A MAGNIFICATION PLAN FOR THE URBAN HEAT ISLAND EFFECT: URBAN GREEN SPACE DEVELOPMENT
A Case Study of Hanoi, Vietnam and Colombo, Sri Lanka

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Abstract*: Urbanization has led to a number of serious problems, including elevated pollution levels, rapid weather shifts, and an increase in localized temperature that has led to the development of metropolitan warm Islands. Urban green development, a crucial part of urban ecosystems, offers a range of environmental and social benefits that enhance city quality of life and support the flora and fauna that are becoming extinct from our expanding metropolitan areas. Maximizing the advantages of urban green spaces in the cities is one of the most crucial challenges for planners. The purpose of this paper is to investigate the urban heat island (UHI) effect and mitigation strategies in the cities of Hanoi (Vietnam) and Colombo (Sri Lanka), under current land use conditions. The consequences of unplanned urban expansion are examined and supported by the identification of contributing factors such as UHIs, increased carbon emissions, and so on. It is crucial to address issues like uneven access to green spaces, environmental deterioration, and the effects of urbanization on natural ecosystems in order to ensure sustainable and equitable urban green space development. Urban farming and the utilization of green roofs are only two examples of cutting-edge techniques that can help build more resilient and long-lasting urban landscapes.*

Keywords *- Urbanisation, Urban Heat Island, Urban Green Space, Temporal variations, Land use Landover*

1. Introduction

Urban green space development is a crucial aspect of urban planning that aims to create sustainable and livable cities. Green spaces are defined as areas that are predominantly covered with vegetation, such as parks, gardens, and forests, which are essential for the ecological, social, and economic health of cities. The purpose of this research paper is to explore the benefits of urban green space development, the challenges that cities face in developing and maintaining green spaces, and the best practices for creating and managing green spaces in urban areas.

Urban centers have expanded considerably over time compared to their rural surroundings, particularly in areas with a high density of buildings and little vegetation, where temperatures are typically higher. The word used to describe this pattern is urban heat islands (UHI). Pollution also plays a part in this scenario because airborne pollutants trap and radiate heat into metropolitan corridors.

The first scientist to propose that temperature data indicated a global warming tendency and that the trend might be fuelled by the greenhouse effect that humans have created was British engineer Guy Stewart Calendar (1898–1964).

Luke Howard was the first to analyze and study the occurrence of urban heat island, and it is currently the subject of the most research in urban areas worldwide. In 1833, he made the hypothesis that the excessive summer heat in cities was caused by the city's vertical surfaces collecting more solar energy and the lack of readily available humidity for evaporation. Surprisingly, the Urban Heat Island data supported Howard's theories.

In order to develop a mitigation plan for urban heat islands, this paper seeks to quantify the effect of green spaces on that phenomenon. The goal is to examine the connection between various land use traits and urban heat island. As part of the study, earlier research papers will be reviewed, and tools and methods used by researchers to analyze green space planning and reduce the urban heat island effect in urban areas will be examined.

2. Literature Review

Urbanization And The Loss Of Biodiversity

Urbanization at an unprecedented rate is leading to increased, dense built-up areas and more impervious surfaces such as roofs, asphalt roadways, paved walkways with decreased green and soft spaces, resulting in less water infiltration. Urban centres' masonry buildings are more effective at absorbing solar radiation than vegetation. Urban sprawl results in many adverse impacts that have direct effects on quality of life. Evaporation and transpiration, shading, and carbon dioxide removal are all hindered, which all work to cool the nearby air.

Building Elements' Thermal Emissivity And Albedo

Albedo has a major impact on the thermal behavior of pavements and other ground surfaces, as well as the effects that this thermal behavior has on people and the environment (or solar reflectance). The urban heat island effect occurs when materials in an urban region absorb a lot of heat during the day and release it back into the atmosphere at night. Buildings in this area turn into metropolitan heat canyons.

Urban Morphology

Improving the albedo of surfaces in urban areas would therefore help reduce the Urban Heat Island Effect because the differences in the albedo of any surface between urban and rural areas are a major factor in the resulting temperature differences between the two.

2.1 Heat Generated by Human Activities

The creation of heat islands is facilitated by the heat produced by transportation, industry, etc. Anthropogenic heat changes with urban activity and infrastructure, with more heat being produced by energy-intensive structures and transit.

Human actions, including the use of air conditioners, factories, and transit, can exacerbate this impact due to the need for a mass transportation system. Additionally, metropolitan areas warm up as a result of effective transit networks and the unrestrained use of fossil fuels.

As cities expand, there will be a massive rise in building activities as carbon-absorbing materials like asphalt and concrete are needed to create everything from simple infrastructure to small urban homes. Due to the huge quantities of heat they trap, metropolitan centers experience an increase in mean surface temperatures.

So, we can say that Urban Heat Islands:

Decreases air quality by increasing the production of pollutants, and

Decreases water quality as warmer waters flow into area streams and put stress on their ecosystems.

Types of Urban Heat Islands

Based on how they develop, UHIs can be divided into two categories. Various methods are employed to locate them, quantify their effects, and, to some extent, find ways to reduce them.

2.2 Surface Urban Heat Island (SUHI)

The human heat produced by urbanization growth and the heat stored by impermeable materials together create the SUHIs. These heat islands are a consequence of urban surfaces such as roadways and rooftops absorbing and releasing heat more than other natural surfaces. Surface heat islands frequently achieve their maximum strength in the early morning hours. Remote sensors have picked up on this metropolitan heat island. It is observed using thermal infrared readings that can be used to calculate ground surface temperatures. Typically, there are significant correlations between ground surface temperature and near-surface air temperature. Therefore, the surface urban heat island is a reliable indicator of the air urban heat island.

2.3 Atmospheric Urban Heat Island

Urban heat islands are regions with warmer air in comparison to adjoining rural areas having cooler air. These heat islands are divided by experts into two categories:

Canopy layer heat islands

These urban heat islands exist in the layer of air where people live, from the ground to below the tops of trees and roofs.

Boundary layer heat islands

These urban heat islands originate at the level of rooftops and treetops and continue upward until urban landscapes have no further effect on the climate. This area normally doesn't extend more than 1.5 km (one mile) below the surface.

2.4 Relation between Surface and Atmospheric Heat Islands

Particularly in the canopy layer, which is closest to the surface, surface temperatures have a considerable but secondary impact on air temperatures. Parks and other green spaces, for instance, where the surface temperature is often lower, help to cool the air.

The temperature of the atmosphere regularly rises in places with a high people density, though. The link between surface and air temperatures is not always constant due to air mixing within the troposphere, and air temperatures typically change locally less than surface temperatures.

3. Research- I: Colombo, Sri Lanka

3.1 Introduction

(Dikman Maheng, 2019) This study examines the presence of UHIs and the role that green spaces play in reducing the effects of UHIs in Colombo, Sri Lanka, using UrbClim, a boundary climate model that performs two different types of models, namely urbanization impact simulations and greening simulations. This study demonstrates how metropolitan heat islands are sensitive to vegetation growth in both urban and country areas. Simulated green area circumstances representing declining and growing green areas are divided into two groups, and the outcomes are contrasted with those from the reference year. By highlighting the susceptibility of UHI to plant cover in both urban and residential regions, the study's goal is to illustrate how more green space can decrease UHI severity. The study starts with a hypothesis that changes in the quantity and distribution of green space have significant impacts on the spatial and temporal temperature distribution in urban areas.

3.2 Relationship of UHI and UGS

(a). Composition: (Dikman Maheng, 2019) refers to the amount of vegetation, the diversity of land cover types, the area of the green space, and its geographic distribution. In Hanoi, Vietnam, where agricultural land was converted into an impermeable (built-up) surface as a result of urbanisation and industry between 2003 and 2015, composition of UGS may have a greater impact on cooling effects. (MLST).

Results: Changing the levels of green space influence air temperature changes and generate various temperature patterns.

(b). Configuration: (Dikman Maheng, 2019) The layout of UGS, which includes the aggregation, form, and cohesion of patches, is connected to spatial pattern as well as the configuration of UGS. Different spatial layouts of ugs can dramatically raise or reduce the intensity of UHI in a specific configuration. The arrangement or geographical distribution of urban green space can have an impact on the interchange or flow of energy between various land-cover components.

Results: The amount of aggregation of green space and mean temperature are not significantly correlated, however it has been discovered that in a given space, a dispersed configuration or uniformly distributed UGS has caused a drop in the mean temperature.

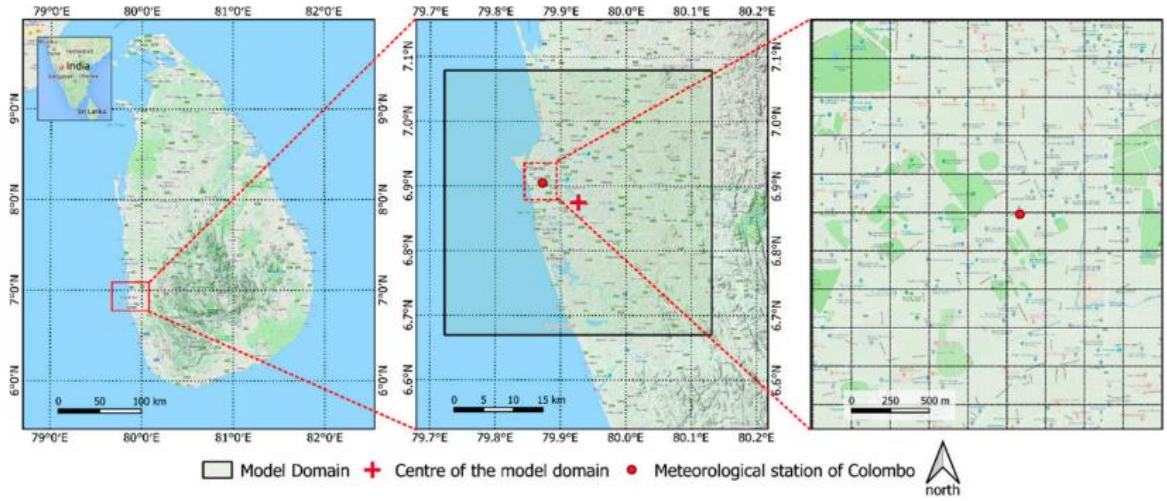

Figure 1: Figure showing location of study area

3.3 UrbClim Model Setup and Validation

(Dikman Maheng, 2019) The urban boundary climate model known as UrbClim was created by combining a land-surface system with condensed urban physics and a 3-D atmospheric boundary layer module. Accurate representation of the temperature and heat-stress domains is achieved by the model's high spatial accuracy, which may exceed 100 m. The surface module and the atmosphere module are the two main parts of UrbClim.

The urban topography is represented by an impermeable block with the appropriate emissivity, albino, and aerodynamic and thermal roughness length values in the UrbClim land-surface system.

The effectiveness of UrbClim has been confirmed by modeling UHI in Toulouse (France), Ghent (Belgium), Antwerp (Belgium), and Bilbao. (Spain). Two Land use pictures for 1997 and 2015 were made based on the UrbClim land-use classifications.

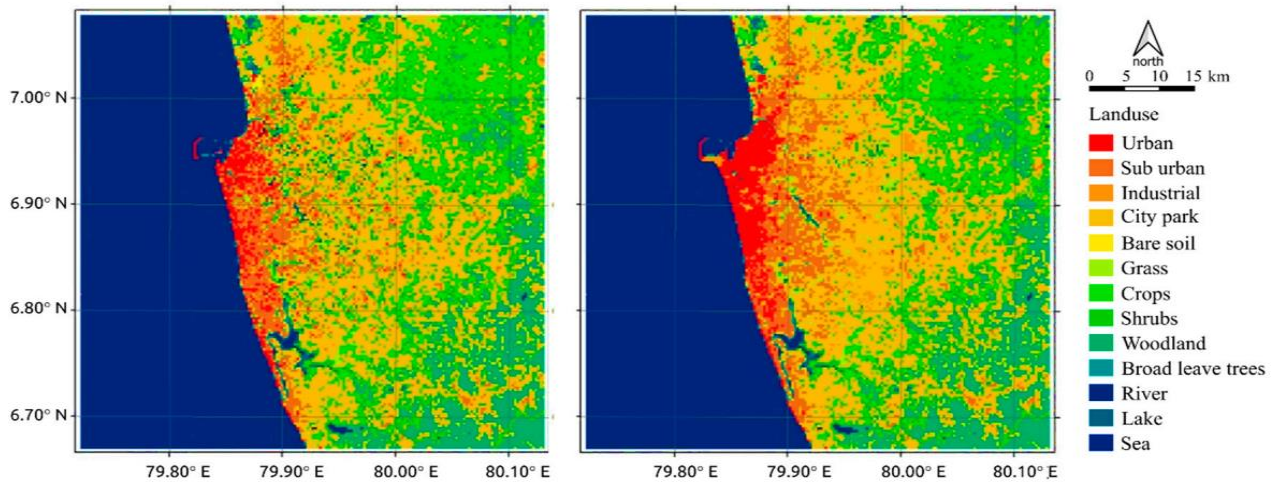

Figure 2: Landcover Map (a). 1997; and (b). 2015

(Dikman Maheng, 2019) This research used two categories of numerical models, referred to as "urbanization impact simulations" and "greening simulations," to examine the susceptibility of the UHI to green space in the city of Colombo. The first urbanization effect simulation was run to determine whether the UHI existed due to changes in land use between 1997 and 2015, and the second simulation was run to look into whether the UHI had spread to suburban regions as a result of increased urbanization. In order to begin the greening simulations, metropolitan regions' green cover was increased by 10%, and the results were compared to the situation in 2015. Similar steps were taken when the amount of natural space grew by 20% and 30%.

Results & Conclusion

(Dikman Maheng, 2019) The geographical distribution and contribution of urban temperature were both altered by an increase in green space. The temperature decrease in urban regions may have an impact on the difference in temperature between urban and suburban areas, which aids in preventing UHI development. In the present study, the impact of green space on the spatial and temporal distribution of urban temperature as well as UHIs has been examined. It is critical to understand the relationship between urban planning, green space, and UHIs as well as how sensitive the UHI impact is to the presence of green area.

Research- II: Hanoi, Vietnam

The study introduces a program for developing green spaces in urban areas through:

i. Land suitability analysis based on GIS

ii. Quantifying green areas based on the ecological factor threshold method to maintain ecological balance. The study focuses on developing green spaces in urban areas to improve micro-climate.

Organizing green places in urban regions using landscape-ecology concepts.

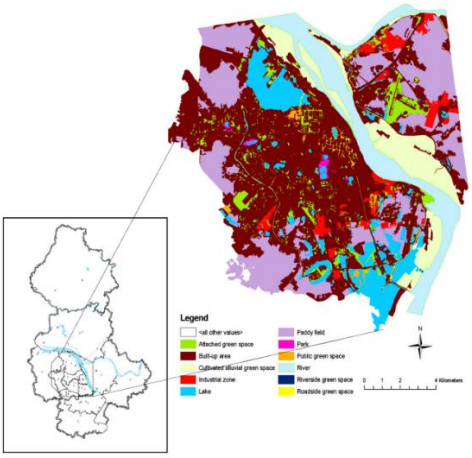

Figure 3: The study area of Hanoi, Vietnam

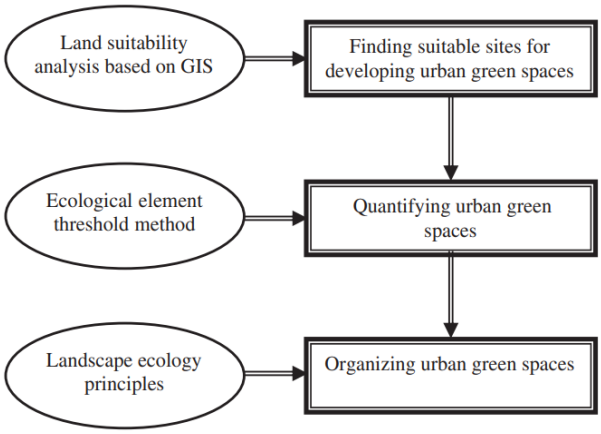

Figure 4: The steps involved in the development of green spaces

Methodology

The first crucial step in ensuring the responsibilities and functions of green spaces is to identify suitable areas for protecting and developing them..

A GIS-based land suitability analysis (LSA) may be used to gather site information.

The ecological factor threshold approach may be used to calculate the amount of green space required to preserve ecological harmony in urban environments.

(Pham Duc Uy, 2008) Hanoi, the capital of the Socialist Republic of Vietnam, is located between 201530 and 211230 north latitude and between 1051440 and 1061020 east longitude. It is the political, economic, cultural, scientific, and technical hub of the whole nation. Nine urban and five rural districts make up the historic city of Hanoi.

(Pham Duc Uy, 2008) The following processes, together with data integration and GIS analysis, were used to assist the LSA using the spatial analysis capabilities of GIS: data identification and collection, weighting using the analytical hierarchy process (AHP), data integration, and GIS analysis, and output assessment.

One of the most crucial processes in suitability analysis is weighting, which has a precise impact on the results and is made challenging by the interactions between many components.

(Pham Duc Uy, 2008) These three fundamental forms—linear, centralized, and gridiron—express physical and cultural influences across time, and the city of Hanoi currently resembles a combination of these influences. The city will be designed and expanded in accordance with a centralized structure, with the old quarter serving as the city centre, as per the 2020 Hanoi Master Plan.

CONCLUSION

The analysis's findings had some consequences for Hanoi, Vietnam's 2020 plans for urban green space, and the city decided to designate 18 square metres per person for these areas. To make the city's green network ecosystem more effective than the total of its individual green spaces, the city will also concentrate on developing a variety of green space planning.

Summary

The value of urban green spaces has long been recognized, but in recent years, attention has turned to the connection between urban liveability and green areas as part of larger urban green systems. The ecological performance and other UGS functions can be more effectively integrated into a planning model based on diverse and well-defined land-use

supply. The study's findings can offer methodical guidelines for organising various forms of UGS as well as fresh perspectives on clever UGS planning and environmentally friendly landscape architecture.

1. RECOMMENDATIONS

Based on the studies of different cities worldwide, some recommendations are as follows:

i. The green spaces to be proposed shall not be concentrated, instead should be appropriately scattered as per the demand of the urban area and its rising temperature.
ii. Multiple regression analysis shall be done before spatializing the UHI of any urban area, thereby providing green spaces.
iii. Awareness programs should be conducted inorder to conserve the remaining green spaces within cities, so as to lessen the effect of UHI. Community level involvement shall be done inorder to make people know the relevance of UGS against UHI.

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