An Overview of the Literature on Green-Blue Infrastructures

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Abstract- As the threat posed by climate risks has grown, several worldwide cities have modified their approaches to urban planning and architecture. These changes aim to counter typical infrastructure practices by utilizing natural solutions that combine green (such as parks, gardens, playgrounds, and forests) and blue elements (such as lakes, rivers, seas, wetlands, and water utilities). This project research paper examines the new idea of "BGI" and evaluates plans and initiatives that are now underway in India and around the world. Additionally, it points out ways that India's cities might take advantage of the blue-green area to promote resilience and equity, respond to climate dangers, and spark economic shifts that would lead to sustainable urban futures.

Keywords– Nature Based Solution, Green Infrastructure, Ecosystem Services.

Abbreviations:

GBI- Green-Blue Infrastructures.
UES- Urban Ecosystem Service.
GI- Green Infrastructure.
NBS- Nature Based Solutions.
CET- Cooling Establishment Time.
NAPCC- National Action Plan on Climate Change.
IBRM- Intercontinental Biosphere Reserve of the Mediterranean.
PRISMA- Preferred Reporting objects for Systematic opinions and Meta-Analyses.
AMRUT- Atal Mission for Rejuvenation and Urban Transformation.

1. INTRODUCTION

Hazards to human comfort and environmental justice are growing in urban areas due to climate change. Three of the primary threats to sustainability are disasters from nature, adverse weather conditions, and biodiversity depletion; the fourth having the lack of climate change mitigation. Temperature increases are predicted to have a negative decadal impact on countries. The potential contribution of blue (seas, rivers, lakes, wetlands, and water utilities) and green (trees, parks, gardens, playgrounds, and woods) areas to resolving these issues is receiving more and more attention This concept of green and blue infrastructure is often used to guide these discussions [1, 2, 3].

The possible role of blue (seas, rivers, lakes, wetlands, and water utilities) and green (trees, parks, gardens, playgrounds, and forests) spaces is becoming more and more recognized in attempts to address these issues; this is frequently done through the concept of green and blue infrastructure [4, 5].

The improvement of the ecosystem base, which is not harmful, benefits both humans and the environment. Green growth is significantly boosted by adopting the blue-green approach in sectors such as housing, water conservation, and transportation. Furthermore, the design and character of the surrounding area may influence the identity of the city, and green spaces enhance aesthetic and ethical qualities.

As a result, more social gatherings will occur. This project intends to lower urban temperatures, improve outdoor activities, and offer shelter at accessible locations.

- ✓ Transportation,
- ✓ A functioning ecosystem,
- ✓ Sustainable drainage,
- ✓ Green infrastructure,
- ✓ Rainwater harvesting

Two more national flagship projects in India that seek to enhance urban living through the combination of blue and green aspects are AMRUT, the Atal Mission for Rejuvenation and Urban Transformation, and the Smart Cities Mission. The NAPCC is enhanced by these programmes. AMRUT works on issues like water supply, sanitation, and green space upgrading, whereas the Smart Cities Mission concentrates on solutions like open space preservation, sanitation, water supply, and raising the standard of living for residents [7].

Blue-green initiatives are being included into master plans and action plans by a number of Indian cities, including Bengaluru, Delhi, Bhopal, Madurai, and others, even though they are a relatively new idea. The goal is to improve the natural blue systems that already exist in the city and its surrounding public spaces by means of a structured approach [8].

In the figure-1, The Meenakshi Amman Temple in Madurai symbolizes architectural brilliance and cultural significance, attracting tourists with its intricate sculptures and local festivals, such as Meenakshi Thirukalyanam. These cities, as well as many others in India, are already high-density constructed regions with a variety of issues, such as mixed land use, overlapping agency authority, skewed development patterns, technological obstacles, and socio-political will. There isn't much room for blue-green installations in high-

density locations due to land constraint, which implies that the construction of urban blue-green infrastructure must be very efficient and flexible [8].

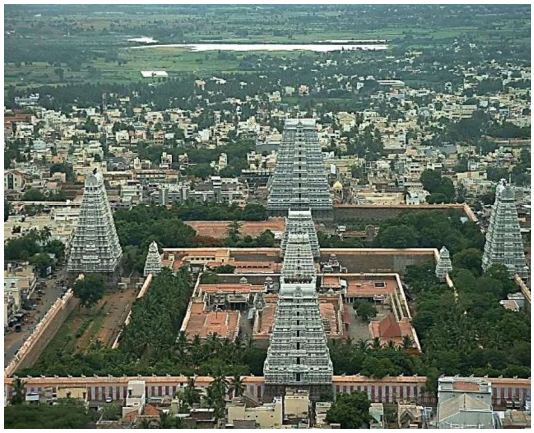

Fig-1: The iconic Meenakshi Amman Temple in Madurai, Tamil Nadu

2. PRESENT STUDY

Like many other cities in the Global South, Indian cities also struggle with challenges of urban poverty, inequality, and unplanned settlements.

We are examining the urbanized region of India's ten most populous cities in order to look at the relationship between changes in blue-green infrastructure, such as surface waters, green cover, and recharge zones, and urban (built-up) expansion. In these ten cities, the interplay between urbanization and natural infrastructure poses a risk to almost thirty percent of India's urban population.

Satellite photos and remote sensing data are used to monitor changes in blue-green infrastructure and urbanization in the ten research cities between 2000 and 2015.

The cities that are the subject of the inquiry are Bengaluru, Surat, Ahmedabad, Chennai, Delhi, Hyderabad, Jaipur, Kolkata, Mumbai, and Pune. To investigate the relationship between urbanization and natural infrastructure, two spatial intervals are used: 20 km (0–20 km) and 50 km (20–50 km) from the center of each research town.

Satellite photos allow us to examine the genuine geographical extents of metropolitan regions with respect to built-up areas, blue cover, and green cover change trend. In ten

In the figure-2, Green-blue infrastructure is vital for urban ecosystems, mitigating flooding and air quality issues. Features like green roofs and permeable pavements support biodiversity and storm water management, essential for sustainable planning. Indian cities, the study uses existing approaches for spatial evaluation and analysis to ascertain the spatial extents of various manmade and natural characteristics.

In the figure-3, Integrated Green-Blue Infrastructure aligns urban development with nature, enhancing aesthetics, air quality, habitats, and climate resilience while managing storm water.

Collaboration promotes sustainable design, yielding economic benefits and improving urban livability. This study's focus is limited to using satellite imagery alone to establish correlations between increases in the built-up area and their consequences on the natural infrastructure. The environmental framework in metropolitan areas is changing due to several interrelated factors, including urbanization, weather extremes brought on by changes in the climate, and other human beings like farming and quarrying.

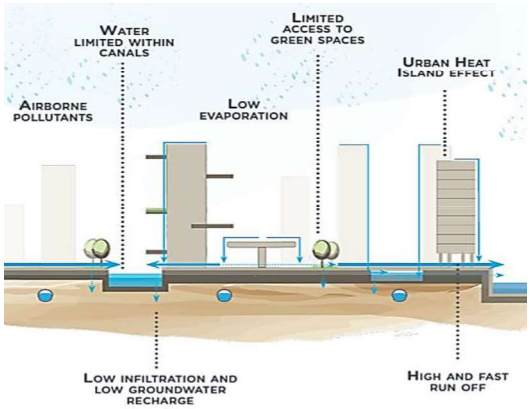

Fig 2: Absence of GBI Approach

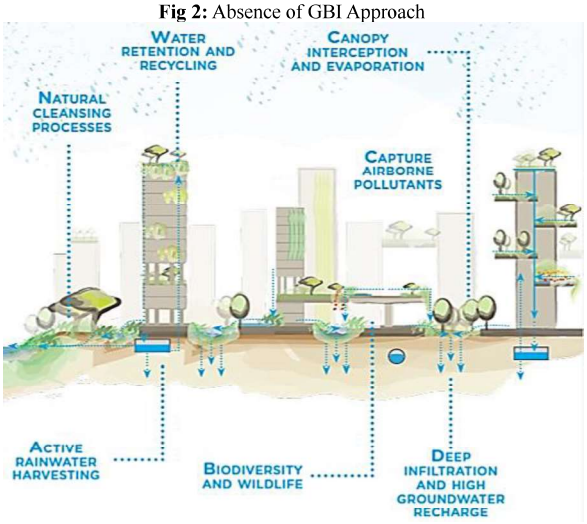

Fig 3: Integrated of GBI Approach

3. LITERATURE REVIEW

Economical preservation as well as restoration organizing within the designs of both blue and green infrastructures. An analysis of the Mediterranean Intercontinental Biosphere Reserve [1].

This research presents a novel methodology for the systematic selection of cost-effective restoration sites in support of blue and green infrastructure designs, based on ecosystem services, biodiversity, and ecosystem condition.

The Intercontinental Biosphere Reserve of the Mediterranean in Andalusia (Spain)–Morocco (IBRM) has freshwater, coastal, and marine aquatic environments. The concept was tested regionally by identifying management zones within the GBI that fulfil different conservation objectives using the Marxian with Zones tool.

The investigation aims to offer a systematic technique for restoration zone allocation in GBI designs that considers factors such as ecosystem-related services ecological state and biodiversity. Implementing GBI is thought to be a potentially useful response to global change, and this approach could guide additional applications of the EU GBI Strategy in scenarios involving transboundary ecosystems.

Blue-green architecture: An examination of a case research taking into account the supplementary roles of vegetation and water. 2019.

The investigation examines the technique of blue and green planning for arrangement, which focuses on varying objectives and issues related to vegetation and water in urban environments. The goal of densifying urban vegetation and building green, which can enhance climate circumstances with enough irrigation, are exemplary of green-motivated initiatives.

Initiatives spearheaded by the blue movement focus on reducing urban water accumulation and exploring methods to enhance local drainage and evaporation. This study examines the extent to which collaborative resource utilization benefits blue-green projects by analyzing four case studies. It is simpler to identify information gaps and current fixes thanks to the case studies' graphical depiction of the blue and green components. The study underscores the need for a new planning methodology that incorporates green and blue aspects at an early stage. The need for more of them is increased by climate change.

Barrier identification framework (2020) for the deployment of green and blue infrastructures

The barrier identification framework for green and blue infrastructures was constructed in December 2019 after a comprehensive literature review was conducted with the use of the Scopes search engine. Because compared to other academic search engines, Scopes covers a broader area engine, was chosen. "Title," "keywords," and "abstract" portions of the literature were searched using the terms "barrier," "challenge," or "obstacle" in conjunction with the search terms "green infrastructure" or "blue infrastructure." Peer-reviewed publications were the only results left after conference papers were removed from the 535 hits that the search yielded. The abstracts of the remaining papers were reviewed, and literature reviews and articles that raised no issues pertaining to BGI were excluded. We also removed articles that focused too much on specific aspects of BGI development or overly specific obstacles. A total of forty pieces were determined to be appropriate for the current research. 56 possible obstacles to the advancement of BGI were compiled into a lengthy list based on the literature assessment.

Multicriteria analysis and different urban service models are applied to the planning of green infrastructure (2022). In a peri-urban catchment in Greater Kuala Lumpur, Malaysia, the study focuses on multi-criteria analysis and multiple urban ecosystem service (UES) models for green infrastructure (GI) design. The authors discovered trade-offs and synergies between the different services after evaluating the coexistence and overlap of hotspots.

The five GI strategies—urban park expansion and conservation, headwaters conservation, greening of existing infrastructure, and reforestation for biodiversity—were analyzed using a multi-criteria approach based on ecosystem service parameters.

Nature-Based Solutions: A typology to direct multifunctional planning of nature-based solutions in urban green infrastructure (2022)

The article provides a typology of urban green infrastructure (GI) and an assessment of the ecosystem services that each type of GI provides to solve concerns unique to cities, all backed by data. The manner in which these services combine to offer multiple capabilities for the deployment of nature-based solutions (NBS) in urban planning contexts is also explored. Making decisions about addressing important urban challenges through public-private partnerships and governmental initiatives can be aided by the typology developed in the study. Through the integration of the sociological, urban, and biophysical perspectives, it offers a deeper understanding of the benefits and co-benefits associated with urban geoengineering.

With this information, multifunctional NBS may be planned and put into practice, and stakeholders and the general public can be informed about its advantages. According to the typology, blue spaces like rivers, lakes, and canals are rated "high," whereas wetlands are classified "low" since they provide comparatively few societal purposes. Spending time with family and friends is one of the advantages of visiting freshwater blue areas that is most frequently highlighted; beaches are particularly important for play across generations.

Sustainable Cities and Society: Examining the establishment period of Blue-Green Infrastructure for urban cooling through satellite images (2023)

This paper discusses the concept of Blue-Green Infrastructure (BGI) and how it might help lower the dangers associated with heat in urban areas. It highlights how important it is to understand the Cooling Establishment Time (CET) of a BGI.

This is the period of time needed for a BGI to operate as a cooling system consistently. The study looks at the feasibility of using satellite data to estimate the CET for various BGI types in Zurich, Switzerland. The results show that remote sensing can be used to quantify the impact of a feature on land surface temperature and estimate the CET of a BGI. For BGIs with trees or climbing plants, a longer CET (seven to ten years) is required than for BGIs with grasses or artificially irrigated systems (one to three years). The type of BGI determines

the CET. By using machine learning techniques, the study's methodology can be extended to evaluate CET in a variety of weather conditions and metropolitan environments with changing urban characteristics. The study's approach can help researchers and decision-makers understand the dynamics of BGI cooling over time and strike a compromise between long-term fixes and short-term retrofits.

Environmental Management Journal (2023)

The article discusses the primary drivers of urban blue-green infrastructure (BGI) as well as the common misconception that biodiversity conservation is an intrinsic benefit rather than an essential part of planning. The authors emphasized the importance of BGI's ecological function as "stepping stones" or linear corridors for fragmented ecosystems. In this study, we examine the challenges of integrating models that support BGI planning with quantitative techniques for modelling ecological connectivity in conservation plans. With a focus on urban areas, the authors offer a paradigm that simplifies and includes regional connectivity evaluations in order to priorities BGI development projects. The framework facilitates the modelling of potential ecological corridors at a coarse regional scale and the prioritization of local-scale BGI projects.

The study demonstrates how to apply the framework to prioritize and rank various sites for BGI initiatives that help the enhancement of biodiversity in the lowlands of Switzerland. The authors emphasize how important it is to consider specific environmental conditions while developing small-scale BGI therapies in a functional manner.

Cities: Views and inclinations of city dwellers towards green infrastructure to support city adaptation to climate change challenges (2023)

Studies looking at urban people perceptions of green infrastructure in relation to the effects of climate change are rather rare. Locals'

A person's sociodemographic profile, which includes things like gender, level of education, and family structure, affects the components of their green infrastructure that they choose. Consumers' age and household demographics have an impact on the components they desire from green infrastructure as well. The sense of "breathing pure air" during heatwaves is altered for Faro residents who are becoming more aware of the effects of climate change. Factors influencing the degree of heatwave awareness among city dwellers may vary from city to city. All natural, semi-natural, and artificial networks of ecological systems within, around, and between urban areas are encompassed by the concept of "green infrastructure". Many societal and personal benefits can be obtained from green infrastructure.

Urban Forestry & Urban Greening: Urban dwellers' perceptions and preferences about green infrastructure to support cities in mitigating the effects of climate change (2023)

A systematic review of the surroundings services (ES) furnished by using inexperienced infrastructure (GI) turned into achieved by way of the have a look at using the preferred Reporting objects for Systematic opinions and Meta-Analyses (PRISMA) statement. Examining 199 studies that satisfied the eligibility requirements demonstrated the need to approach many ES concurrently and to conceptualize GI.

An intentionally constructed network of locations intended to offer various advantages. The application of multi-criteria decision analysis and geo-processing techniques resulted in the proposal of indicator systems that could account for numerous ES.

The review examined the participants' demographics and the analytical techniques used in the assessment of GI-related ES. The review's conclusions provide insight into the patterns in ES research that GI has been providing for over a decade. The review's conclusions may be helpful to policymakers, researchers, practitioners, and consultants in determining goals, methods, information gaps, joint venture possibilities, and tactics for planning and implementing GI for ES maximization.

4. CONCLUSION

By integrating considerations related to the constructed environment, blue and green frameworks possess the capability to significantly enhance the resilience and sustainability of metropolitan regions. The implementation of such frameworks can lead to a more environmentally friendly future, one that not only boosts biodiversity but also elevates living standards and mitigates the impacts of climate change. Embracing biophilic design and green infrastructure as a progressive strategy can truly transform urban landscapes.

For instance, initiatives like the Green Roof Initiative and Vertical Greening can play crucial roles in this transformation. Green roofs not only provide insulation and reduce energy costs but also contribute to storm water management and habitat creation for various species.

Similarly, vertical greening can help maximize limited space in urban areas, offering aesthetic appeal while also improving air quality. Moreover, technology integration is essential for optimally managing these initiatives. By utilizing smart technologies, cities can monitor green spaces' health, ensuring they receive the necessary resources and attention to thrive.

Additionally, exploring innovative funding models can facilitate the development and maintenance of these projects, making them more viable for municipalities and attracting private investments. Overall, the concerted application of these strategies can foster thriving, sustainable communities that are better equipped to face the challenges posed by climate change and urbanization. In doing so, metropolitan areas can enhance their livability and ecological footprint,

promoting a harmonious relationship between urban development and nature.

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