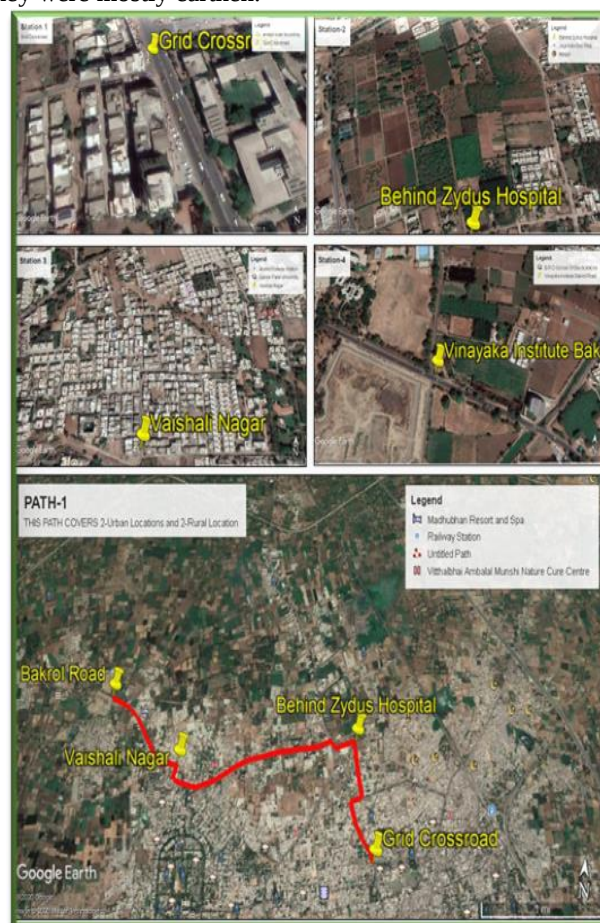


Figure 4 Path for surface temperature measurement
Source: Google Maps

Analysis

The on field collected surface temperature data were tabulated in Microsoft Excel for evaluation purpose. From tow rural and urban location, average daily temperature was calculated for both months. The notable daily temperature fluctuation for particular location and daily temperature fluctuations for various locations were observed. The Urban Heat Island intensity were calculated using difference between urban temperature and rural temperature.

The average daily urban temperature, average daily rural temperature and UHI intensity of the path for January month are in Chart 2.

From daily UHI intensity, the average monthly UHI intensity was evaluated by taking mean of daily temperature difference. It came out as about 1.13 degree Celsius. However, maximum UHI intensity for the January month was 2.5 degree Celsius on 6th January, 2020.

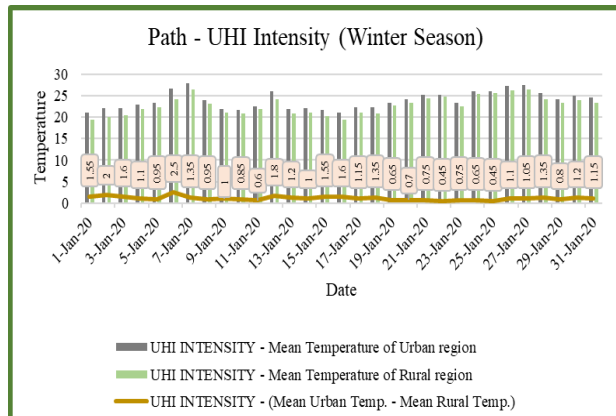


Chart 2 UHI intensity of January Month, Winter Season

The UHI intensity by evaluating temperature difference for March month are in Chart 3.

From daily UHI intensity, the average monthly UHI intensity was evaluated by taking mean of daily temperature difference. It came out as about 1.78 degree Celsius. However, maximum intensity for the month was 2.35 degree Celsius.

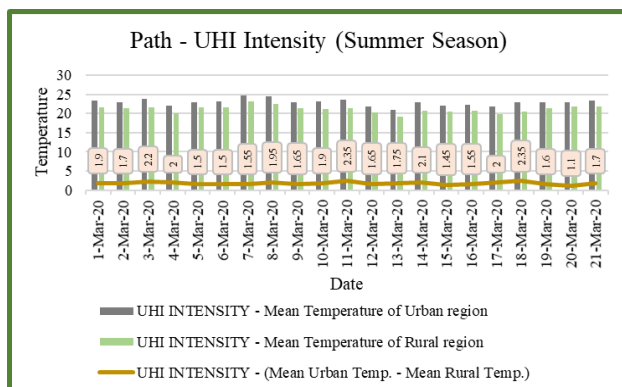


Chart 3 UHI intensity of March Month, Summer Season

Conclusion

The average temperature difference observed during two months are ranging 0.5 degree Celsius to 2.5 degree Celsius. The maximum UHI intensity was observed in January but, average daily intensity for March was much higher than that of January.

There are several reasons for such notable temperature difference between rural and urban areas. Key reasons are as follow,

- Green Cover reduction in city leads to poor evapotranspiration and it reduces shading. This results in low Relative Humidity and high Air temperature
- Due to more buildings, there is increase in impervious surfaces in the region and heat absorption also increases.
- High density in the city, more H/W ratio and more emissivity traps the heat to the surface during night and hence, the night temperature remains high for longer time.
- The urban sprawl is also one of the prime reasons behind UHI effect since, more vegetations is being destroyed and areas become dense with concrete jungles.

Recommendation

It is essential to provide more green space in the city to cope up with the urban heat island situation. The key recommendations are follows,

- In urban area, landscape provision in open spaces, whereas in various buildings, developing various landscape elements like vertical gardening and terrace gardening may help to mitigate the UHI effect.
- In urban region, identifying various voids in the city, planning to utilization of such space for public facilities and proper urban street designing may help to reduce UHI effect.
- The use of various Albedo material like paints, white colour faced in the buildings, light colour pavements and light colour building materials may help in reducing temperature retention and this also play an important role in mitigating UHI intensity.
- A sustainable transportation system in the city help in reducing air pollution which also contributes considerably in UHI intensity.
- Proper orientation of streets in cities and proper building orientation also help in proper air circulation and can limit UHI intensity.

Limitations Of Study

There were few limitations during the on-field study of surface temperature and UHI intensity. The limitations are as follows,

- Study was limited to measure surface temperature only. Air temperature and other allied parameters are not considered in the study.
- Air pollution and vehicular movement study are not considered.
- As other measuring instrument are very expensive, simple temperature gun was used to measure temperature.
- The study duration was 2 months. For more detailed and accurate evaluation, a large duration may be helpful.

References

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