Research Paper

Mitigating urban heat island effect with nature based solutions in indian cities

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ABSTRACT

Urban heat island, which is a complex function of some anthropogenic and environmental issues, has become a major concern in Indian cities. Nature-Based Solutions (NbS), like green, blue, and gray infrastructure, offer one of the best solutions to reduce the impact of the urban heat island effect. This technique is an environment-friendly solution that lessens the detrimental effects of climate change, reduces carbon emissions, and increases building energy efficiency while also improving the health and well-being of urban residents in the most resource-efficient way possible. This makes cities more resilient by improving urban microclimates, restoring nature, and enhancing the overall quality of urban ecosystems. This review is an attempt to understand the potential of nature-based solutions for mitigating urban heat in Indian cities in light of the DPSIR model. The study was conducted by reviewing a wide range of research articles, feedback pieces, short notes, and review papers published in scholarly journals. A framework for the planning and design of nature-based solutions is proposed based on the review that could help city planners and decision-makers address the issue. Some recommendations have also been suggested to successfully implement the strategy.

1. INTRODUCTION

Urbanization is taking place at a faster rate in India. This has resulted in the country's land surface changing from natural landscapes like forests, open space, croplands, and water bodies to structures like buildings, roads, impervious surfaces, industrial and power plants, and other infrastructure. All these make urban areas warmer than their adjacent non-urban or rural landscapes, causing surface temperatures and overall ambient temperatures to rise. The term "urban heat island" (UHI) refers to this phenomenon [1]. It is denoted as Urban Heat Island Intensity (UHII) and is expressed by the mean of the highest and lowest land surface temperatures in the city center and the neighboring rural areas. This phenomenon has been studied widely by several researchers in various Indian cities. Their studies show that UHII reaches upto 9° C [2] in some Indian million-plus cities.

UHI is a complex function of some anthropogenic and environmental issues such as the morphology and design, building materials, emissivity, population size, lack of green spaces, climate, topography, etc. of the cities and their geographic location [3]. UHI raises the usage of cooling energy, which increases the peak electricity load by 0.45% to 4.6% per degree increase in ambient temperature [4]. In their study shows that a median 19% increase in cooling energy usage is caused by UHI. This requires power plants to use more fossil fuels, which eventually results in a rise in the quantity of pollutants and GHGs affecting the microclimate of the cities [5]. The Figure 1 shows the relationship between the UHI and the urban microclimate. An increase in UHII can have a detrimental impact on the health of the urban populace in a number of ways, such as general discomfort, cardiovascular stress, respiratory difficulties, heat syncope, all heat-related illnesses, heart attacks, and even death [6]. Urban heating issues directly affect 48% of the world's population, including the 400 million urban dwellers in India.

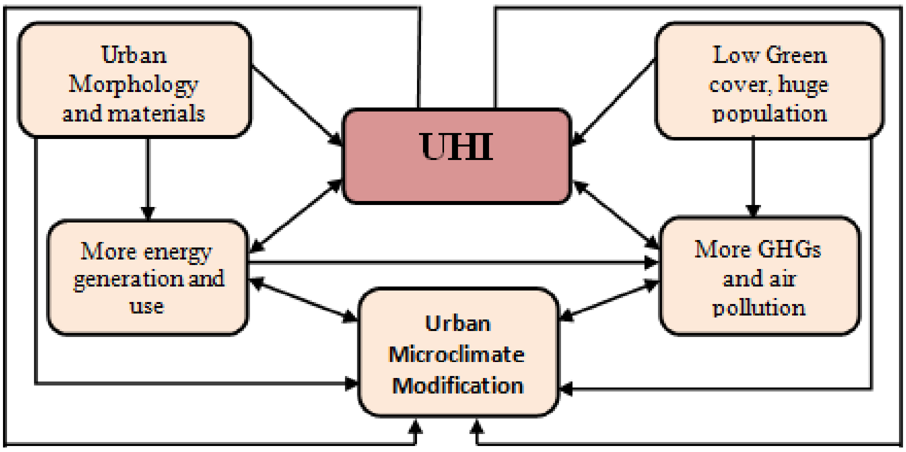

Figure 1. Interlinkages between Urban UHI and Microclimate

In order to mitigate UHI effects, governments everywhere are investing more in ecosystem-based approaches such as nature-based solutions (NbS) [7]. Consequently, policymakers and practitioners are starting to favor such an approach for urban development and newly built cities. This can address the challenges caused by UHI and heat waves by offering cooling services. By restoring nature, this approach seeks to create more resilient cities that can support infrastructure systems which were designed traditionally [8].

In this context, the main objective of the paper is to help understand how NbS may be used to reduce urban heat in Indian cities and to propose a conceptual and inclusive model of NbS for mitigating the problem. The study also offers some proposals for applying the model, which may offer urban planners and policy maker's useful information for mitigating UHI and the sustainable development of cities.

1.1 Defining Nature-Based Solutions

The concept of NbSs was first mentioned in 2008 by the World Bank [9]. NbS's are environment-friendly solutions that reduce the negative effects of pollution and climate change, mitigate carbon emissions, and improve the energy efficiency of buildings while simultaneously enhancing urban people's health and well-being, economic development, and promoting biodiversity in the most resource-efficient manner [10]. The three most popular categories of NbSs for urban heat adaptation include green infrastructure, grey infrastructure, and blue infrastructure.

1.1.1 Green Infrastructure (GI)

Green Infrastructure (GI) is a linked network of all kinds of green spaces "that support native species, maintain natural ecological processes, sustain air and water resources, and contribute to the health and quality of life" [11]. It is one of the most reasonable ways to lessen the effects of UHI and heat waves through the development of greenery in urban and suburban areas. Strategically placed urban greenery comprising of green spaces (parks, urban forests, nature reserves), community woodlands, urban agriculture, kitchen gardens, bio-retention cells in the streets, green roofing, vertical greenery, green facades, or terrace gardening can successfully offer thermal comfort in hot, humid urban settings [12].

Green roofing, or the vegetation grown over a building's roof, can shade the building and control runoff water, noise, and ultraviolet radiation [13]. The shadow of green can also help reduce a building's energy use for cooling. During the height of tropical temperatures, green roofs have been observed to lower the temperature by roughly 1.70° C [14]. On rooftops, a hybrid green-blue roof can lower temperatures by 5 to 9° C [15]. For densely populated places with little or no space for more expansive green cover on the ground or on the roof but a lot of exposed façade, vertical greenery, green facades, or terrace gardening with climbing plants acts as an effective UHI mitigation strategy. The physiologically equivalent temperature (PET), a common metric for the bio-meteorological evaluation of the thermal environment, is mitigated by green facades by 5%–10% [16]. Systems with vertical vegetation vary in success in reducing the external wall surface temperature by 1.61°C [14].

It has been found that GIs cool surrounding built-up regions by making tree canopy, evapotranspiration, and cutting down significantly carbon emissions [17]. By putting green infrastructure into place, cities can improve habitat quality, conserve biodiversity [18], and lessen environmental stresses like land-use intensification, fragmentation, and climate change brought on by human activities.

1.1.2 Blue Infrastructure (BI)

Surface water (such as ponds, wetlands, urban lakes, and rivers) cooling techniques are referred to as blue measures. This system provides a cooling impact in the urban environment during hot summer days by transferring heat through latent heat flux, or the movement of heat away from the center via rivers, streams, and canals [13].

On a sunny day in a subtropical region, blue infrastructure near lawns can lower the temperature by 0.7° C [19]. Restoring wetlands also benefits the urban ecosystem by boosting the production of forest products, shielding infrastructure and communities from flooding and soil erosion, and recharging groundwater storage. Artificial water features such as a spray fountain, a small waterfall, and a shallow pond or rooftop pond also provide a location where the air temperature declines.

1.1.3 Grey Infrastructure

The energy budget for the roof surface and the underlying structure is reduced when roofing materials reflect short-wave incoming solar radiation back to space. By doing this, high-albedo construction materials, especially white in color, can lower the building temperatures substantially during the daytime. The albedo of common urban materials, such as asphalt and concrete, is between 0.05-0.2 and 0.25-0.7 respectively, although the albedo of reflecting surfaces is typically larger than 0.5 which reflects more short-wave solar radiation [20].

The negative impacts of heat islands on the microclimate and human thermal comfort are, to some extent, lessened by the cooling action of wind. A wind velocity of 1-2 m/s produces a cooling impact in tropical locations like Singapore, which is equal to a 2° C drop in temperature [21].

Wind relieves heat-related stress and improves the dependability of mechanical air conditioners by lowering CO2 emissions. Additionally, suitable wind-induced airflows can help disperse air pollution in cities. So, naturally ventilated buildings using high-albedo materials, light-colored paint, a white roof, and passive daytime radiative cooling technology for both residential and commercial purposes may be a good means of UHI mitigation measures.

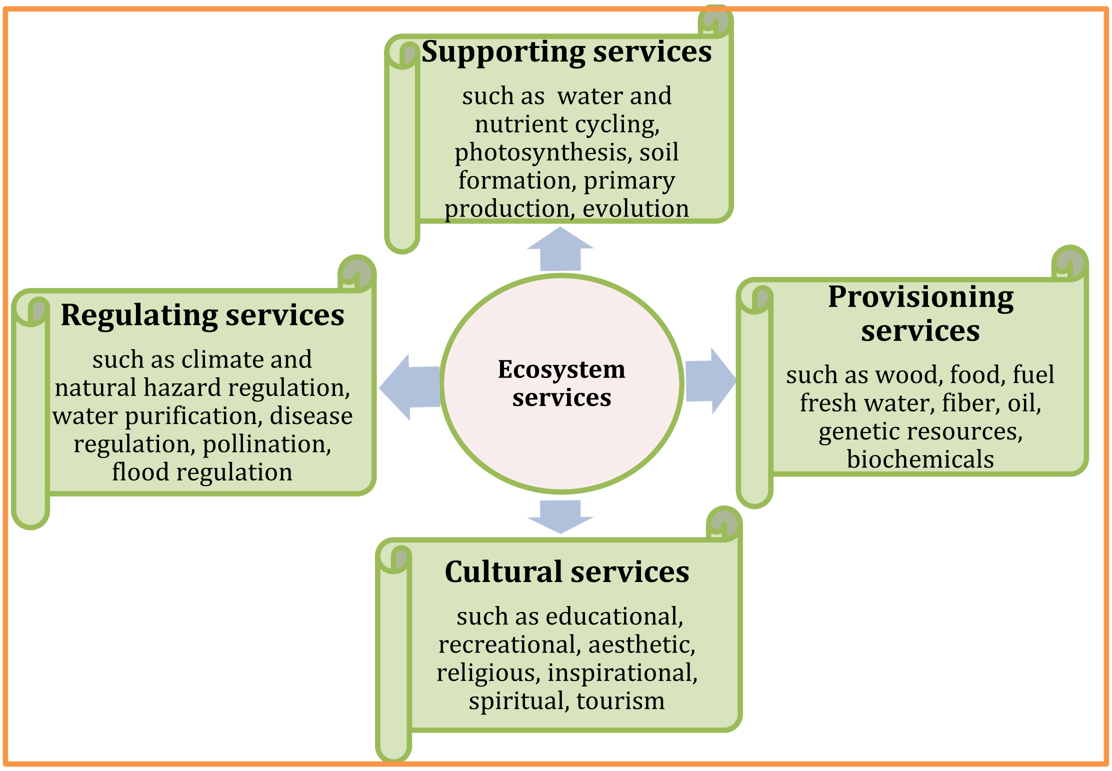

Figure 2. Co-Benefits of NbS (Ecosystem Services) in the Urban Environment (Made by Author)

The co-benefits-including air and water purification, reduction of greenhouse gas emissions and air pollution, microclimate regulation, flood control and recharge of ground water, soil formation, nutrient cycling, food production, biodiversity support, social and recreational activities, etc.-that NbS solutions can provide for city dwellers in addition to mitigating the HI effect are referred to as ecosystem services. Figure 2 clearly indicates the co benefits of NbS (Ecosystem services) in the urban environment [22].

2. RELATED WORK

Several empirical studies conducted in India and abroad have demonstrated the potential of Nature-based Solutions (NbS) including green, blue, and grey infrastructures in mitigating the Urban Heat Island (UHI) effect. In Delhi, [23] found that the installation of green roofs could reduce summertime ambient temperatures by up to 2.5°C, highlighting their effectiveness in densely built environments. Similarly, in Kolkata, Chatterjee and Majumdar (2020) [24] reported that the evaporative cooling impacts due to the restoration of urban water bodies led to a decrease of around 1–1.5°C in air temperatures at the local level. Consequently, these results highlight the importance of the blue infrastructure being part of the climate adaptation strategies in the urban environment.

A nationwide study conducted by Singh [25] support the conclusions drawn above and pointed out the necessity of having standardized national frameworks which would help in the systematic incorporation of NbS into the urban climate resilience planning. Knowledge [26] also revealed the case of Ahmedabad's Heat Action Plan which was the first in India and included the use of reflective surfaces, tree planting, and cool roofing systems to mitigate heat among the poor. Similarly, Nagendra and Gopal (2010) [27] reported that tree-covered areas in Bengaluru had surface temperatures that were 2–3°C lower than in the surrounding densely built areas, thus highlighting the cooling function of urban trees as an essential one.

Ashok and Gupta (2021) [28] state that lack of multi-sectoral planning frameworks that consider ecological functions is one of the main reasons for the weaknesses of projects under AMRUT and Smart Cities Mission. To make sure that the NbS interventions are successful in the long run, [29] support the use of participatory planning methods and claim that the participation of different stakeholders and local ecological knowledge are the two main factors that make the sustainability and acceptance of the NbS projects higher. Collectively, these studies highlight that well-designed and community-inclusive NbS strategies can play a transformative role in reducing urban heat stress while fostering climate-resilient urban ecosystems in India.

According to cross-regional assessments, the integration of NbS in urban policy frameworks can bring about various co-benefits, such as enhancement of air quality, increase of biodiversity, and a boost in social well-being [30] according to the researchers.

3. METHODOLOGY

The study was conducted by reviewing existing literature with the goal of understanding the UHI phenomenon, the NbS concept, and its application to mitigate UHI effects in Indian cities. For this, a non-systematic review of a wide range of research articles, feedback pieces, short notes, and review papers published in scholarly journals was conducted by using a combination of chosen titles, abstracts, or key words like 'urban heat island effect,' 'nature-based solutions,' and 'urban heat island and nature-based solutions' from the databases (Web of Science, Google Scholar, and Scopus Index Journals) during July 2024. The articles from the last twenty years (2003-2022), containing information on UHI and NbS were considered for this purpose.

Based on the nature of the study, 78 articles were retrieved using the databases mentioned above. Subsequent to a separate review of the list of abstracts, 39 articles were eliminated for not intent on cities or languages other than English, being unavailable (i.e., no definition of NbS), and being duplicates (i.e., repeated ones). The remaining 39 articles were identified as containing the most important keywords that could be used to construct the central ideas related to the UHI and NbS concepts. Parallel to this, a pertinent report from the UNEP [31] was also included. Finally, a thorough assessment and analysis of 40 publications is conducted to frame the article. Following Figure 3 and Table *1* give a detailed view of the methodology search for finalize articles for investigation.

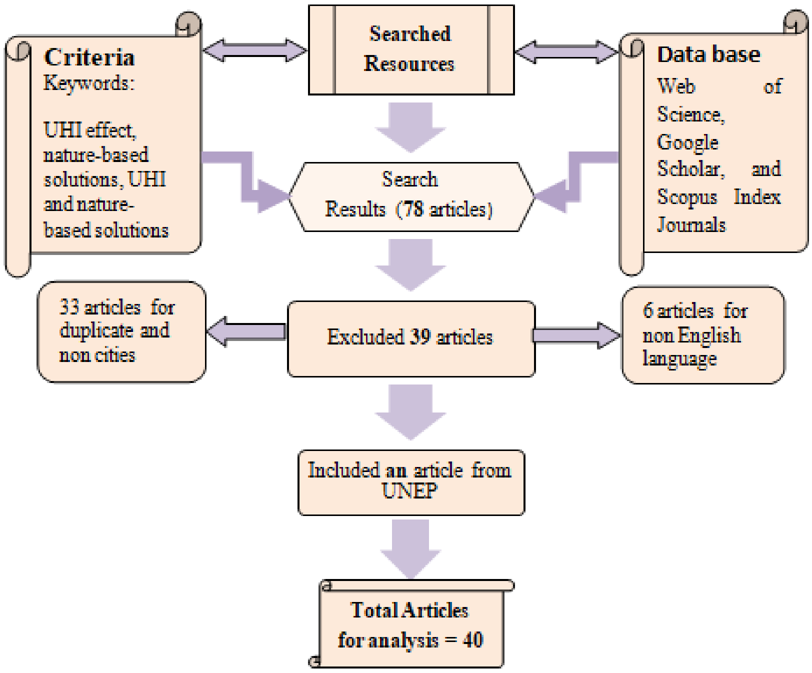

Figure 3. Methodology Search for Finalize Articles for Investigation

Table 1. UHI and NbS Studies in Indian Cities

Sr. No.	Study Site	Paper Title
1	Chennai, Bangalore, Hyderabad	Some signatures of Urban Heat Patches in southern India
2	Visakhapatnam, Andhra Pradesh	Project report
3	Bhopal, Madhya Pradesh	Mitigation of thermal pollution to enhance urban air quality through Remote Sensing and GIS
4	Bangalore, Karnataka	Greater Bangalore: Emerging UHI
5	Delhi	Assessment of UHI effect for different LULC from meteorological measurements and RS data for megacity Delhi
6	Delhi	The evaluation of HI effect in various cities in Ganga-Yamuna Doab using modis land surface temp. product
7	Bangalore, Karnataka	Impacts of increased urbanization on surface temp., vegetation, and aerosols over Bangalore, India
8	Delhi	UHI Assessment for a Tropical Urban Airshed in India
9	Pune, Maharashtra	UHI studies: Current status in India and a comparison with the International studies
10	Delhi	A study of UHI and its association with particulate matter during winter months over Delhi
11	Jaipur, Rajasthan	Temporal and Spatial Variations of UHI Effect in Jaipur City Using Satellite Data
12	Kochi, Kerala	Analysis of UHI in Kochi, India, Using a Modified Local Climate Zone Classification
13	Guwahati, Assam	Summertime UHIstudy for Guwahati City, India
14	Bhatinda, Punjab	Assessment of UHI in India using Geospatial Technology- A Review
15	Thiruchirappalli, Tamil Nadu	Significance of Microclimatic Study in Urban Canyons towards Ambient Urban Space Design
16	Delhi and Mumbai, Maharashtra	Analysis of UHI in Relation to NDVI: A Comparative Study of Delhi and Mumbai
17	Delhi	Estimation of the UHI in local climate Change and vulnerability assessment for air quality in Delhi
18	Ahmedabad, Gujarat	A temporal study of UHI-A Evaluation of Ahmadabad city, Gujarat
19	Ernakulam, Kerala	A Study of UHI and Its Mapping
20	Chennai, Tamil Nadu	Urbanization and its impact on UHI Intensity in Chennai Metropolitan Area, India
21	Uttarakhand	Case study for change detection analysis and land surface temp. retrieval in Uttrakhand Region
22	Residential area	The Bigger, the Better?The influence of urban green space design on cooling effects for residential areas
23	Bhubaneswar, Odisha	Impact of rapid urbanization on the microclimate of Indian cities: a case study for the city of Bhubaneswar
24	Noida, Uttar Pradesh	Assessing UHI and thermal comfort in Noida City using geospatial technology
25	Kanpur, Uttar Pradesh	Understanding diurnality and inter-seasonality of a sub-tropical UHI

26	Lucknow, Uttar Pradesh	Impact of LU change and Urbanization on UHI in Lucknow City, A Remote Sensing Based Estimate
27	Delhi	Seasonal Variation of UHI and Its Impact on Air-Quality Using SAFAR Observations at Delhi, India
28	Amravati, Andhra Pradesh	Emerging UHI in the New Capital Region of Andhra Pradesh, India - A Satellite based Evaluation
29	Mumbai, Maharashtra	Diurnal thermal diversity in heterogeneous built area: Mumbai, India
30	Kolkata, West	UHI and its effect on Dweller of Kolkata Metropolitan area using Geospatial Techniques
31	Delhi	Spatial Variations of Intra-city UHI in Megacity Delhi
32	Mumbai, Maharashtra	Application of split- window algorithm to study UHI effect in Mumbai through land surface temp approach
33	Bengaluru, Karnataka	The UHI of Bangalore, India: Characteristics, Trends, and Mechanisms
34	Cities	Urban green space cooling effect in cities
35	Delhi	Investigating the spatio-temporal correlation between UHI and atmospheric pollution island interaction over Delhi
36	Indian cities	NbSs for Co-mitigation of Air Pollution and Urban Heat in Indian Cities
37	Ahmedabad, Gujrat	Trends of surface UHI in past few years in the city of Ahmadabad
38	Kolkata, West Bengal	Assessing the local- impacts of heat advection on UHI in Kolkata Metropolitan Area
39	Chandigarh, India	Evaluating outdoor thermal comfort in urban open spaces in a humid subtropical climate: Chandigarh

4. RESULTS AND DISCUSSION

4.1 Proposed Framework for Implementing NbS in Indian Cities

As previously stated, the primary objective of this study is to develop a framework for implementing appropriate NbS techniques for mitigating UHI effects in Indian cities. The most popular structure for choosing an indicator for this purpose is the Causal Network (CN) method, which combines a number of causal and feedback loops such as driving force-pressure-state–impact–response (DPSIR) [32] as given in Figure 4. This model is now the most internationally recognized model of UHI mitigation measures in urban areas. It serves as a causal framework to explain how human activity and natural resources interact in a balanced way, demonstrating the degree of sustainability in urban development.

In this network (DPSIR), 'driving forces' indicate the basic causes (economic and human activities) of heat island effects like urbanization and associated activities, while 'pressure' signifies excessive use of natural resources, including changes in land use and land cover (emissions, waste, etc.). 'State' is the quality of the environment (physical, chemical, and biological), such as climate change, pollution, and changes in the quality of human life. 'Impact' indicators express the level of environmental damage to human health, ecosystem health, and functionality.

The 'responses' are human behavior and policy measures against dreadful conditions. For executing the model, a number of stakeholders, such as researchers, urban planners, ecologists, social scientists, and political leaders, should be actively involved in the planning stage because landscape and landuse characteristics, cost-effectiveness, and other societal and practical challenges all play a vital role in how successfully a project is implemented [10]. Planning in-depth is necessary for the identification of possible implementation locations and NbS in the designated priority site [33].

UHI varies both in space and time, as well as because of the variations in variables including urban morphology, thermal properties of construction materials, anthropogenic heat, reduction of evaporating surfaces, reduced turbulent transfer, climate type, physical layout of the built environment, and short-term weather conditions [34]. So, comprehending these variables is essential for formulating and executing this strategy to alleviate UHI effects. The Figure 5 gives a detailed view of different steps of NbS implementation.

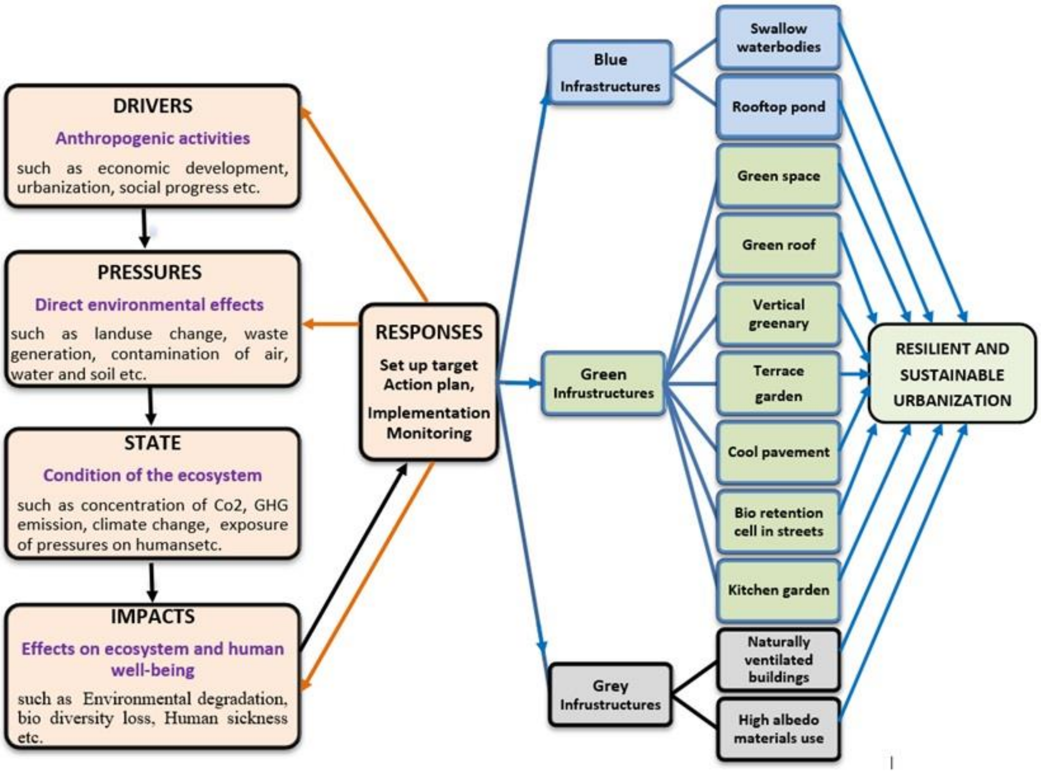

Figure 4. DPSIR Model: A Framework for Executing and Evaluating NbS for Mitigating UHI

4.1.1 Heat Hot-Spot Mapping

In urban areas, heat stress caused by UHI is not equal everywhere; rather, it varies both spatially and temporally. Therefore, it is necessary to identify the susceptible locations in the city suffering from heat stress. So, the first and most important stage in implementing NbSs is the identification of locations characterized by high heat stress.

These are the heat hotspot zones [35]. There, urban dwellers are highly exposed to the hassle of heat and are at significant risk for both physiological and socioeconomic problems. The identification of city hotspots can be aided by freely available spatiotemporal UHI maps from the NASA website, which show both urban and non-urban areas divided by local climate zones (LCZ).

Daily land surface temperature (LST) data provided by LandSat thermal bands [36], MODIS LST products [37], and ASTER thermal data [38] with high temporal (four times per day) and relatively high spatial resolution (1 km) is commonly used for this purpose. Policymakers and municipal administrators then analyze the local sources causing heat stress in certain wards or areas and develop NbS to mitigate the same with the help of hotspot maps.

4.1.2 Vulnerability Mapping and Identification of Priority Zones

In this stage, a vulnerability mapping is conducted for the city suffering from UHI to identify places where exposure to heat stresses is more fatal. A person's vulnerability to heat stress can be determined with the help of factors such as sensitivity to changes in weather, the degree of exposure to the heat hazard, adaptive capacity, etc. [39].

A comprehensive index comprising factors such as sanitation, water, electricity, health, transportation, housing, cooking, awareness, and heat symptoms may be used to examine the heat stress vulnerability throughout the heat hotspot areas.

The thorough heat stress sensitivity hotspot maps produced by analyzing thermal hotspots, socioeconomic vulnerability status, and exposure to UHI make them priority zones for performing heat stress adaptation and mitigation strategies. Subsequently, these zones are arranged accordingly.

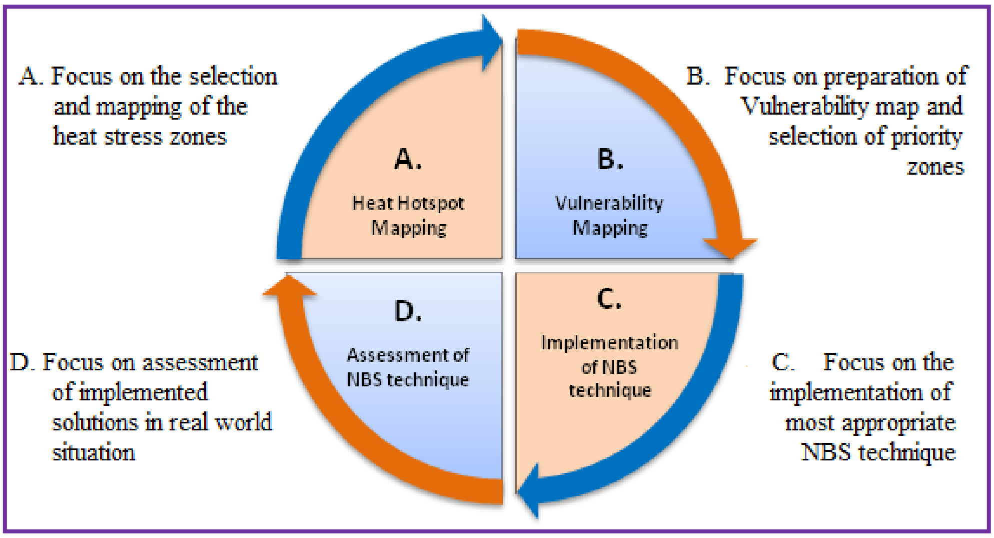

Figure 5. Hermeneutic Circle Focusing Steps of NbS Implementation

4.1.3 Implementing the Most Appropriate NbS

The most important task for successful implementation of NbS is to select the most appropriate (optimal) mitigation strategies. The various NbS types need to be assessed in light of the city's geographical location, morphology, climate type, available space and funding sources, and suggested level of viability. Once the effectiveness of various NbS solutions in the identified vulnerability regions has been estimated, the NbS solution will be finalized. As for example, cities with available open space can create green space, including urban parks and forests, nature reserves, community woodlands, and urban agriculture, to act as cool islands and to offer easily accessible green areas for leisure and entertainment. In densely populated cities like New Delhi, Mumbai, Chennai, Kolkata, etc. where there are space restrictions, planting a wide variety of native, heat-tolerant tree species with strong cooling capability, bio retention cells in the street, green walls and roofs, moss walls (a wall covered in moss), and installing cool-roof solutions are expected to be the most effective NbS for mitigating heat stress.

In cases where the cities have huge vertical growth, like Mumbai, Delhi, etc., the system of vertical greenery, green facades, or terrace gardening with climbing plants acts as an effective UHI mitigation strategy. Coastal cities like Mumbai, Chennai, and others can lessen the intensity of HUIs by planting and conserving the mangrove forests along the coast. But reducing urban heat and planting the right tree in the right location is very important. The placement of large trees and other kinds of plants in street canyons should be avoided since their presence can diminish the natural flow of air, thus leading to a rise in temperature. Urban development and the effectiveness of the NbS methods are based on the use of the planting typologies that can adapt to the specific area's environmental disturbances and are therefore native and heat-tolerant. The heat reduction potential (HRP) of the selected plant species must be discovered by thermal evaluation. The blue infrastructure can be established in cities that have roofed buildings where artificial water features such as spray fountains, shallow pools, or rooftop ponds may be constructed.

The most exposed areas to heat in Indian cities usually coincide with direct proximity to slum areas and other locations that might not accommodate modern green infrastructure, like vertical vegetation, that might not be feasible due to various reasons. Community gardens may be created in this area where locals can cultivate their own produce. It will also encourage social contact and enhance mental health.

Alternative building materials for homes can naturally prevent heat stress in these areas. Particularly, homes built of bamboo provide shelter from both heat and flooding. Experts point out that cutting-edge bamboo homes with features like raised stilts that keep floodwaters out of the house and a tilting roof that collects rainwater and lowers heat gain can be produced in only one week [40]. Pilot projects for bamboo housing have previously been implemented in the Indian cities of Ahmedabad and Surat [41], and it is well known that these initiatives significantly reduce the amount of heat exposure for those living in particularly vulnerable areas, such as slums. Figure 6 clearly indicates a proposed framework for implementing most appropriate NbS's in metropolitan cities.

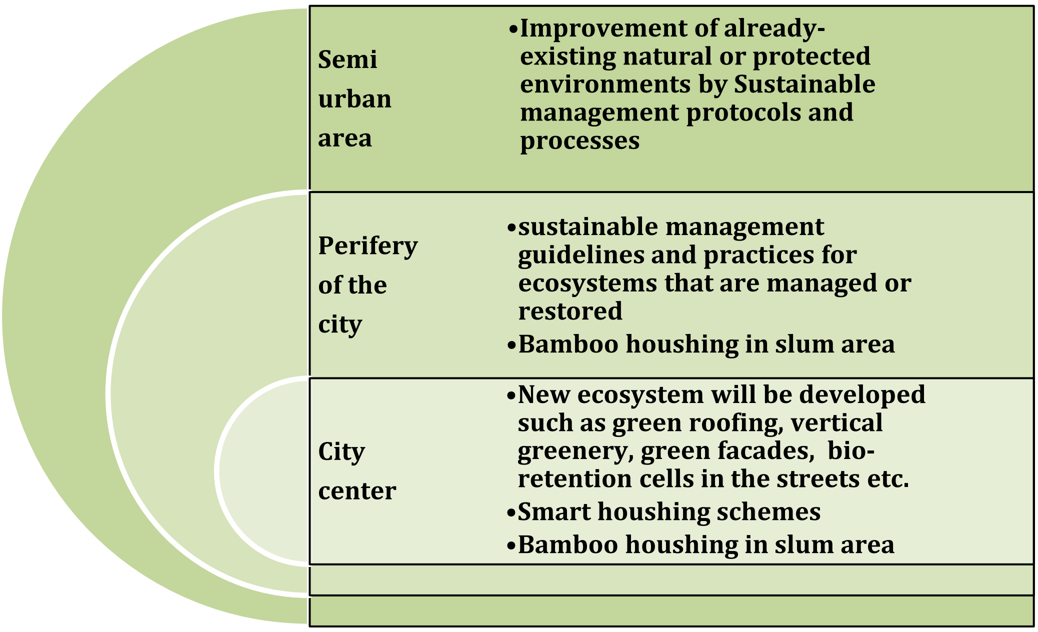

Figure 6. Proposed Framework for Implementing Most Appropriate NbS's in Metropolitan Cities

4.1.4 Assessment of Potential Mitigating Strategies

The final step of NbS implementation involves analyzing the impact of various mitigation plans and techniques, both separately and in combination, on the evolution of air temperature and thermal comfort in the vulnerable area. In this stage, the implementation plan will be incorporated into the Heat Action Plans and shared with the local government and stakeholders who are actively working on climate adaptation and mitigation projects. In order to comprehend the intricacies surrounding NbS interaction with the ecosystem, its services towards mitigation and adaptation, and the possible paths for additional improvements, the sorted NbS will thereafter be re-evaluated using the DPSIR model.

5. CONCLUSION

NbS has a lot of promise in lessening the negative effects of UHI and modifying urban microclimate. It has shown considerable promise in disaster management and risk reduction, energy and water security, and enhancing social well-being in metropolitan environments. NbS aims to build more resilient cities that can sustain traditionally constructed infrastructure systems by restoring nature. So, the author recommended the green infrastructure schemes and, to some extent, the hybrid schemes with the blue infrastructure for mitigating UHI and heat wave effects in Indian cities.

However, careful planning and management are required for the implementation of these measures in order to fully realize the promise of NbS as a UHI mitigation scheme. The author proposes the following recommendations necessary for the successful planning and implementation of the NbS before the research bodies:

a. A key component of NbS deployment success is governance. So, adaptive governance based on local knowledge and culture is necessary since NbS tactics heavily rely on socio-political context and local knowledge. Governments should stimulate the adoption of NbS by communities, enterprises, and municipalities by offering financial support in the form of grants, funding methods, and subsidies.
b. Using a nature-based solutions approach, monitoring has multidimensional functions in minimizing UHI effects by providing crucial information for risk assessment, public involvement, performance evaluation, and decision-making. Cities may become more resilient to heat stress, more livable, and develop healthier and more sustainable urban environments by incorporating monitoring into their planning and management procedures.
c. Local communities should be involved in the planning, design, and maintenance of NbS projects in order to ensure their significance, acceptance, and longevity. Building up the participation of the community in the project of NbS can help them feel responsible and thus sustainability can be ensured in the long run.
d. Greening cities requires a significant amount of water supply and has to take into account the presence of dense networks of underground pipes and cables. But water shortages are already a problem in many Indian cities because of urbanization, population growth, and the effects of climate change. Governments should supply the required water for this purpose, preferably from natural sources or by harvesting it during rains.
e. In Indian cities, climate change intensifies the impacts of UHI, raising temperatures and causing more heat stress. Urban planners, researchers, communities, and government agencies must work together to develop comprehensive solutions that take into account the interplay of social, economic, and environmental factors in order to effectively address the interrelated problems of climate change and the UHI effect in urban areas. A city-specific heat action plan (NbS) will be implemented in Indian cities.

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Author Contribution Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dr. Lakshman Chandra Pal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

I, the author had full access to all in this study and take complete responsibility for the integrity of data and the accuracy of data analysis. I declare there is no conflict of Interest.

Informed Consent

I give my consent to publish the data, images and the paper.

Ethical Approval

I assure that this article do not have any plagiarism.

Data Availability

All the datasets generated and/or analyzed during the current study are available in File depository.

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