Study on Global Climatic Changes And Its Effects In Urban Areas

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Abstract- *In the last few decades, cities around the world have seen significant urbanization, marked by the increase in building infrastructure and automobiles. Permeable land surfaces which were once covered by vegetation have now been replaced with impermeable and high emissivity surfaces and mostly un-shaded. Such urban surfaces tend to absorb the solar radiation and emit it later, which causes an increase in local temperatures. Consequently, the urban areas observing higher temperatures become ''heat islands'', compared to their rural counterpart.Urban Heat Islands (UHI) can cause deterioration of living environment, elevation of ground level ozone, health disorders and increase in building energy consumptions. Thus the aim of the project includes assessing the impact of urban planning aspects of urban geometry and green cover on the formation of UHI within different zones of Bangalore. The study therefore helped in developing relationship between planning characters and microclimatic influence which will be useful for urban planners to mitigate UHI in newly developing areas of the city.The building typologies were considered to be residential and commercial (IT or Information Technology) as they are predominant in Bangalore. Three locations were strategically selected for each monitoring based on various urban characteristics such as green cover, open lands, water bodies, height to width (H/W) ratios etc. Continuous monitoring of thermal parameters such as air temperature (AT), globe temperature (GT) and relative humidity (RH) was carried simultaneously in these selected locations.*

Keywords- Urban Heat Islands, energy consumptions, green cover, globe temperature, relative humidity

I. INTRODUCTION

Urban Heat Island (UHI) is being experienced in developing cities of developing countries,
and it is predicted that the magnitude of Urban Heat Island will further intensify with high rise-high density development.As per United States Environmental Protection Agency ,As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation that were once permeable and moist become impermeable and dry. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape' (1). Urban structure of a city which includes, land use planning, building morphology, surface characters along with the anthropogenic heat which is generated from vehicles and equipment such as air conditioners are the most crucial factors causing increase in air temperature or urban heat island. These in turn increase air pollution and also energy consumption of buildings in providing thermal comfort inside the buildings by use of refrigeration. This eventually leads to an increase of greenhouse gas emissions and negative impacts on health of citizens of developing cities.

IPCC (Intergovernmental Panel on Climate Change) 2014, had one chapter dedicated on UHI. The report recognizes the presence of UHI due to urban densification, reduction in vegetation cover, and increase in anthropogenic heat. UHI mitigation strategies are seen necessary in order to reduce GHG emissions from urban areas.

In context to the above, it is important that State Governments and urban planning agencies are equipped with tools, guidelines and understanding of impact of buildings and urbanization on climate of the city. The overall objective of the exercise is to look at urban planning as a tool to make urban centres more manageable and liveable.

The focus is on Bangalore city, as the city has gone through rapid urbanization in the last few decades. Bangalore is classified as the third most populous city of India, after Mumbai and Delhi, with a population hitting about 11.5 Million in 2016. Rapid urbanization has seen many negative environmental impacts on the city, which include, diminishing lakes, traffic congestions along with high air pollution levels, urban flooding during heavy rains and increase in summer temperatures. In the summer of 2016, highest air temperature recorded in Bangalore was 39^{o}C. All the above environmental impacts are related to Urban Heat Island effect, which is mostly related to the manner urban development takes place. If the current scenario continues, Bangalore could lose its charm of enjoying the salubrious temperate/moderate weather conditions.Thus, in this project, it is planned to study the effect of urban characteristics on UHI by recording temperatures at strategically identified locations, along with the documentation of physical characteristics of urban planning and anthropogenic heat being emitted in the locations. Based upon the monitored results relation between urban planning characteristics and UHI will be framed. This will provide with important guidelines for urban planners, while carrying out urban planning for new locations/satellite towns around Bangalore.

II. OBJECTIVE

To study the Urban Heat Island effect within different pockets of Bangalore with respect to urban planning and develop relation between planning characteristics and microclimate, which will be useful for urban planners/authorities to mitigate UHI and climate change in newly developing areas of Bangalore.

III. NEED

Urban heat islands can cause deterioration of living environment, increase in energy consumption, elevation in ground-level ozone, and even an increase in mortality rates. In a research by Konopacki and Akbari, it was observed that by mitigating UHI effects in Houston, it was possible to achieve savings of 82 million USD with a reduction of 730MW peak power, leading to an annual decrease of 170000 tonnes of carbon emission. (2). In context of Bangalore, implementing white roofs alone can reduce energy consumption by 1642 MWh/Sqm/yr, which would result in savings of Rs. 10,348 million per year. (3).

In 1998, it was reported that the ozone level could exceed 120 ppbv at 22^{o}C, and could reach 240 ppbv at 32^{o}C. Hence, annual reduction of 25GW of electrical power or potential savings of USD 5 billion by year 2015 can be predicted.

It is apparent that the benefits of mitigation of UHI are vast, and particularly for a developing tropical country like India, study in this field can bring about timely intervention in urban policies to result in energy savings and outdoor thermal comfort.

IV.URBAN HEAT ISLAND AND CLIMATE CHANGE

The effect of Urban Heat Island on Climate change is two-fold. Firstly, the heat build-up caused by urban heat island effect can worsen the effect of global warming in affected urban areas. As the result, these areas may experience more severe heat-waves with very high daytime summer temperature.
Secondly, the increased heat gains in conditioned buildings caused by the heat build-up leads to increased electricity demand for cooling. As developing countries are predominantly dependent on conventional1 methods of energy generation, the increased electricity demand can cause surge in the rate at which greenhouse gases are released into the atmosphere. For developing countries having limited natural resources and a developing economy, the increased demand of electricity may also lead to economic stress.

Hence employing strategies to mitigate UHI can benefit tropical countries in the mitigation of climate change. predominantly dependent on conventional1 methods of energy generation, the increased electricity demand can cause surge in the rate at which greenhouse gases are released into the atmosphere. For developing countries having limited natural resources and a developing economy, the increased demand of electricity may also lead to economic stress.

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4.1.URBAN HEAT ISLAND AND THE BUILT ENVIRONMENT

Urbanization has led to rampant deforestation and construction activities in urban areas. The reduction in urban green cover and the increase of built-up hard surfaces as well as emissions are primary causes of urban heat islands.

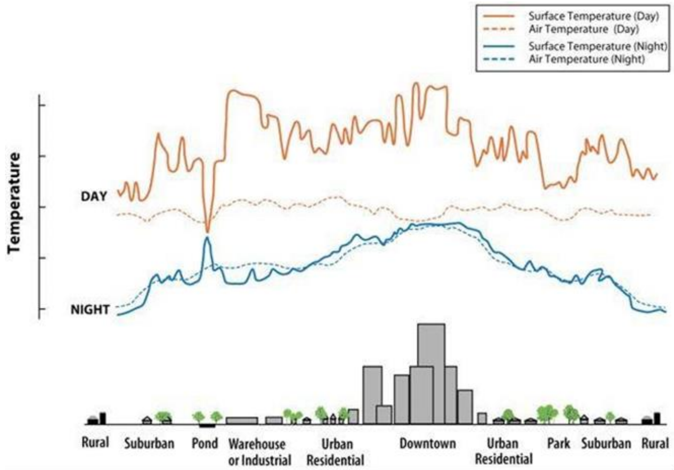


Figure 4.1 Urban heat island and the built environment

4.1.1.Green cover:

Trees reduce temperature by means of shading and evapotranspiration. With reducing green cover, there is less shading, hence exposed surface tend to absorb more heat which is later dissipated into the air. With reduced evaporation, the moisture required to cool down the air is not available, hence the air temperature remains increased. Urban paved surfaces consist of upto 75% impervious surfaces, whereas natural ground cover is about 10% impervious, hence natural ground surface can provide sufficient moisture for cooling the air near the surface.

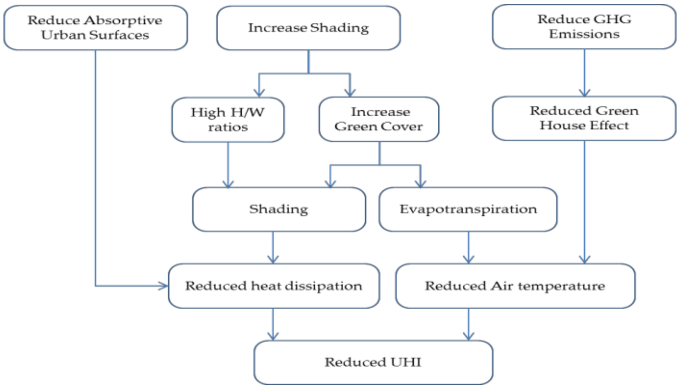


Fig 4.1.1 green cover

4.1.2.Urban Geometry:

Urban geometry deals with the dimensions of the built environment for a given urban area. It may directly influence wind movement, shading patterns, heat absorption and the ability of a surface to emit long-wave radiation back to the space. (1). The effect or UHI is particularly distinct in urban canyons, which are urban enclosures formed by narrow streets and tall building on both sides. On one hand, during the daytime, the tall buildings can shade the canyon reducing surface temperature, but on the other hand the surfaces of these tall buildings may reflect and absorb the heat leading to increased air temperatures.

4.2. Types Of UHI:

On the basis of its impacts, the urban heat island effect can be of two types: Surface UHI and Atmospheric UHI.

4.2.1Surface-Urban Heat Islands:

These are caused when the heat from solar radiation is absorbed by dry and exposed surfaces of the urban set-up. Its magnitude is thus dependent on the intensity of solar radiation, which changes seasonally and diurnally. This is why Surface Urban Heat Islands are highest during summers, especially during the day-time. Another reason why summers characterize high Surface UHI is that: in summers, due to prevalent clear-sky conditions,

solar radiation remains undispersed. Also, the days are calm, with low wind speeds, because of which the mixing of air is minimized.

4.2.2.Atmospheric Urban Heat Islands

These are formed where there is a difference between the air temperatures of urban and rural areas. These are further sub-dived into two types:

4.2.3.Canopy Layer UHI

They occur close to the ground surface, where people and built environment exists, that is from the ground surface to the topmost level of trees and roofs.

4.2.4.Boundary Layer UHI

They occur at a level starting from the rooftops and tree tops, until the point where urban landscapes no longer affect the atmosphere..

Surface UHI may indirectly affect Canopy Layer UHI, when the heat absorbed by urban surfaces throughout the day gets slowly released to the atmosphere at the end of the day, thus adding to the temperature of the air near the surface.

Table 4.2.1.Characteristics of Surface and Atmospheric Urban Heat Islands (1)

Feature	Surface UHI	Atmospheric UHI
Temporal Development	Present at all times of the day and night Most intense during the day and in the summer	May be small or non-existent during the day Most intense at night or predawn and in the winter
Peak Intensity	More spatial and temporal variation: Day: 10 to 15°C Night: 5 to 10°C	Less variation: Day: 1 to 3°C Night: 7 to 12°C
Typical Identification method	Remote Sensing (Indirect Measurement)	Through fixed weather stations or mobile traverses

Table 4.2.1. gives a comparison of the two types of Urban Heat Islands

V.CLIMATIC CHANGES IN HYDERABAD

Telangana, India, 17.38°N 78.46°E 515m asl
The meteoblue climate diagrams are based on 30 years of hourly weather model simulations and available for every place on Earth. They give good indications of typical climate patterns and expected conditions (temperature, precipitation, sunshine and wind). The simulated weather data have a spatial resolution of approximately 30 km and may not reproduce all local weather effects, such as thunderstorms, local winds, or tornadoes.

You can explore the climate for any location like the Amazon rainforest, West-Africa savannas, Sahara desert, Siberian Tundra or the Himalaya.

5.1 Average temperatures and precipitation

The "mean daily maximum" shows the maximum temperature of an average day for every month for Hyderabad.

Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years. For vacation planning, you can expect the mean temperatures, and be prepared for hotter and colder days. Wind speeds are not displayed per default, but can be enabled at the bottom of the graph.

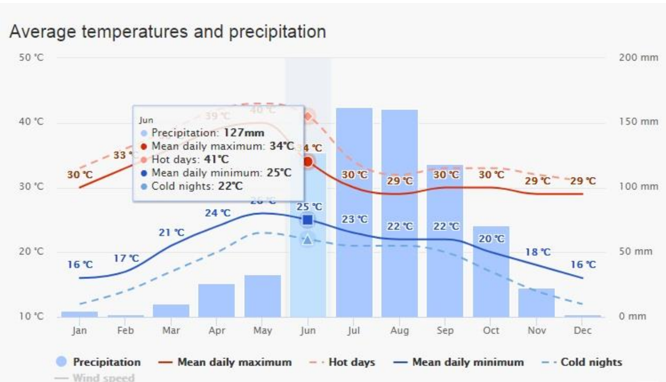


Figure:5.1.1 average temperature and precipitation

The precipitation chart is useful to plan for seasonal effects such as monsoon climate in India or wet season in Africa. Monthly precipitations above 150mm are mostly wet, below 30mm mostly dry. Note: Simulated precipitation amounts in tropical regions and complex terrain

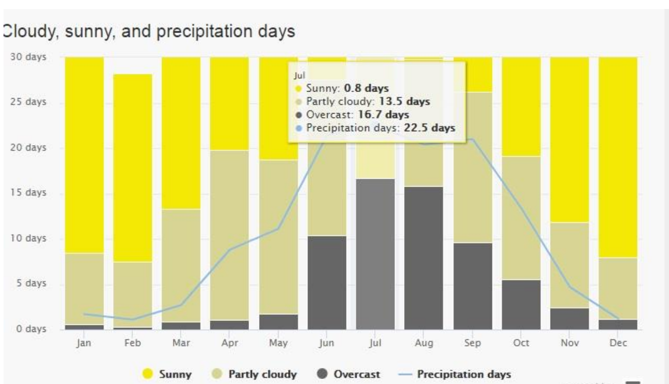


Figure:5.1.2.cloudy,sunny,& ppt days

Sunny Partly cloudy Overcast Precipitation daysJanFebMarAprMayJunJulAugSepOctNovDec0 days5 days10 days15 days20 days25 days30 daysmeteoblueSep● Sunny: 3.8 days● Partly cloudy: 16.6 days● Overcast: 9.6 days● Precipitation days: 21 days The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast. While Reykjavík on Iceland has mostly cloudy days, Sossusvlei in the Namib desert is one of the sunniest places on earth.

5.2 Maximum temperatures

The maximum temperature diagram for Hyderabad displays how many days per month reach certain temperatures. Dubai, one of the hottest cities on earth, has almost none days below 40°C in July. You can also see the cold winters in Moscowwith a few days that do not even reach -10°C as daily maximum.

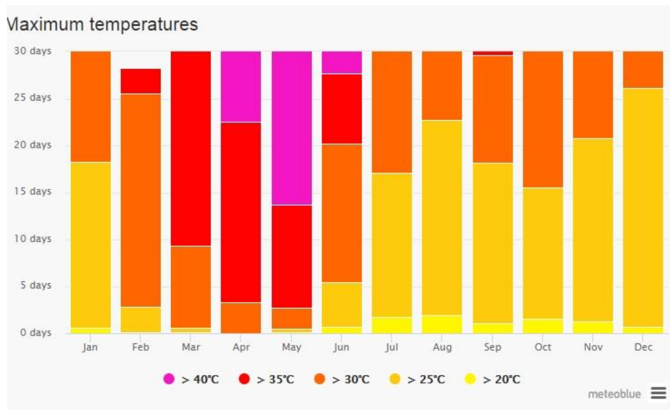


Figure:5.2:maximum temperature

5.3 Precipitation amounts

The precipitation diagram for Hyderabad shows on how many days per month, certain precipitation amounts are reached. In tropical and monsoon climates, the amounts may be underestimated.

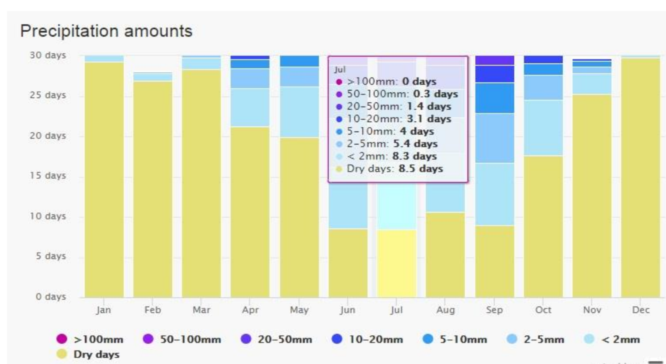


Figure 5.3 precipitation amounts

5.4 Wind speed

The diagram for Hyderabad shows the days per month, during which the wind reaches a certain speed. An interesting example is the Tibetan Plateau, where the monsoon creates steady strong winds from December to April, and calm winds from June to October.

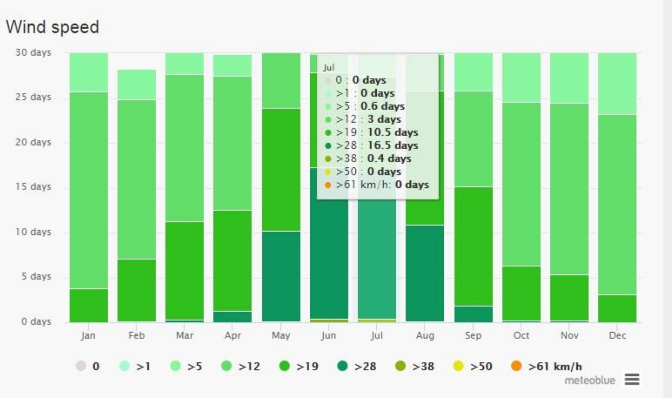


Figure :5.5 wind speed

Wind speed units can be changed in the preferences (top right).

5.4.1 Wind rose:

The wind rose for Hyderabad shows how many hours per year the wind blows from the indicated direction. Example SW: Wind is blowing from South-West (SW) to North-East (NE).
Cape Horn, the southernmost land point of South America, has a characteristic strong west-wind, which makes crossings from East to West very difficult especially for sailing boats.

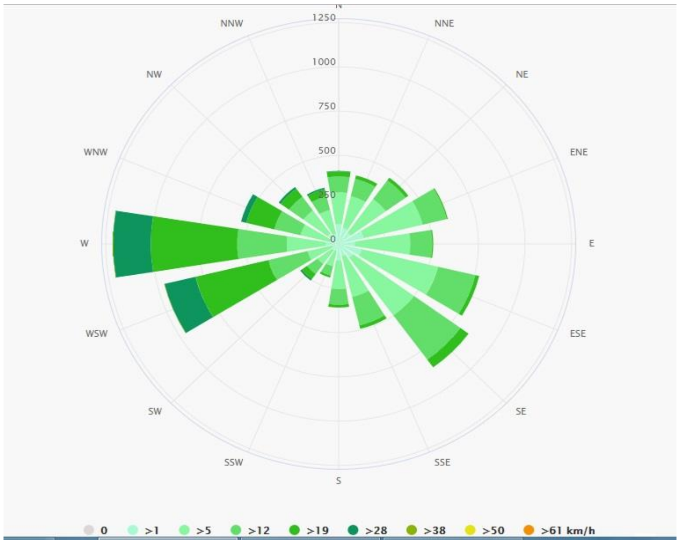


Figure:5.4.1 wind rose

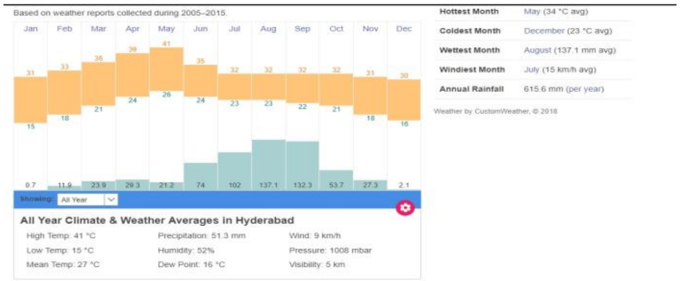
VI.CONCLUSION

The results revealed that many states in India have indeed experienced significant state-wide warming in both maximum and minimum temperatures over the last six decades. However, the changes are not equal for all states of India, spatially and temporally. Trends in temperatures showed a much higher degree of spatial coherence and statistically significant warming, reflecting increases in both maximum and minimum temperatures. Though rainfall trends are not significant in many states, spatially coherent decrease in rainfall in most of the states in India particularly in monsoon season is a cause of worry.

Annual climate change trends

- Significant increasing trends were found in the mean maximum temperature over all states in India except those in the Indo-Gangetic plains wherein spatially coherent decreasing trends were observed in the annual mean maximum temperature with significant decrease over Haryana (-0.02 o C/year) and Punjab (-0.01 o C/year).
- The maximum increase in annual mean maximum temperature was observed in Himachal Pradesh where the rate of change is +0.06 o C/year.
- Annual mean maximum temperature has significantly increased over Lakshadweep and Andaman and Nicobar islands by 0.02 o C/year.
- Annual mean minimum temperatures have significantly increased in states of northwest, northeast and southeast parts of India while extreme northern states have shown decreasing trends. The rate of increase in annual mean minimum temperature is highest in Sikkim (0.07 o C/year) while the rate of decrease is highest in Uttarakhand (-0.03 o C/year).
- Spatially coherent increasing and decreasing trends in annual rainfall are found in many states of India, though not statistically significant. However, annual rainfall is significantly increasing in West Bengal (+3.63 mm/year) and significantly decreasing in Uttar Pradesh (-4.42 mm/year) and Andaman and Nicobar (-7.77 mm/year) during 1951-2010

Annual Weather Averages Near Hyderabad



The above details are showing that how the climate is varying day to day because of heavy amount of pollution.If the climatic conditions vary in this way means the living lives will face most dangerous situations in the future. So to control these conditions everyone on the earthneed to increase the greenery and control of pollution.

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