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Biophilic Urbanism as an Approach towards Mitigating Urban Heat Island in Thiruvananthapuram City

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Abstract: ***A rising number of people are realizing how important everyday exposure to nature is for leading fulfilling lives. The study outlines major pathways through which biophilic urbanism improves climatic conditions. The urban heat island (UHI), which is defined by temperature differences between urban and rural regions, is a prime example of micro-climate changes brought on by urbanisation. The destruction of vegetation as a result of recent expansion has resulted in the loss of vegetation land cover. This study aims to create strategies and action plans by interrelating the parameters of biophilic urbanism and urban heat island for Thiruvananthapuram city.***

Keywords: Biophilic urbanism, Climate Change, Urban heat island, green cover, Built Density, Land surface temperature

1. Introduction

In recent years urban areas have been growing as a result of population expansion, which has increased the danger of overheating and produced unmanageable microclimate conditions in the urban region. Urban regions and cities will therefore be substantially warmer than the neighboring rural areas.[1] Meanwhile, research is emphasising the importance of maintaining a balance between such density and urban nature in order to improve climatic conditions and to decrease the negative consequences of densely inhabited, impermeable metropolitan areas on the environment and the economy.

In 1973, German psychotherapist Erich Fromm coined the word "biophilia," which he described as "love of life." Humans have an innate need to interact with nature and the natural world, according to later research on this topic by E.O. Wilson. “Biophilic urbanism” was introduced as a new approach to urban planning and architecture that intended to integrate nature into the urban fabric in a methodical way to transform lifeless urban landscapes into regenerative and livable spaces. [2] A metropolis that is much warmer than the rural areas around it is referred to as an urban heat island, or UHI which was coined by Howard, an urban climatology pioneer. [3]

The main objective of biophilic urbanism is to strengthen the bond between urban residents and urban nature as well as to promote nature as an essential element of daily urban life.[4]

2. Aim and objective for the study

To formulate a planning approach to mitigate urban heat island effect through biophilic urbanism.

- To study the elements of biophilic urbanism and parameters of urban heat island in urban planning.
- To understand the issues and challenges in urban heat island and develop relationship between parameters of Urban heat island and Biophilic urbanism elements.
- To analyse the intensity of urban heat island parameters in the study area using Landsat images and spatial mapping
- To suggest strategies and action plansusing biophilic urbanism to reduce the effect of urban heat islands in the study area.

3. Methodology

Methodology of the study is followed by the four objectives conducted at different stages. The analysis of the Biophilic urbanism elements and Urban heat island parameters for the comparative analysis study and case study analysis of Singapore, Portland, Bangalore are carried out in the secondary study. The analysis of Multitemporal Landsat images of LC, LST mapsof 2022 extracted using Qgis for the study area and the components identified in the comparative analysis are accomplished. Data validation for the study area was carried out through field observations by delienating 3 wards considering the built density and green cover through landuse maps and through measuring the LST of the area using thermometers. Finally, the analysis of the identified components w.r.t study area is achieved to suggest planning approaches for urban heat islands of Thiruvananthapuram city.

4. Importance of biophilic urbanism in urban heat island

4.1 Biophilic urbanism Elements identified in urban planning level

Table 1: Biophilic urbanism elements in urban planning

Streets	*Neighbourhood*	*Regions*
Green streets	Stream restoration	Riparian systems
Sidewalk gardens	Urban forests	Regional green space system
Vegetated swales	Ecology parks, Neighbourhood parks, Pocket parks	City tree canopy
Edible landscaping	Greening gray and brown fields	Community gardens
High degree of permeability	Low impact development	Ecosystem restoration

4.2 Urban heat island parameters in urban planning

Table 2: Urban heat island parameters in urban planning

The city radius	Wind velocity	Warm ambient air temperature
Urban morphology	Cloud cover	Vegetative surfaces
Tree coverage	Sky view factor	City tree canopy
Anthropogenic heat from vehicles	Land surface temperature	Heat production from materials
Air and water pollution	Presence of water bodies	Built Density

4.3 Comparative analysis

The elements are identified through the comparative analysis of Biophilic urbanism elements and urban heat island parameters. The comparison shows the relation between them and how they can be interconnected. From the indicators formed with respect to the elements and parameters derived, we can arrive at a conclusion of the influence of the above-mentioned elements, sub elements and parameters.

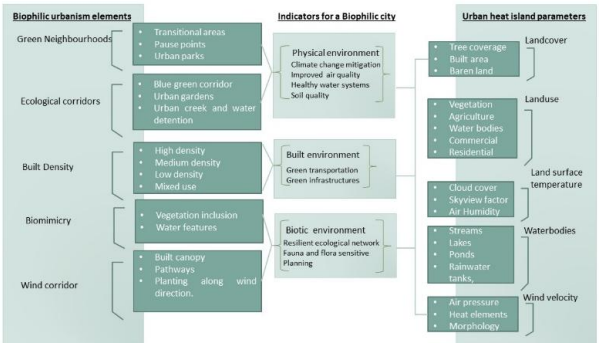

Figure 1: Comparative analysis of BU elements and UHI parameters

5. Study Area

The capital and largest city of the Indian state of Kerala is Thiruvananthapuram, sometimes referred to as Trivandrum. The population of the city is 957,730, while there are 1.68 million people living in the nearby metropolitan region. As of 2015, 55% of Kerala's software exports came from Thiruvananthapuram, a significant IT centre in India. On India's west coast, not far from the country's southernmost point, is the city of Thiruvananthapuram. The 2192 sq. km. district as a whole is classified as a single revenue division. [5]

Figure 2: Location of study area

6. Study Area Data

As per the latest report of Kerala Forest Department, there is decline forest cover in three districts of Kerala in which 23 sq km decline of forest cover is in Thiruvananthapuram.[6] Thiruvananthapuram have been listed as one of the highly vulnerable districts among the four as per SAPCC.[7]

6.1 Land Cover

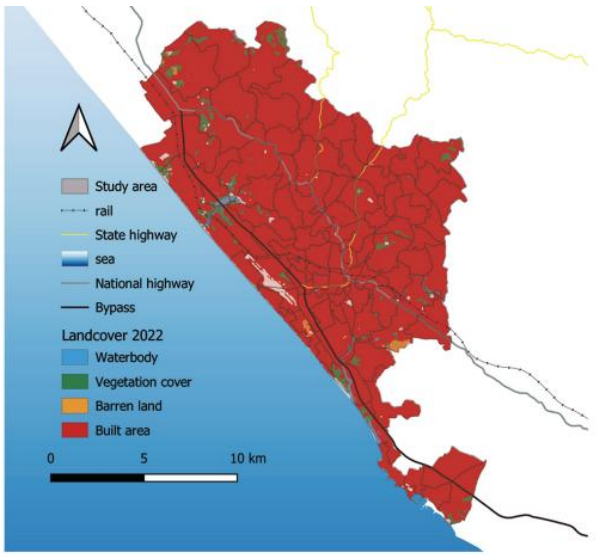

Figure 3: Landcover map, 2022

The built area increased due to the urbanisation and population growth and vegetation reduced immensely due to the increase in built.

6.2 Land surface temperature

LST values are clustered at central core of the study area. Central region is characterized with the traditional urban growth of the center of the city. The absence of green cover and the built density in the central core is visible from land cover and built density maps.

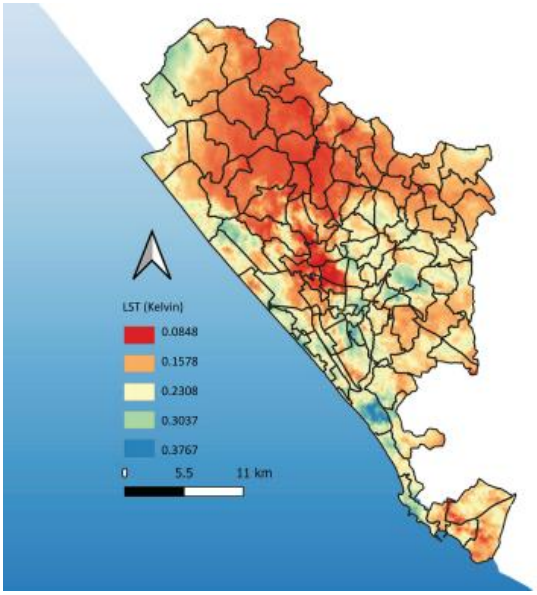

Figure 4: Land surface temperature map, 2022

6.3 Landuse

The increasing built up areas such as residential, commercial, public and semipublic and a decreasing trend in the green areas over the years is observed in the landuse breakup pie charts.

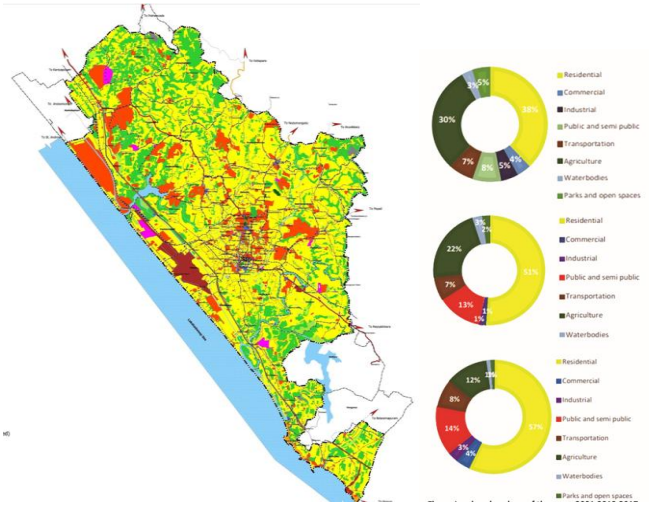

Figure 5: (a) Land use map (2012), (b) land use break up of 2001, 2012, 2017

The change over the years is notable that the percentage of water bodies had a huge shrinkage and also the green cover and agricultural areas has been affected due to the growth and urban sprawl in the city. Most of the areas has been converted to build use where encroachment due to urbanisation occurred over the years.

6.4 Built Density

The built density increased covering the open and green spaces causing reduction in the non-built area. The built is more concentrated in the city center due to the spatial structure of the city as Thiruvananthapuram Corporation is the first order settlement.

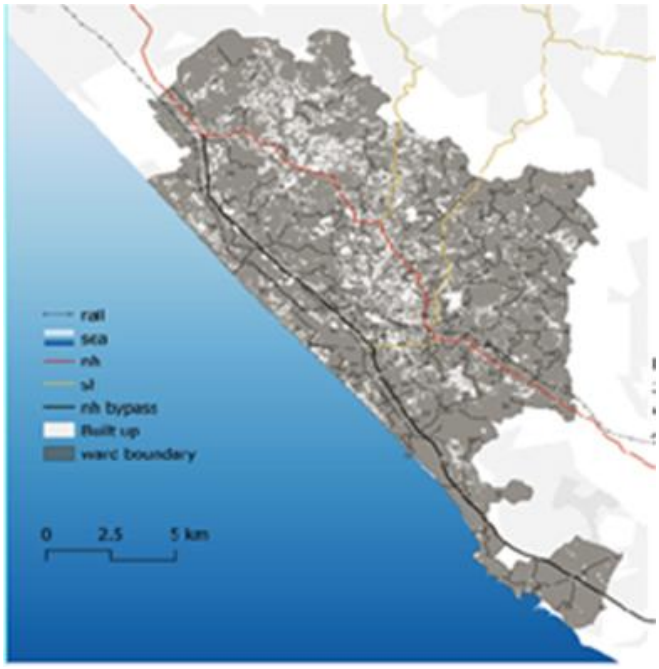

Figure 6: Built Density map, 2022

6.5 Surface water

The area of waterbody declined over years as inferred from the landuse map due to the encroachment of built use still the

area of water body in the present scenario is 25.65sqkm out of total corporation area which is very less in percentage. The waterbodies are shrinking in their length and width due to the built encroachments and the landuse changes.

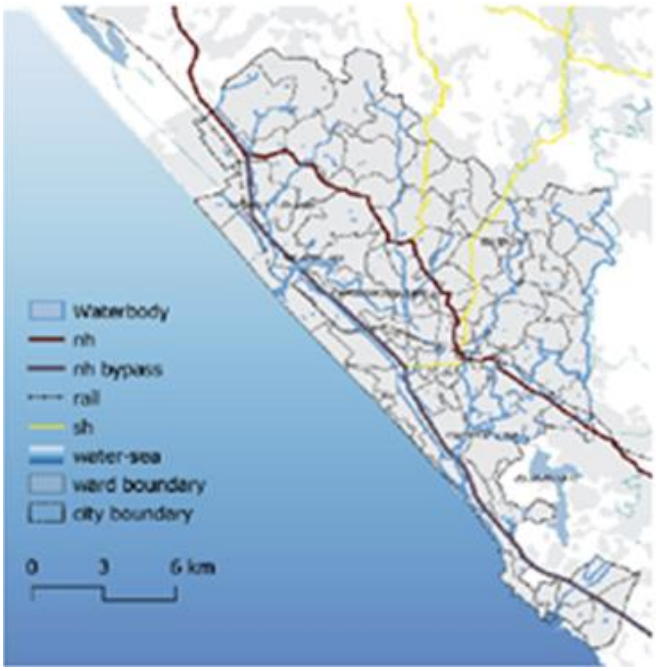

Figure 7: Surface water map, 2022

Results and Discussions

Ward wise land use analysis

The wards with no, medium and high green cover was selected by analysing the landuse map.

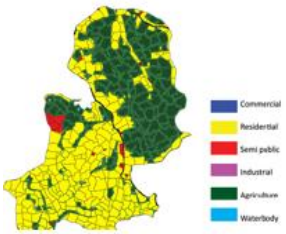

Figure 8: Land use map of Njandoorkonam ward,2022

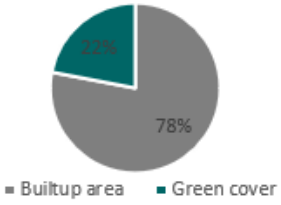

Figure 9: Built up and green cover of Njandoorkonam ward,2022

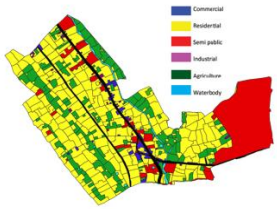

Figure 10: Landuse map of Kazhakoottam ward,2022

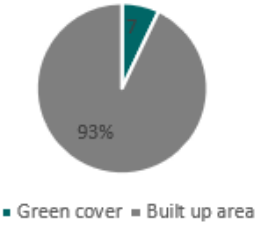

Figure 11: Built up and green cover of Kazhakoottam ward,2022

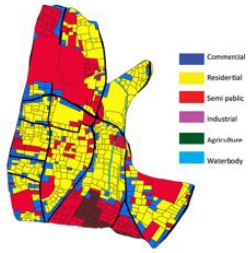

Figure 12: Landuse map of Thampanoor ward,2022

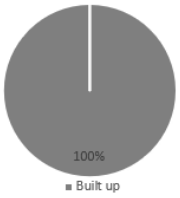

Figure 13: Built up and green cover of Thampanoor ward,2022

The wards depicted the lack of green cover that cause urban heat island effect in the surrounding areas which resulted in an increase in built up area and the difference in temperature variations w.r.t the green cover was also analysed.

6.6 Land surface temperature analysis

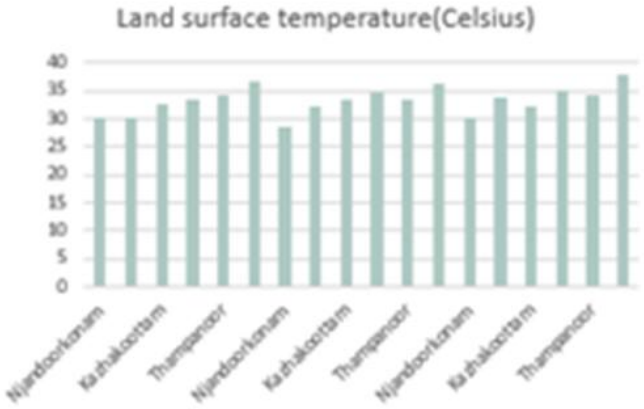

Figure 14: Graph showing LST variations

It is observed that as green cover reduces temperature increases from the green cover analysis and temperature measures. The highest temperature was noted in Thampanoor where there is no green cover area and least temperature in Njandoorkonam ward where there is high density of green cover.

7. Strategies and Recommendations

- Land cover-Increase the Tree coverage at different scales of Biophilic urbanism. Integrate green areas at neighbourhood level to create microclimate within built area.
- Landuse-Agriculture zones should be provided with conservation measures or policies. Opportunities for the sustainable use of natural resources.
- LST-Decreasing surface temperatures, reducing energy demand, improving water quality, controlling storm water runoff and supporting biodiversity.
- Ecological corridors-To maintain the ecological corridors with immense green and blue infrastructures to enhance the biodiversity
- Green neighbourhood-Sustainable neighbourhood planning and open areas where walkability can be provided. Improvements in both thermal comfort and

quality of environment.

8. Action plans

- Landcover-Plant more trees wherever possible by enhancing the nature. Implement shared urban amenities, community dwellings.
- Landuse-Promoting mixed use development. Proper zoning and planning of spaces.
- LST-Passive energy consumption methods can be adopted. Create wind corridors. Green roofs and cool pavements.
- Ecological corridor-Implement artificial waterbodies and green cover areas along the areas with high density.
- Green neighbourhood-Create neighbourhood interacting nodes and open spaces and promote small scale activities among households.

9. Conclusion

This study makes the argument that the notion of biophilic urbanism may be expanded upon by incorporating it into urban heat islands. The proper management of above-mentioned elements of biophilic urbanism and urban heat island (Land cover, Land use, land surface temperature, ecological corridors and green neighbourhood) can mitigate the heat stress of a region highly vulnerable to climatic conditions. By using a biotic and social environment as indicators of biophilic urbanism, the value of all of these biophilic qualities may be increased. The strategies and action plans for biophilic urbanism planning can satisfy the urban heat island parameters and dimensions of biophilic urbanism in Thiruvananthapuram city and to inspect the presence of representative biophilic elements that contribute to adapt urban heat island parameters.

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Author Profile

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