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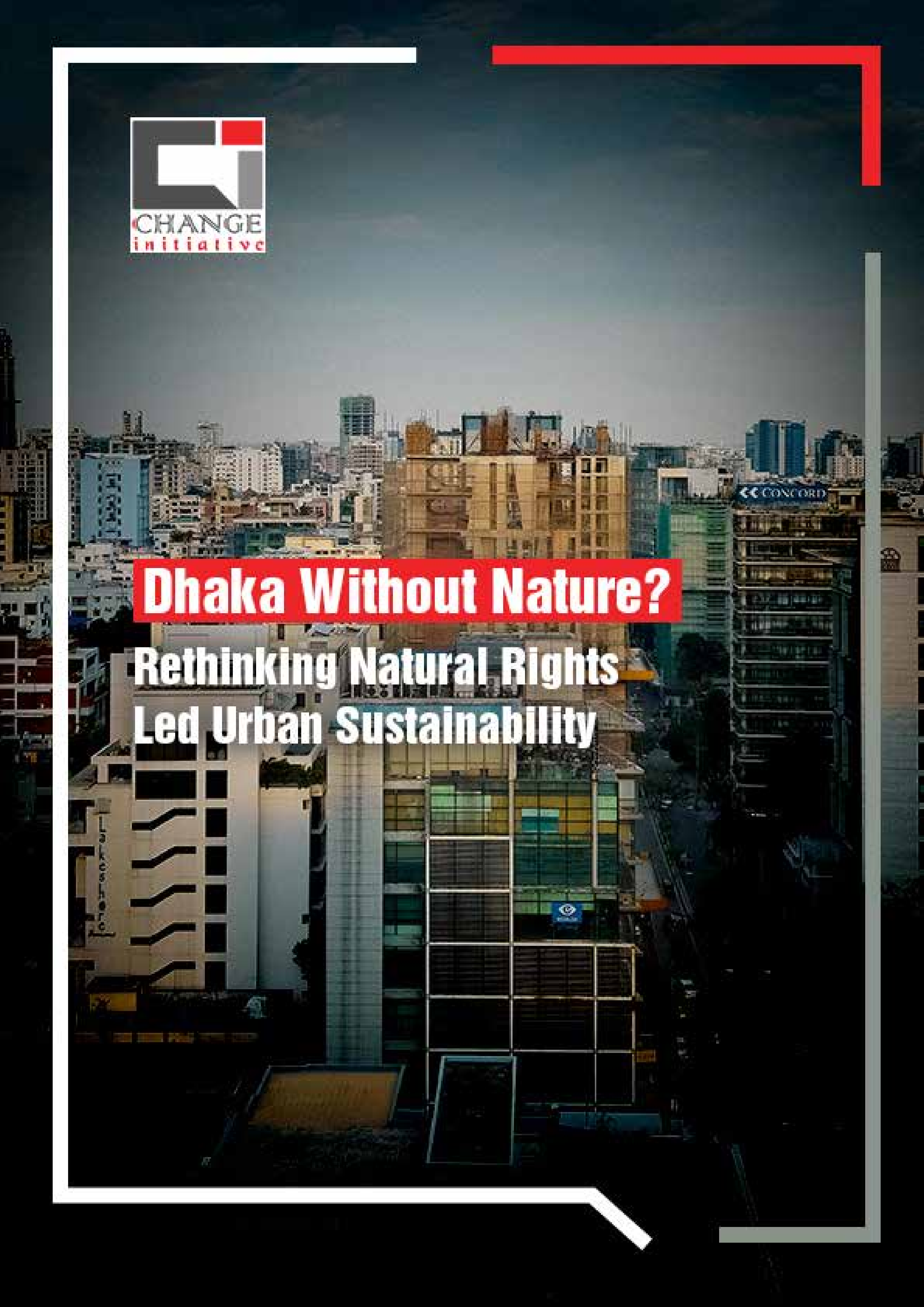

Dhaka Without Nature?

Rethinking Natural Rights Led Urban Sustainability

About Change Initiative

Change Initiative (CI) is an emerging organisation dedicated to research and evidence generation as well as pushing for innovative governance and integrity to find creative solutions and be a pioneer of change.

CI was founded with the primary goal of accelerating the establishment of a society based on equity, justice, and wellbeing.

The name 'Change Initiative' (CI) represents the goal of embarking on the journey of devising an alternative research paradigm beyond the orthodox modalities.

Dhaka Without Nature?
Rethinking Natural Rights Led Urban Sustainability

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Abbreviation

BBS	Bangladesh Bureau of Statistics
BT	Brightness Temperature
CBC	Centro Brasil no Clima
DAP	Detailed Area Plan
DNCC	Dhaka North City Corporation
DSCC	Dhaka South City Corporation
GEE	Google Earth Engine
GIS	Geographic Information System
G&A	Grass and Agricultural
km^2	Square Kilometer
LST	Land Surface Temperature
LP	Land Price
LULC	Land Use and Land Cover
MoEFCC	Ministry of Environment, Forest and Climate Change

NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NDBI	Normalized Difference Built-up Index
NRLG	Natural Rights Led Governance
PV	Proportion of Vegetation
RAJUK	Rajdhani Unnayan Kartripakkha
REHAB	Real Estate and Housing Association of Bangladesh
TOA	Top of Atmosphere
UN	United Nations
UN-Habitat	United Nations Human Settlements Programme
WHO	World Health Organization

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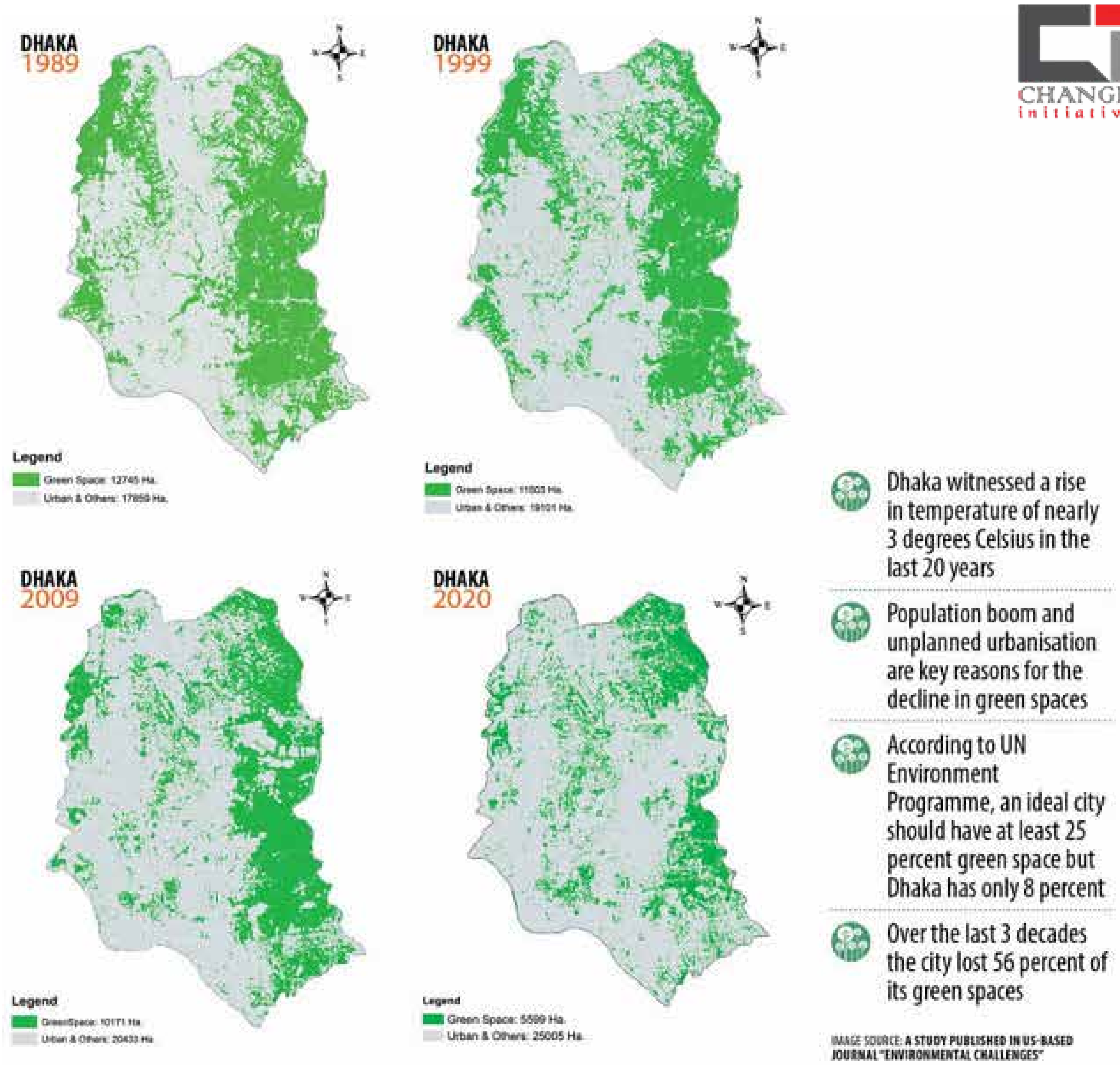


Executive Summary

Over the past four decades, Dhaka has undergone profound ecological transformation. Driven by rapid urbanization, real estate development, and the centralization of economic activities, the city's natural environment-wetlands, tree cover, and open spaces-has steadily eroded. Built-up areas have expanded aggressively, fragmenting hydrology, undermining biodiversity, and sharply increasing surface temperatures. By 2024, maximum average land surface temperature (LST) in parts of Dhaka reached 39.8°C, with low-income communities suffering the most due to poor ventilation and lack of access to green areas.

This study offers a natural rights-based ecological audit of Dhaka from 1980 to 2024, using satellite imagery, GIS-based land use and land cover (LULC) analysis, and LST mapping. The analysis reveals a disturbing trajectory-one where urban growth consistently violates the rights of nature. The study is grounded in the Natural Rights framework, which asserts that nature is not merely a resource but a living entity with the right to exist, flourish, and regenerate. It argues that Dhaka's development, as currently pursued, is both environmentally unsustainable and ethically flawed.

1. Methodology

The study adopts a mixed-methods approach. Landsat satellite imagery (1980–2024) was analyzed using Google Earth Engine, classifying land into five categories: waterbodies, tree cover, grass/agriculture land, barren land, and built-up areas. A directional analysis traced the spatial growth of the city. LST data for 1990 and 2024 was derived through thermal band processing. ArcGIS was used for spatial mapping. Combined, these tools provide a disaggregated, temporal view of urban ecological decline.

State of Nature (Land Use Change): 1980–2024

Class	Waterbody		Tree cover		Grass & Agriculture		Vacant land		Built-up Area	
Year	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%
1980	37.3	12.3	65.7	21.6	168.8	55.4	11.7	3.8	20.7	6.8
1990	24.1	7.9	49.9	16.4	178.3	58.5	16.5	5.4	35.8	11.8
2000	16.8	5.5	47.1	15.5	152.1	50	18.1	5.9	70.2	23.1
2010	19.3	6.3	41.9	13.8	111.3	36.6	26.2	8.6	105.7	34.7
2020	20.1	6.6	37.5	12.3	76.6	25.2	39.3	12.9	130.6	42.9
2024	14.7	4.8	35.3	11.6	74.4	24.4	31.1	10.2	148.8	48.9

Table: Land Use change Estimation of Dhaka Mega Urban

Dhaka's built-up area expanded from 20.7 km^2 (6.8% of total land area) in 1980 to 148.8 km^2 (48.9% of total land area) by 2024. This growth has come at a significant ecological cost:
• Grass/agricultural land declined from 168.8 km^2 to 74.4 km^2 (total 56%)
• Tree cover reduced from 65.7 km^2 to 35.3 km^2 (around 50%).
• Waterbodies shrank from 37.3 km^2 to just 14.7 km^2 (61%).

In Dhaka North City Corporation (DNCC):

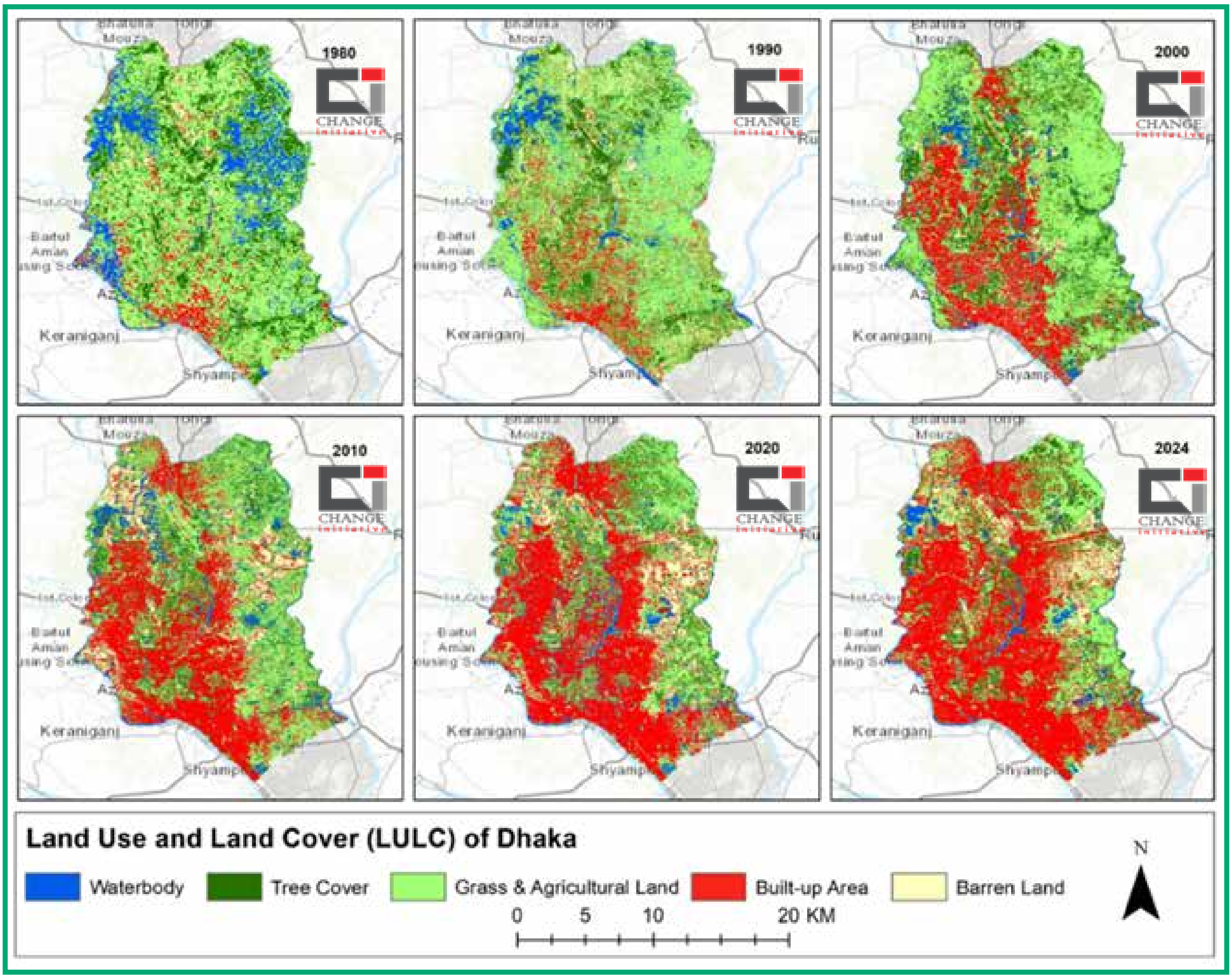
• Built-up area rose from 9.1 to 93.2 km^2.
• Grass/agriculture decreased from 108.4 to 51.2 km^2.
• Tree cover dropped from 45.8 to 25.0 km^2.
• Waterbodies fell from 32.7 to 10.6 km^2.

In Dhaka South City Corporation (DSCC):

• Built-up area grew from 11.7 to 55.6 km^2.
• Grass/agriculture fell from 60.3 to 23.2 km^2.
• Tree cover declined from 19.9 to 10.3 km^2.
• Waterbodies remained nearly static, at around 4.1 km^2.

Tree loss was most severe in the southeast and northeast. In DNCC, thanas like Adabar (0.02 m^2), Rampura (0.38 m^2), and Kafrul (0.39 m^2) fall drastically below the WHO standard of 9 m^2 of green space per person. Only a few thanas, such as Bimanbandar (77.8 m^2) and Uttarkhan (44.8 m^2), meet or exceed it. Similarly, in DSCC, many areas such as Bangshal, Wari, and Sutrapur offer less than 0.5 m^2 of green space per capita.

Waterbody access also remains far below the required benchmark of 4.5 m^2 per person in most thanas. DNCC, in particular, experienced steep waterbody loss in its east and west zones. DNCC has 1.79 m^2 per person and DSCC has 0.97 m^2 per person waterbody.



Land Surface Temperature (LST) Trends

The thermal impact of ecological loss is stark:
• In 1990, 56.3% of Dhaka had standard-range LST (26–30°C); by 2024, this dropped to 21.7%.
• Areas above 30°C grew from 5.3% in 1990 to 78.3% in 2024.
• By 2024, no part of the city remained below 26°C.

DNCC:

From 2000 to 2024, the share of land above 30°C grew from 2.9% to 79.2%, while below-standard zones (cooler areas) disappeared completely.

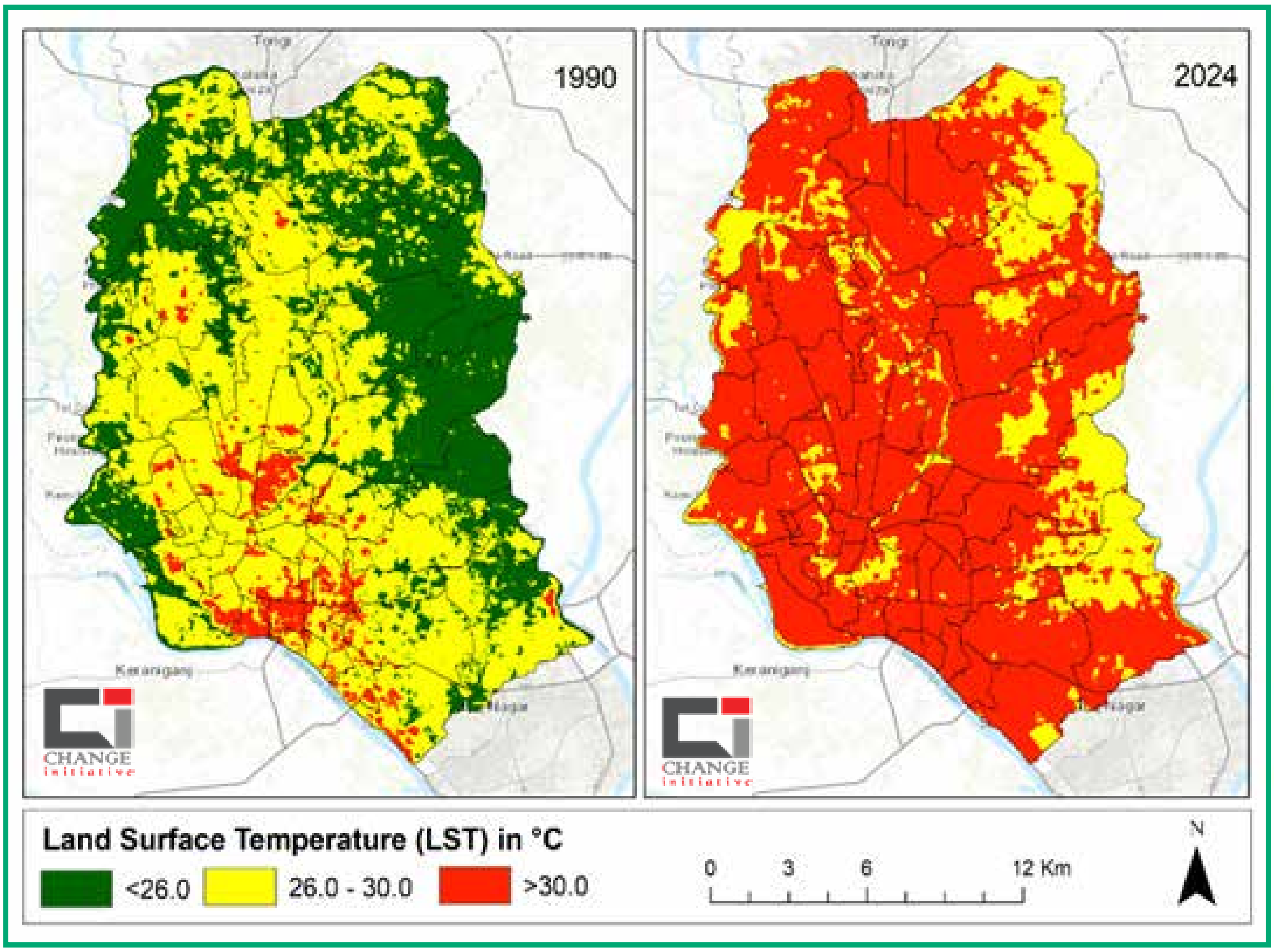
DSCC:

The pattern is similar-an 80% share of the city now suffers from excessive surface heat, particularly in high-density localities with limited green space.

Heat vs. Land Use: A Thana-Level Analysis

Thanas with high built-up density and low vegetation record the highest LST. For example:

• Tejgaon Shilpa Elaka: 63.91% built-up, 9.69% tree cover, 33.08°C LST.
• Rampura and Darussalam: Both exceed 32°C LST with very low tree coverage.



In contrast, greener areas show cooler temperatures:

- Uttarkhan: 27.92% tree cover, 10.45% built-up, LST of 29.80°C.
- Shah Ali and Cantonment: LSTs between 30.5°C and 31.1°C.

DSCC shows a more severe heat profile. Shyampur and Hazaribag-with 88.8% and 82.3% built-up area respectively-have LSTs well above 32.7°C. Thanas with better vegetation (e.g. Demra, Khilgaon, Shahbag) record lower LSTs of around 30–30.5°C.

Discussion and Recommendations

Dhaka's unchecked urbanization has triggered serious ecological degradation, particularly in DSCC where tree cover and per capita green space are alarmingly low. The urban heat island effect, driven by loss of vegetation and spread of impervious surfaces, has made much of the city thermally unsafe. If Dhaka achieves the minimum ecological standards of 9 m2 of tree cover and 4.5 m2 of waterbody area per capita, the city could experience an average reduction in land surface temperature (LST) of approximately 1.01°C.

Parks like Ramna and Shahbag demonstrate the cooling benefits of green infrastructure-temperatures drop by 2–3.5°C inside these spaces. But such areas are rare and unevenly distributed. The degradation of waterbodies, pollution of canals, and rampant land filling continue unchecked due to weak governance and institutional fragmentation. Agencies like RAJUK and REHAB have prioritized commercial expansion over ecological safety, while coordination among DNCC, DSCC, MoEFCC, and others remains inadequate.

To reverse this trajectory, the report recommends:

Actions	Concerned Stakeholders
0–3 Years (Short-Term)	
1. Following the Recent Judgement of International Court of Justice legislate Nature's Rights in Bangladesh.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
2. Ban filling of natural forest, canals, ponds, and wetlands and declare such actions as Crime Against Nature	
3. Reform the Detailed Area Plan (DAP) with clear ecological buffers; and declare Urban Ecologically Critical Zones; legally restrict Floor Area Ratio (FAR) in eco-sensitive zones.	
4. Form Community Stewardship (guardianship) Model to Protect Natural Resources	
5. Enact mandatory green zoning and eco-compensation; Embed equity metrics into DAP and zoning laws.	
6. Implement tree census, ecological audit, afforestation zones, green rooftop laws.	
7. Restore 31.2 km² of waterbodies.	MoWR, DNCC, DSCC
8. Impose at least 5 times higher Holding Tax for Concrete Structures compare to the same for Nature Friendly Structures	DNCC, DSCC
3+ Years (Medium to Long-Term)	
1. Prioritize low-income and high-density areas for nature protection related bio-investment.	MoEFCC, MoLGRD, MoF, DNCC, DSCC
2. Plant 56.5 km² of trees, targeting ecologically deprived zones.	DoForest, DNCC, DSCC, DCCI, Community
3. Greening and wetland restoration can lower temperatures by ~1°C.	
4. Reintroduce buffer zones and community water stewardship programs	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC, Private Sectors
5. Prioritize heat-vulnerable zones and water stressed Thanas in climate adaptation.	
6. Digital System Based Natural Accountability of All Stakeholders.	

The report clearly links Dhaka's ecological collapse to poor land use decisions and absence of nature in urban planning. As the green spaces disappear, urban heat rises, and vulnerable populations are left exposed to compounding risks. The disparity between DNCC and DSCC highlights environmental injustice across the city.

Without urgent reforms-both technical and institutional-Dhaka risks becoming unlivable for millions. A rights-based ecological framework can offer a new path forward: one that treats nature not as a passive backdrop to development, but as a co-equal entity deserving of protection, restoration, and respect.

Introduction

1.1.1 Background

Dhaka, the capital of Bangladesh, has witnessed a significant transformation in its ecological landscape over the past four decades. Driven by demographic pressure, real estate expansion, and centralized economic activities, the city's natural elements such as wetlands, tree cover, and open spaces have rapidly declined (Dewan & Yamaguchi, 2009; Ahmed & Ahmed, 2012; Rahman & Zhang, 2018). Unplanned urbanization has reshaped the city's land surface, replacing natural land cover with built-up structures that disrupt water flow and balance, increase atmospheric temperatures, and degrade biodiversity.

Between 1993 and 2020, Dhaka's built-up area increased by 67%, largely at the expense of wetlands (-55%), vegetation (-47%), bare soil (-33%), and water bodies (-23%) (Imran et al., 2021). A temporal analysis by Ahmed et al. (2013) using satellite imagery from 1989, 1999, and 2009 confirmed this trend that vegetated areas declined from 36.9% to 18.1%, while water bodies dropped from 10.7% to 6.1%, and built-up areas surged from 25.1% to 44.2%. This ecological shift is not merely spatial but thermal. Studies show that built-up areas, due to their impervious surfaces, trap and re-emit solar heat, significantly increasing land surface temperatures (LST), with heat accumulation persisting into the night (Argueso et al., 2013; Imran et al., 2018, 2019a; Jacobs et al., 2018).

These temperature surges are directly linked to the loss of ecological surfaces. Vegetation and water bodies regulate microclimates by controlling evapotranspiration and humidity (Purwanto et al., 2016; Ibrahim, 2017). Ideally, urban LST should range between 26-30°C for human comfort, yet by 2020, Dhaka's LST peaked at 44.6°C with an average annual increase of 0.24°C (Imran et al., 2021). If current trends persist, more than 87% of Dhaka may experience temperatures above 30°C by 2029 (Ahmed et al., 2013).

The degradation is spatially uneven. Following administrative bifurcation in 2011, the Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC) display divergent ecological patterns. DSCC, the denser historical core, had 78.34% built-up area by 2020, while vegetation and water bodies shrunk to 7.36% and 3.56%, respectively (Hafiz et al., 2022). This imbalance is accompanied by alarming LST levels in DSCC, often exceeding 34°C (Imran et al., 2021). In contrast, DNCC retained relatively more green and blue space e.g. 66.59% built-up area, 20.16% vegetation, and 5.35% water bodies in the same period (Hafiz et al., 2022). Yet, DNCC too faces encroachment risks, especially in Uttara, Gulshan, and Mirpur, where construction pressure is surging (Hossain et al., 2023).

Areas like Motijheel, Kotwali, and Sutrapur in DSCC have lost over 90% of their green and aquatic coverage. These localities now record LSTs above 34°C and offer less than 2% vegetation cover conditions that aggravate heat stress, particularly for low-income groups residing in poorly ventilated environments (Imran et al., 2021). In contrast, northern thanas like Uttara or Mirpur retain relatively better green patches but face rapid ecological loss due to infrastructural expansion (Hafiz et al., 2022).

Ecological benchmarks show how far Dhaka has deviated from sustainable urban norms. The World Health Organization (WHO) recommends 25 m² of urban green space per capita for a megacity, yet Dhaka offers just 1.5–2 m² (WHO, 2016). Waterbody coverage ideally should be 12-15% of city area, yet in central Dhaka it has fallen to only ~5% (Toufiq, 2019). Built-up areas are considered manageable below 50% for urban health, but several wards in Dhaka already exceed 60-85% (Ahmed et al., 2013). This systemic overshoot in urban development has destabilized Dhaka's climate and undermined thermal comfort.

Urbanization has long been framed as a symbol of progress, but it often comes at the silent expense of nature. As concrete spreads and cities swell, we tend to focus narrowly on economic growth, infrastructure, and expansion, rarely pausing to ask: can cities survive without nature? The answer lies in the imbalance we are creating. While nature nurtures us, we are degrading its core elements e.g. trees, rivers, soils, and biodiversity without considering their right to exist. This neglect is not just environmental; it is moral. The urban futures we are building are eroding the ecological foundations that sustain them. Wetlands are cleared for roads, air and water bodies are polluted for industrial growth, and green belts vanish in the name of "development." Each of these acts constitutes an injustice against nature (Khan, 2024).

"Natural Rights" for Nature affirm that nature is not a property to be possessed, managed, or exploited by humans but is a living entity with intrinsic worth and dignity. These rights assert that all components of the natural world e.g. rivers, forests, mountains, air, water, and biodiversity have the inherent right to exist, flourish, regenerate, and evolve.

This study builds upon four foundational pillars of the Natural Rights: Life or Self-dignity of Lives and Nature; Liberty or Freedom; Social Harmony & Justice; Indigenous Knowledge & Culture(khan,2025). These principles form a framework for imagining cities not as antagonists to nature, but as spaces of mutual coexistence.

Through satellite imagery, land use analysis, and LST mapping, this study presents a high-resolution assessment of Dhaka's ecological transition from 1980 to 2024. It also examines spatial inequality in nature access across thanas (administrative units), focusing on the dual city structure of DNCC and DSCC. By doing so, it not only tracks environmental degradation but redefines urban sustainability through a rights-based ecological lens. Urban development, if it is to be sustainable, must integrate legal recognition, moral reasoning, and environmental accountability, because nature is the very foundation to human life

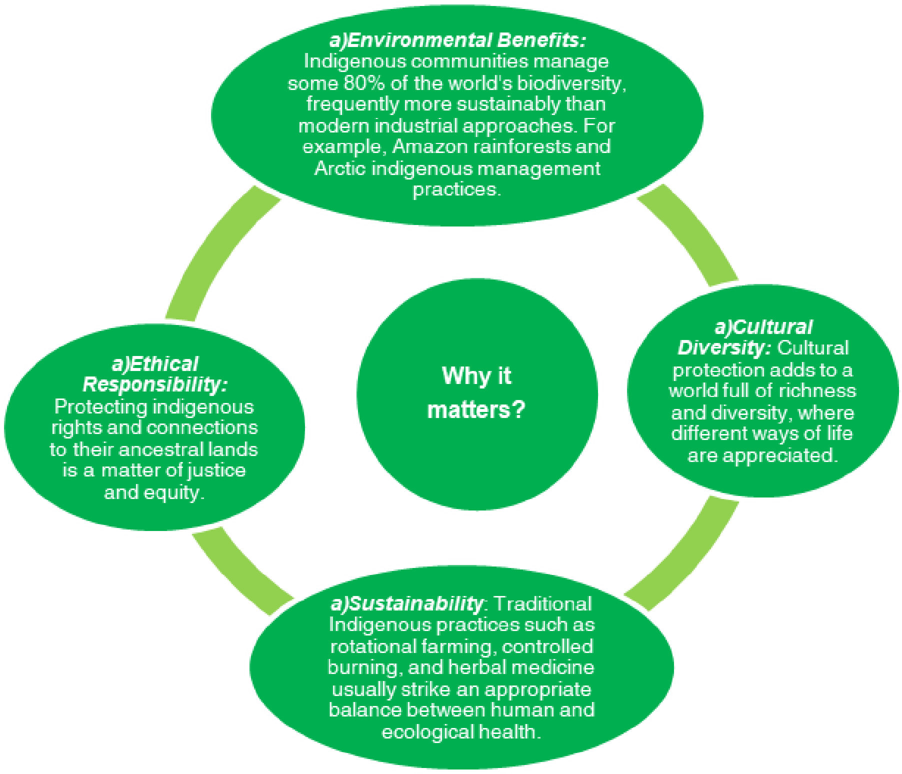


Figure 1: Benefits and Contributions of Protecting Natural Resources, Indigenous Knowledge, and Culture

1.1.2 Rationale

Dhaka, one of the fastest urbanizing cities in the Global South, continues to experience rapid expansion in population, infrastructure, and built-up area. This accelerated transformation has come at a considerable cost to nature wetlands filled, green areas razed, waterbodies fragmented, and biodiversity displaced. Yet amid this growth, a fundamental question remains overlooked: Is Dhaka's urban development respecting nature's rights, or is it contributing to a deeper structural denial of those rights?

The ecological condition of Dhaka presents a compelling case of cumulative violations of the foundational natural rights outlined in the framework namely, the right of nature to exist, the liberty or freedom of ecological systems, the principle of social harmony and justice, and the protection of indigenous knowledge and culture. The right of nature to exist has been systematically undermined by unchecked urban expansion: data from the Center for Environmental and Geographic Information Services (CEGIS) reveal that approximately 75% of Dhaka's wetlands have been lost between 1989 and 2014, while vegetative cover has declined to below 10% of the metropolitan area, as confirmed by longitudinal satellite imagery. The liberty of nature understood as the autonomous functioning of ecosystems has been curtailed by widespread encroachments and artificial alterations to natural flows; 65 of the city's 95 canals have either been encroached upon or rendered non-functional (IWM, 2019), while rivers such as the Buriganga and Turag exhibit critically high pollution levels and obstructed flow regimes. The principle of social harmony and justice is compromised by deep spatial inequalities in environmental access and risk exposure: low-income settlements face disproportionately higher exposure to urban heat and flooding, with per capita green space well below 0.5 m^2, compared to over 5 m^2 in affluent zones (BUET, 2021). Moreover, indigenous knowledge systems and cultural practices historically embedded in wetland stewardship, urban agriculture, and communal land management have been excluded from formal planning processes, leading to the erosion of community-based ecological governance (BIP, 2020).

This study frames the current ecological condition of Dhaka through the lens of Natural Rights , which recognizes that "nature is not an object. It is a living subject and the basis of life on Earth"(Khan,2025). This research does not limit itself to technical analysis of land use change or environmental indicators; it seeks to uncover whether the city's development trajectory upholds or violates nature's right to exist, regenerate, and flourish.

The assessment is guided by four foundational pillars of natural rights as articulated in the pillars of Natural Rights:

• Life or Self-dignity of Lives and Nature:
"Every component of nature has the right to live with dignity. Nature is not an object. It is a living subject and the basis of life on Earth. The right of nature to life means the protection of the biological and physical integrity of nature."

• Liberty or Freedom:
"The right to freedom guarantees that nature can perform its natural and ecological functions free from exploitation, abuse, and destruction. It affirms that nature should not be subjected to forced degradation."

• Social Harmony and Justice:
"This right recognizes that nature and its components are entitled to a balanced coexistence with humans. Social harmony includes inclusion, accountability, and justice, where nature has access to justice mechanisms and institutional protection."

• Indigenous Knowledge and Culture:
"Nature is inseparable from the traditional knowledge systems, culture, and livelihoods of Indigenous and local communities. The right affirms the role of these communities in conserving, restoring, and governing natural ecosystems."

This study investigates to what extent these four pillars have been respected or violated across Dhaka's urban landscape. It reveals how specific areas of the country, particularly within DNCC and DSCC have undermined the pillars of life, liberty, justice, and cultural continuity through ecological degradation and spatial exclusion.

The rationale for this study, therefore, is to provide evidence on whether Dhaka's urban trajectory is compatible with nature's right to exist, regenerate, and thrive. It calls for a rethinking of urban development, not just as a question of sustainability, but as one of justice.

1.1.3 Research Question

Based on the objectives and identified gaps, the study addresses the following research questions:

1. How has land use changed in Dhaka City- from 1980 to 2024, particularly within the administrative boundaries of DNCC and DSCC?

2. What is the relationship between tree cover and LST at the Thana wise in DNCC and DSCC, and how does this relationship vary across the city?

3. How much can temperature drop if Dhaka meets the benchmarks?

4. From the perspective of natural rights, what is the current state of Dhaka city's ecological condition? To what extent have the four pillars been violated?

Based on these findings, what are the necessary pathways and institutional responses for restoring a balanced human–nature relationship?

1.1.4 Objectives

This study aims to understand how land use in Dhaka has changed over time, especially from 1980 to 2024. It looks closely at green areas, tree health, and how heat is affecting different parts of the city, with a focus on DNCC and DSCC to.

1. Find out how land use has changed in different directions and areas across Dhaka, especially in DNCC and DSCC, between 1980 and 2024.

2. Examine how different land use influences local temperature patterns at the Thana wise, with special attention to both DNCC and DSCC areas.

3. Assess how meeting green and blue space standards can help reduce temperature in Dhaka City.

4. Assess the current ecological condition of Dhaka city through the Natural Rights framework. Identifying the degree to which these principles have been violated across the urban landscape and proposing actionable directions for restoring a balanced, rights-respecting relationship between nature and urban development.

1.1.5 Scope and Limitations

This study examines the current state of Dhaka City through the lens of natural rights, focusing on the right of nature to exist. Using satellite imagery, GIS-based land use classification, and LST analysis, the study quantifies urban ecological decline and estimates the required extent of tree plantation and waterbody restoration necessary to reduce city-wise temperature by 0.5°C and 1°C. It investigates the spatial inequality of nature access and thermal stress across thanas and the impacts of environmental amenities in property price and identifies the nature-based solutions required to re-balance the urban environment.

The fundamental limitation of this study is that it focuses solely on the state of natural elements such as vegetation, waterbodies, and land cover but does not include an assessment of air quality or atmospheric conditions. The state of air, a crucial environmental component, has not been covered in this phase. To address this gap, future research could incorporate a comprehensive air quality analysis to provide a more holistic understanding of urban environmental health in Dhaka.Despite these limitations, the study provides a comprehensive spatial assessment of Dhaka’s land use trends over four decades.

2. Methodology

This study employs a mixed-methods approach, combining spatial analysis with policy evaluation. The journey begins with satellite imagery analysis from 1980 to 2024, using GIS to examine land use changes in DNCC and DSCC. LST data is used to assess the thermal impacts of these changes, while estimates of tree planting and waterbody restoration are made to determine temperature reductions. Together, these methods provide a comprehensive framework for assessing Dhaka's urban transformation from a natural rights perspective. To assess the land use changes this study divided the area into five categories, this are:

Table 1: Land Use categories of Study Area

Land Use Class	Land/Features Covered	Standard Value Consideration	Standard Unit / Description	Source
Tree Cover	Street trees, park trees, institutional gardens, urban forest patches	≥ 9 m² per capita	Minimum Tree Cover per person	WHO, 2010
Built-up Area	Buildings, roads, flyovers, rooftops, pavements, commercial zones, residential blocks, transport terminals	≤ 50%	Maximum percentage of total land area	RAJUK
Waterbody	Wetlands, ponds, lakes, rivers, canals	≥ 4.5 m² per capita	Minimum blue space per person	Toufiq, 2019
Grass / Agricultural Land	Grasslands, crop fields, farmlands, fallow agricultural land, playing fields, open green spaces	Trend Analysis		
Vacant/Barren Land	Empty plots, construction sites, partially developed land			

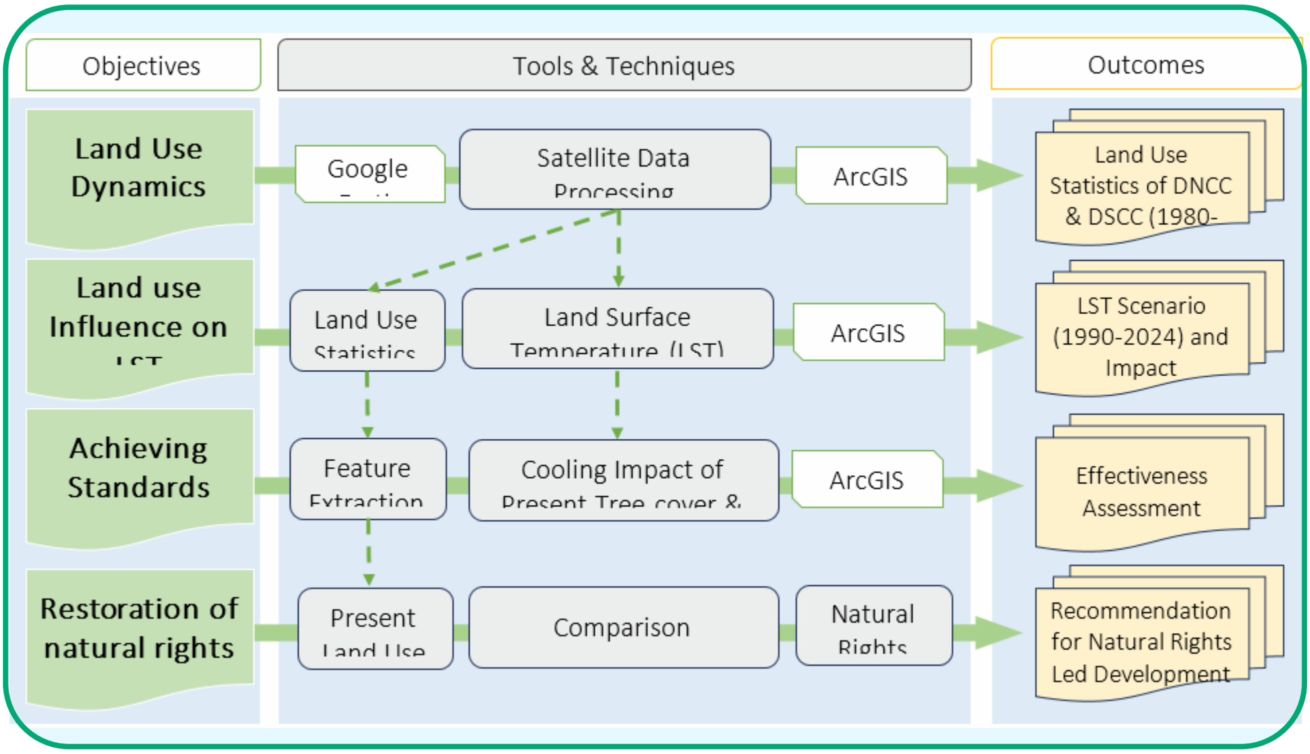


Figure 2: Methodological Flowchart

2.1.1 Study Area

Dhaka City has been selected as the study area due to its critical importance as one of the fastest-growing megacities, where rapid urbanization has resulted in significant land use transformations and related environmental impacts. The city is located in latitude 23°42′ N and longitude 90° 22′ E and the Buriganga, Shitalakshya, Turag, Balu, and Tongi Khal rivers round the city. Dhaka City is administratively divided into two major municipal zones: DSCC and DNCC. Under DSCC, there are 24 thanas: Bangshal, Chakbazar, Demra, Dhanmondi, Gendaria, Hazaribag, Jatrabari, Kadamtali, Kalabagan, Kamrangichar, Khilgaon, Kotwali, Lalbag, Motijheel, Mugda, New Market, Paltan, Ramna, Sabujbag, Shahbag, Shahjahanpur, Shyampur, Sutrapur, and Wari. These areas primarily cover the historic core and older urban fabric of the city, marked by high-density settlements and limited open space. DNCC comprises 26 thanas: Adabar, Badda, Banani, Bhasantek, Bhatara, Bimanbandar, Cantonment, Dakkhinkhan, Darussalam, Gulshan, Hatirjheel, Kafrul, Khilkhet, Mirpur, Mohammadpur, Pallabi, Rampura, Rupnagar, Shah Ali, Tejgaon, Tejgaon Shilpa Elaka, Turag, Uttara Pashchim, Uttara Purba, Uttarkhan, and Shere Bangla Nagar.

According to the United Nations (UN), Dhaka city is located on roughly 30,504.3 hectares and has 19.58 million residents in 2018 (UN, 2019). The city's central and southern areas are densely populated, while the city's outskirts are covered in lowlands (Imran et al., 2021).

Dhaka's demographic expansion underpins much of this transformation. Between 2011 and 2022, the city's population grew from 6.97 million to 10.28 million, with an annual growth rate of 3.6 percent (BBS, 2022). DNCC had 5.98 million people over 197 km² (around 30,500 persons/km²), while DSCC had 4.3 million across 109 km² (39,400 persons/km²), making both among the most densely populated zones in the country (BBS, 2022; UN DESA, 2019). The broader Dhaka metropolitan region reached 19.58 million in 2018 and is projected to exceed 25 million by 2025. This concentration of people, buildings, and traffic has overwhelmed ecological buffers, such as wildlife and wetlands, and intensified surface temperature anomalies across both city corporations (BBS, 2022; Imran et al., 2021).Long-term data indicate worsening climate and environmental conditions in Dhaka. From 1981–2015, mean temperatures increased by 0.013°C/year (Khatun et al., 2017). Rainfall patterns remain mixed, as some studies report declines in monsoon rainfall, while others note modest annual increases and rising humidity. Extreme heat events have intensified, with Dhaka recording its highest temperature in decades (40.6°C in 2023) and a 42% increase in dangerous wet-bulb temperature days between 2020–2024 compared to the previous decade (Reuters, 2024). Additionally, Dhaka witnessed a 42% increase in wet-bulb temperature days above 30.5°C from 2020–2024 compared to the 2005–2009 baseline (Reuters, 2024).

Migration trends further aggravate the city's ecological vulnerabilities. Dhaka receives over 500,000 new migrants annually, largely from climate-vulnerable districts such as Bhola, Barisal, and Noakhali. The drivers of this rural-to-urban migration include river erosion, salinity intrusion, loss of livelihood, and absence of rural safety nets. Approximately 60–63% of Dhaka's annual population growth is attributable to internal migration, fueling the expansion of densely packed informal settlements with minimal vegetation. The internal migration rate rose from 24.7 per 1,000 in 2021 to 30.8 in 2022, with urban-bound migration growing 2.5 times faster than rural-bound flows. These pressures have direct implications for green space allocation, surface temperature variations, and long-term urban resilience—all central to this study.

2.1.2 Data Sources

Table 2: Data Sources

Data Type	Satellite/Source	Dataset Name	Year(s)	Purpose
Satellite Imagery	Landsat-2	LANDSAT/LM02/C02/T2	1980	Land Use classification and historical feature extraction
	Landsat-5	LANDSAT/LT05/C02/T1_TOA	1990, 2000, 2010	Temporal land use analysis and extraction of urban features
	Landsat-8	LANDSAT/LC08/C02/T2_TOA	2020	Land Use mapping and surface temperature estimation
Park Area Shapefile	Google Earth Pro	Digitized Park and Green Area Map	2024	Feature extraction of urban green spaces
Population Data	Bangladesh Bureau of Statistics (BBS)	Population Statistics	2022	Spatial population analysis and per capita green space estimation

2.1.3 Land Use Change and Urban Growth Dynamics Assessment in Dhaka (1980–2024)

Land Use changes and urban growth in Dhaka from 1980 to 2024 were assessed using satellite imagery and geospatial analysis. Landsat data from MSS (Multispectral Scanner System), TM(Thematic Mapper), OLI(Operational Land Imager)/TIRS(Thermal Infrared Sensor), and OLI-2(Operational Land Imager Sensor-2)/TIRS-2(Thermal Infrared Sensor-2) sensors were processed in Google Earth Engine (GEE), with annual median composites used to ensure cloud-free analysis. Supervised classification using the Random Forest algorithm categorized land into five classes: waterbodies, tree cover, grass/agriculture, vacant land, and built-up areas. Training data were derived from ground-truth points and high-resolution imagery. Classification accuracy ranged from 89.24% to 97.21%, confirming the reliability of results.

Table 3: Accuracy assessment

Table 3: Accuracy Assessment

Year	Overall Accuracy
1980	92.23%
1990	89.24%
2000	94.76%
2010	97.21%
2020	94.54%
2024	97.21%

To examine the spatial directionality of urban expansion, eight directional sectors (North, Northeast, East, Southeast, South, Southwest, West, Northwest) were defined and intersected with classified built-up polygons from 1980, 2001, 2014, and 2024. Area calculations within these zones identified direction-specific growth trends. Results were visualized using radar charts to illustrate spatiotemporal dynamics and directional shifts in urban development across Dhaka over the 44-year period.

2.1.4 Land Surface Temperature (LST) Assessment

In this study, LST for 1990 and 2024 was estimated using Landsat 5 TM and Landsat 8 OLI/TIRS data via GEE. Cloud-free images were filtered to create annual median composites, and mean LST values were calculated.

LST was derived in four steps: (1) TOA (Top of Atmosphere) radiance conversion, (2) Brightness Temperature calculation, (3) surface emissivity estimation using NDVI. (Normalized Difference Vegetation Index), and (4) final LST computation with emissivity correction. Final maps were prepared in ArcGIS 10.8.

Step 1: TOA Radiance Calculation

For Landsat 5 TM (Band 6), TOA spectral radiance was calculated using the radiometric rescaling formula:

$$L_\lambda = \left(\frac{L_{MAX} - L_{MIN}}{QCAL_{MAX} - QCAL_{MIN}}\right) \times (QCAL - QCAL_{MIN}) + L_M$$

Where:

- $L\lambda$ = TOA spectral radiance ($W \cdot m^{-2} \cdot sr^{-1} \cdot \mu m^{-1}$)
- QCAL = Quantized calibrated pixel value (DN)
- L MAX and L MIN = Spectral radiance scales (sensor-specific)
- QCAL MAX=255, QCAL MAX =1

For Landsat 8 (Band 10), TOA radiance was computed using:

$L\lambda = ML \times QCAL + AL$ (2)

Where,

$L\lambda$ = TOA spectral radiance

ML, AL= Band-specific multiplicative and additive factors

QCAL = Pixel digital number (DN)

Step 2: Brightness Temperature (BT)

Brightness Temperature (BT) was derived from the TOA radiance using the inverse Planck function:

$$T_B = \frac{K_2}{\ln(\frac{K_1}{L_\lambda} + 1)} \tag{3}$$

Thermal constants used:
Landsat 5: K1=607.76, K2 =1260.56
Landsat 8: K1 =774.89, K2 =1321.08

Step 3: Surface Emissivity Estimation

Surface emissivity (ε) was estimated using the NDVI-based proportion of vegetation (Pv) method:

Ɛ=0.04×P_v+0.986 (4)

$$P_v = \left[\frac{NDVI - NDVI_{min}}{NDVI - NDVI_{\max})}\right]^2 \tag{5}$$

NDVI was calculated from the red and near-infrared (NIR) bands of the respective sensors.

Step 4: Land Surface Temperature Calculation

Finally, LST was computed by incorporating surface emissivity into the BT values using the following equation:

$$LST = \frac{T_B}{1 + \left(\frac{\lambda - T_B}{\alpha}\right) \ln \mathcal{E}} \tag{6}$$

Where,

λ=central wavelength of the thermal band (11.5 µm for Landsat 5, 10.8 µm for Landsat 8)
α=1.438×10-2 m•K

The resulting LST was then converted to Celsius by subtracting 273.15.

$$LST_{(\bullet C)} = LST_K - 273.15 \tag{7}$$

The final output was exported as raster for layout design and presentation in ArcGIS 10.8.

2.1.5 Urban parks cooling benefit assessment

To assess the cooling benefits of urban parks and water bodies, LST imagery for 2024 was used. The LST image, processed in GEE, was exported to ArcGIS 10.8 for spatial analysis. Two transect lines were manually drawn in ArcGIS: one across a prominent urban green space (park) and another across an area combining vegetation and water bodies (e.g., lakes or ponds).

2.1.6 Estimation of Required Green and Blue Cover

This analysis estimates how much the average LST across Dhaka's urban core could be reduced by meeting internationally recognized standards for urban greenery and waterbody distribution, tailored to local demographic and spatial characteristics.

Tree Cover Benchmark:

Following the WHO recommendation of 9 m^2 of green space per person, and Dhaka's population of 10.2 million in 2022, within the 304.5 km^2 core city, the required tree-covered area is:
Minimum required green space = 10.2 million × 9 m^2 = 91.8 km^2
Current tree cover is only 35.3 km^2, so the required increase = 91.8 – 35.3 = 56.5 km^2

Waterbody Benchmark:

Urban cooling literature and sustainable planning practice (e.g., UNHabitat, Asian Cities Climate Resilience reports) recommend 15–20% of land area as waterbody in hot cities for effective thermal regulation.
Target waterbody area (15–20% of 304.5 km^2) = 45.7 to 60.9 km^2

Current waterbody area = 14.7 km^2
Required increase = +31 to +46.2 km^2
Total Population: 10.2 million
Benchmark: 4.5 m^2 waterbody per person
Target Waterbody Area
= 10.2 million × 4.5 m^2
= 45.9 km^2
Current Waterbody Area = 14.7 km^2
Required Increase = 45.9 – 14.7 = +31.2 km^2
Cooling Coefficients from Local and Global Studies:

Based on the operational LST analysis and previous satellite-based classification:

Tree cover contributes ~0.15°C cooling per 18.6% (35.3 km^2 over 304.5 km^2)
→ ~0.008°C cooling per km^2 of tree cover
Waterbody contributes ~0.13°C cooling per 4.8% (14.7 km^2 over 304.5 km^2)
→ ~0.018°C cooling per km^2 of waterbody
These coefficients are broadly consistent with global studies (Weng et al., 2004; Cao et al., 2010) that estimate:
0.3–0.6°C cooling for every 10% vegetation increase in dense urban zones
0.6–1.1°C cooling from waterbodies within local influence zones (~200–500m radius)

3. Results and Findings

3.1.1 Historical Trends in Land Use (1980–2024)

The land transformation in Dhaka City over the 44-year period from 1980 to 2024 reveals a dramatic shift from a predominantly natural and agricultural landscape to a highly urbanized and built-up environment. Each land cover class has undergone notable changes that reflect broader socio-economic and environmental trends shaping the megacity's growth.

3.1.2 Land Use Trends of Dhaka Metropolitan Area (DMA)

Between 1980 and 2024, DMA saw a dramaticsharp increase in built-up areas, from 20.7 square kilometers (6.8%) in 1980 to 148.8 square kilometers (48.9%) by 2024. This almost seven-fold rise reflects rapid urbanization driven by population growth, migration, economic expansion, and large-scale infrastructure projects

Grassland and agricultural land experienced the most significant decline, shrinking from 168.8 sq.km (55.4%) in 1980 to 74.4 sq.km (24.4%) by 2024, indicating a loss of over 94 sq.km. Tree covers also decreased from 65.7 sq.km (21.6%) in 1980 to 35.3 sq.km (11.6%) in 2024. Water bodies, including lakes, rivers, and wetlands, reduced by 60.6%, from 37.3 sq.km (12.3%) in 1980 to 14.7 sq.km (4.8%) in 2024.

To better understand the spatial variation of these trends across the city, the following analysis divides Dhaka into DNCC and DSCC, presenting detailed land use patterns through mapped comparisons.

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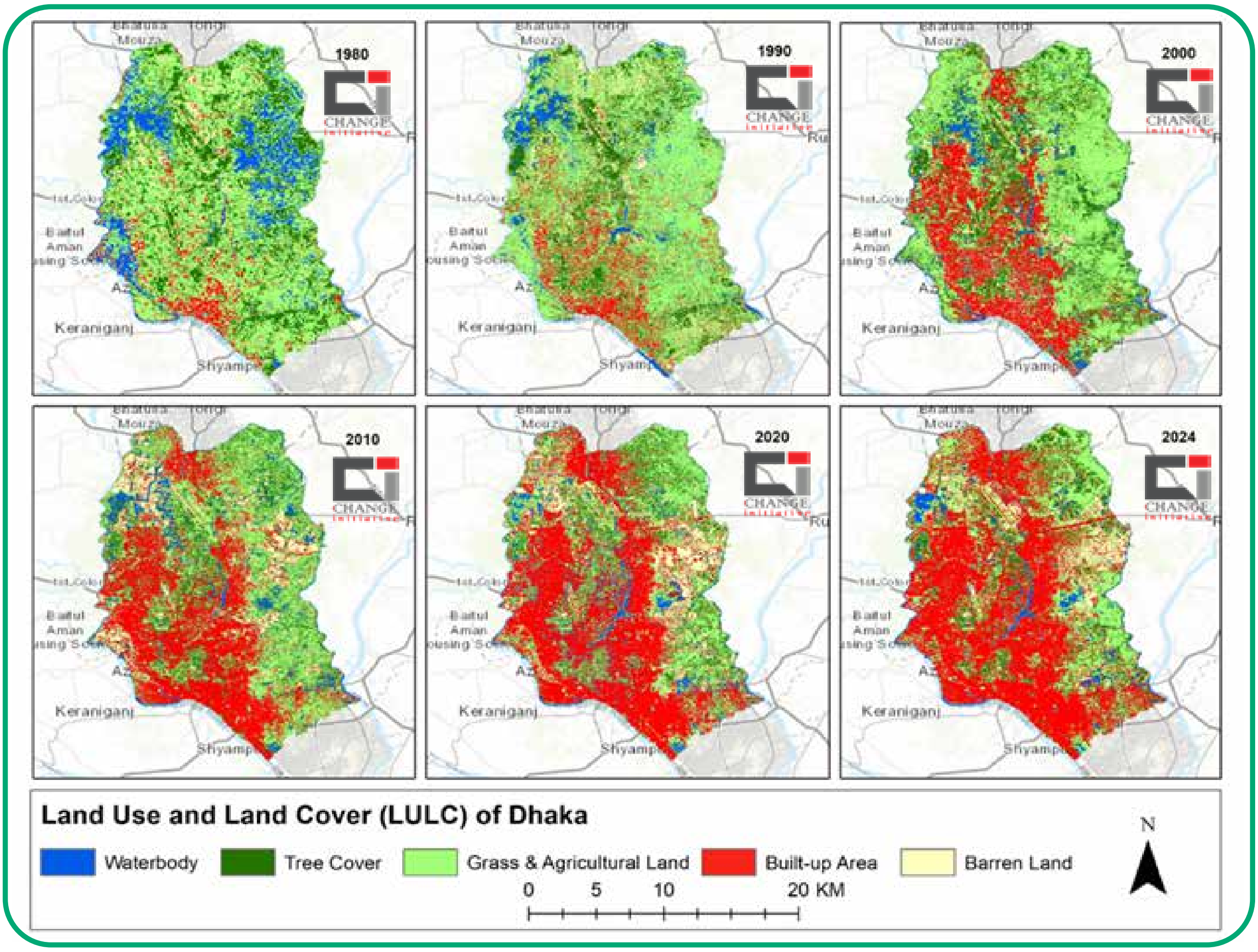

Figure 3: Land Use Trend of Dhaka Metropolitan Area

3.1.2.1 Land Use Trends of DNCC

From 1980 to 2024, DNCC experienced substantial urbanization. Built-up areas increased from 9.1 sq.km (4.4%) to 93.2 sq.km (45.4%), while grassland and agricultural land decreased from 108.4 sq.km (52.8%) to 51.2 sq.km (24.9%). Tree cover shrank from 45.8 sq.km (22.3%) to 25.0 sq.km (12.2%), and waterbodies reduced from 32.7 sq.km (15.9%) to 10.6 sq.km (5.1%) (Annex-2,3).

Urban growth was most significant between 1990–2000 (+23.1 sq.km) and 2000–2010 (+22.8 sq.km). The largest decline in grassland and agricultural areas occurred between 2000–2010 (−35.4 sq.km), while tree cover decreased the most between 1980–1990 (−12.2 sq.km).

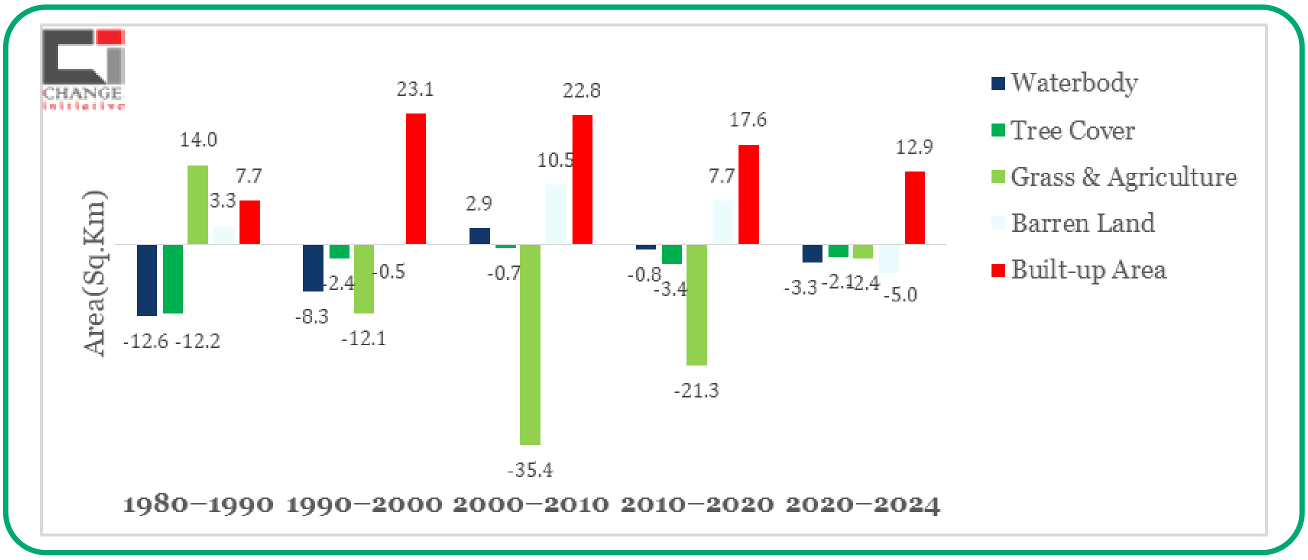

Figure 4: Land Use Change Trends (%) of DNCC

3.1.2.2 Land Use trends of DSCC

From 1980 to 2024, the built-up area in DSCC increased significantly, from 11.7 sq.km (11.8%) to 55.6 sq.km (56.2%), an increase of 43.9 sq.km. Grassland and agricultural areas have witnessed a steep decline, falling from 60.3 sq.km (61%) to 23.2 sq.km (23.4%). Tree cover decreased from 19.9 sq.km (20.1%) to 10.3 sq.km (10.4%). Waterbodies, although smaller compared to DNCC, saw a slight decline, from 4.6 sq.km (4.6%) to 4.1 sq.km (4.1%) (Annex-3).

The largest built-up area increases occurred between 1990–2000 (+11.3 sq.km) and 2000–2010 (+12.7 sq.km). Grass and agricultural land declined most sharply between 1990–2000 (−14.1 sq.km) and 2010–2020 (−13.4 sq.km). Tree cover decreased steadily, particularly in 1980–1990 (−3.6 sq.km) and 2000–2010 (−4.5 sq.km). Waterbodies declined consistently, while vacant land fluctuated due to redevelopment. In 2020–2024, built-up growth continued (+5.3 sq.km), with ongoing losses in grass/agriculture (−3.2 sq.km) and a slight recovery in waterbodies (+0.2 sq.km).

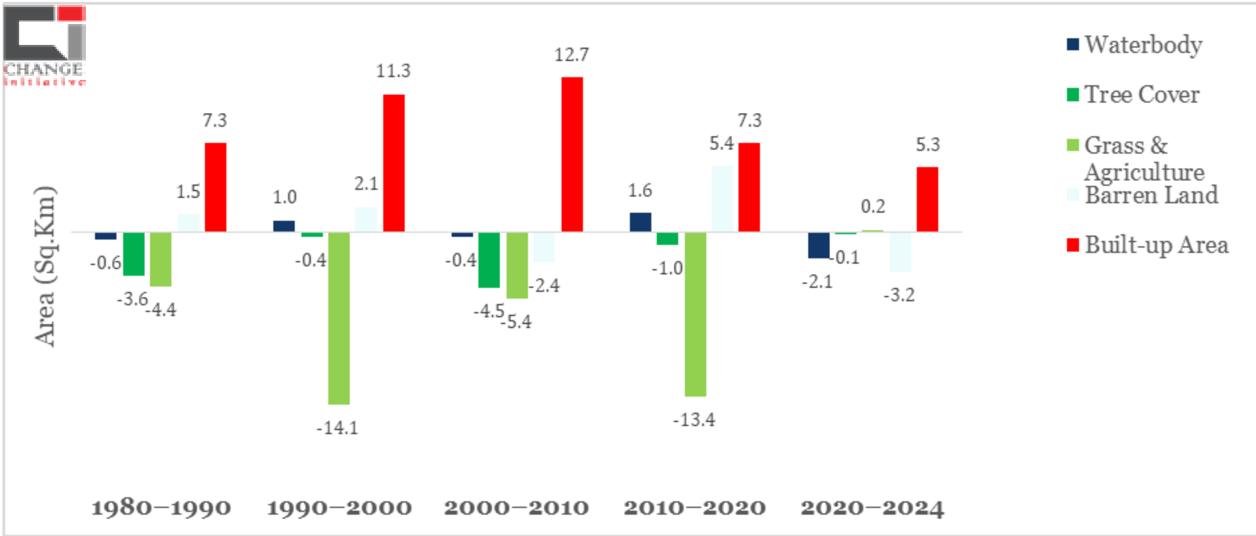

Figure 5: Land Use Change Trends of DSCC

3.1.3 Comparative Analysis of Land Use Change Rates in Dhaka North and South City Corporations (1980–2024)

The land use changes in DNCC and DSCC from 1980 to 2024 show contrasting trends in urbanization and environmental changes. In DNCC, waterbodies and tree cover have decreased at a faster rate than in DSCC. DNCC lost waterbody areas at -0.25 km²/year and tree cover at -0.23 km²/year, while DSCC saw minimal reductions in waterbodies at -0.01 km²/year and tree cover at -0.22 km²/year. Grass and agricultural land also declined more sharply in DNCC (-0.63 km²/-year) than in DSCC (-0.85 km²/year). Urban growth was faster in DSCC, with built-up areas increasing at a rate of +1.01% per year, compared to DNCC's +0.93%. These findings indicate that DSCC is densifying quicker, while DNCC is experiencing greater loss of natural resources.

Table 4: Comparative Analysis of land use for DNCC and DSCC

Land Use Class	DNCC				DSCC			
	1980 (%)	2024 (%)	Change (%)	Avg. Annual Change (%/year)	1980 (%)	2024 (%)	Change (%)	Avg. Annual Change (%/year)
Waterbody	15.9	5.1	-10.8	-0.25	4.6	4.1	-0.5	-0.01
Tree Cover	22.3	12.2	-10.1	-0.23	20.1	10.4	-9.7	-0.22
Grass & Agriculture	52.8	24.9	-27.9	-0.63	61	23.4	-37.6	-0.85
Vacant Land	4.5	12.3	7.8	0.18	2.5	5.8	3.3	0.08
Built-up Area	4.4	45.4	41	0.93	11.8	56.2	44.4	1.01

This comparison highlights that although both zones are urbanizing, DSCC is densifying more rapidly, whereas DNCC is losing more natural resources like water and green cover over time.

3.2 Tree Cover Change (1980-2024) Directional Pattern of Dhaka Metropolitan Area

Between 1980 and 2024, Dhaka Metropolitan area experienced substantial tree cover loss across its zones. The northeast and southeast saw the sharpest declines, losing 61.5% and 63.5%, respectively. The eastern zone saw a 42.9% decrease, while the northern zone faced a smaller decline of 26.9%. Other zones, including the northwest and west, also experienced significant losses, with the northwest losing 54% and the west 46.9%. However, the northern zone retained about 75% of its tree cover, showing the least change (Annex-4).

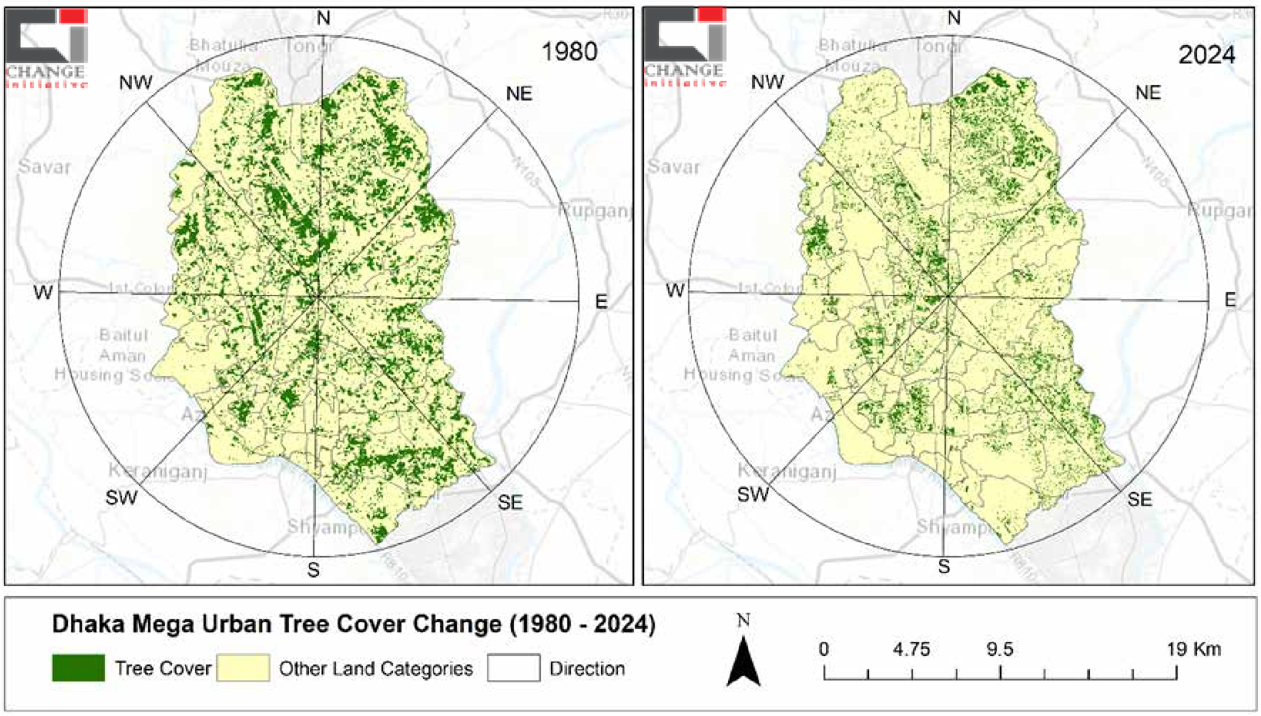

Figure 6: Tree Cover Change (1980-2024) Directional Pattern of Dhaka City

Between 1980 and 2024, all directions of Dhaka experienced significant loss in tree cover. The highest percentage losses occurred in the southeast (-63.5%) and northeast (-61.5%) regions.

In DNCC, tree cover has significantly declined from 1980 to 2024, following the overall city trend. Notable losses occurred in the northwest (-54.0%), northeast (-61.5%), and north (-26.9%) directions.

In Dhaka South City Corporation (DSCC), tree cover has also declined notably between 1980 and 2024, especially in the southeast (from 14.4% to 5.8%) and south (from 6.8% to 1.6%) directions. While the northeas and west directions saw relatively stable or slightly improved shares, central and southern parts of DSCC experienced major green space loss.

After observing the directional trends of tree cover change, this study further analyzed thana wise data of DNCC and DSCC to gain a more in-depth understanding of localized green cover distribution and degradation.

3.2.1 Thana wise tree-coverage of DNCC:

The WHO recommends a minimum of 9 m² of tree cover per person to support healthy urban living (WHO,2016). However, DNCC falls significantly short, with an overall average of just 4.23 m² per capita.

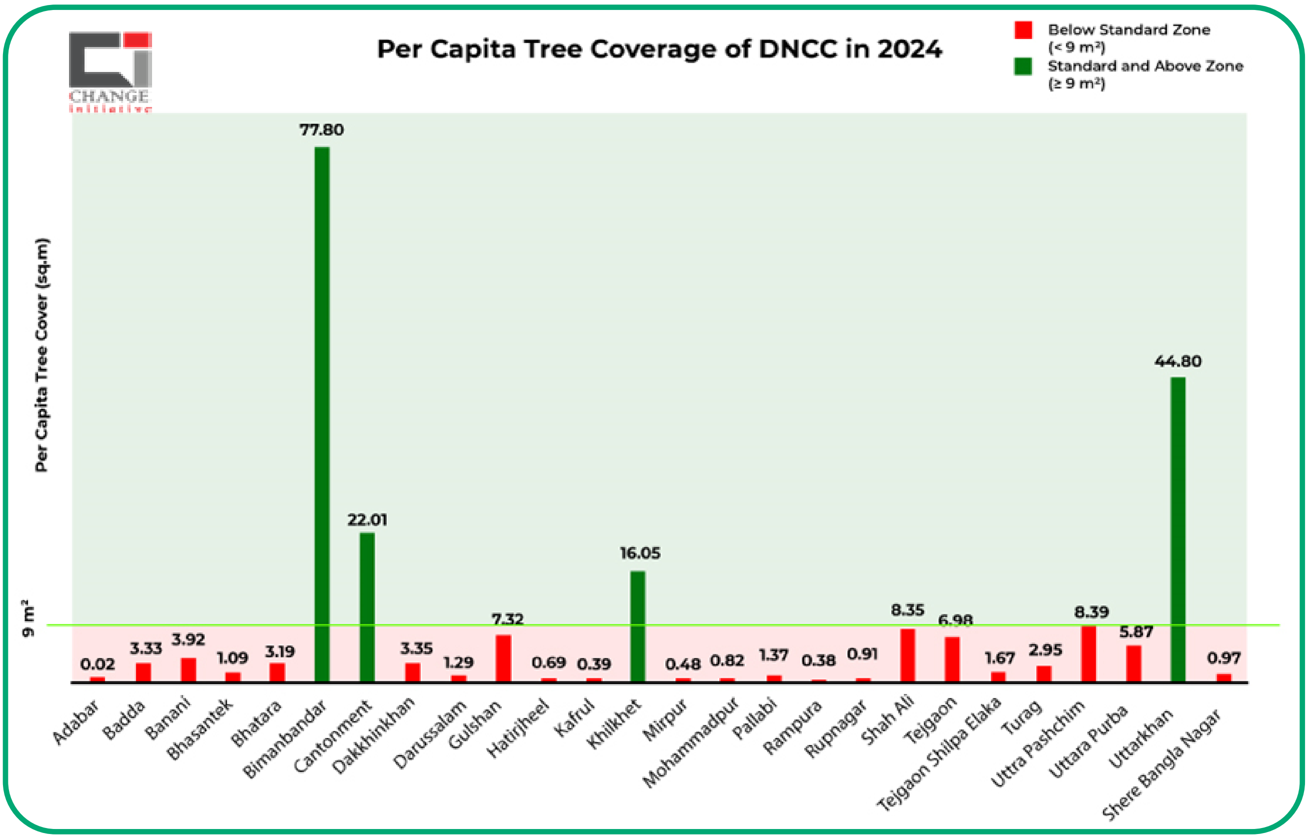

Figure 7: Per Capita Tree Coverage of DNCC in 2024

To better illustrate the disparities across the city, the thanas have been divided into two groups based on per capita tree coverage. The Below Standard Zone (< 9 m²) includes most of the thanas in DNCC, such as Adabar (0.02 m²), Rampura (0.38 m²), and Kafrul (0.39 m²) and other thanas where tree cover is alarmingly low. In contrast, the Standard and Above Zone (≥ 9 m²) includes only a few thanas that meet or exceed the WHO benchmark, notably Bimanbandar (77.80 m²), Uttarkhan (44.80 m²), Cantonment (22.01 m²) and Khilkhet (16.05 m²). This stark contrast highlights the unequal distribution of green space in DNCC and the urgent need for targeted urban planning to address this imbalance.

3.2.2 Thana wise tree-coverage of DSCC:

The 2024 data shows that the majority of thanas fall into the Below Standard Zone, with extremely low per capita tree coverage in dense urban areas such as Wari (0.01 m²), Sutrapur (0.09 m²), and Bangshal (0.46 m²). These figures reflect a critical shortage of green space in some of the most populated parts of the city.

Only a handful of thanas enter the Standard and Above Zone. Notably, Shahjahanpur (20.17 m²) and Demra (12.27 m²) stand out with exceptionally high per capita tree coverage. Other moderate-performing thanas include Newmarket (7.36 m²) and Khilgaon (4.44 m²), which are close to the standard threshold.

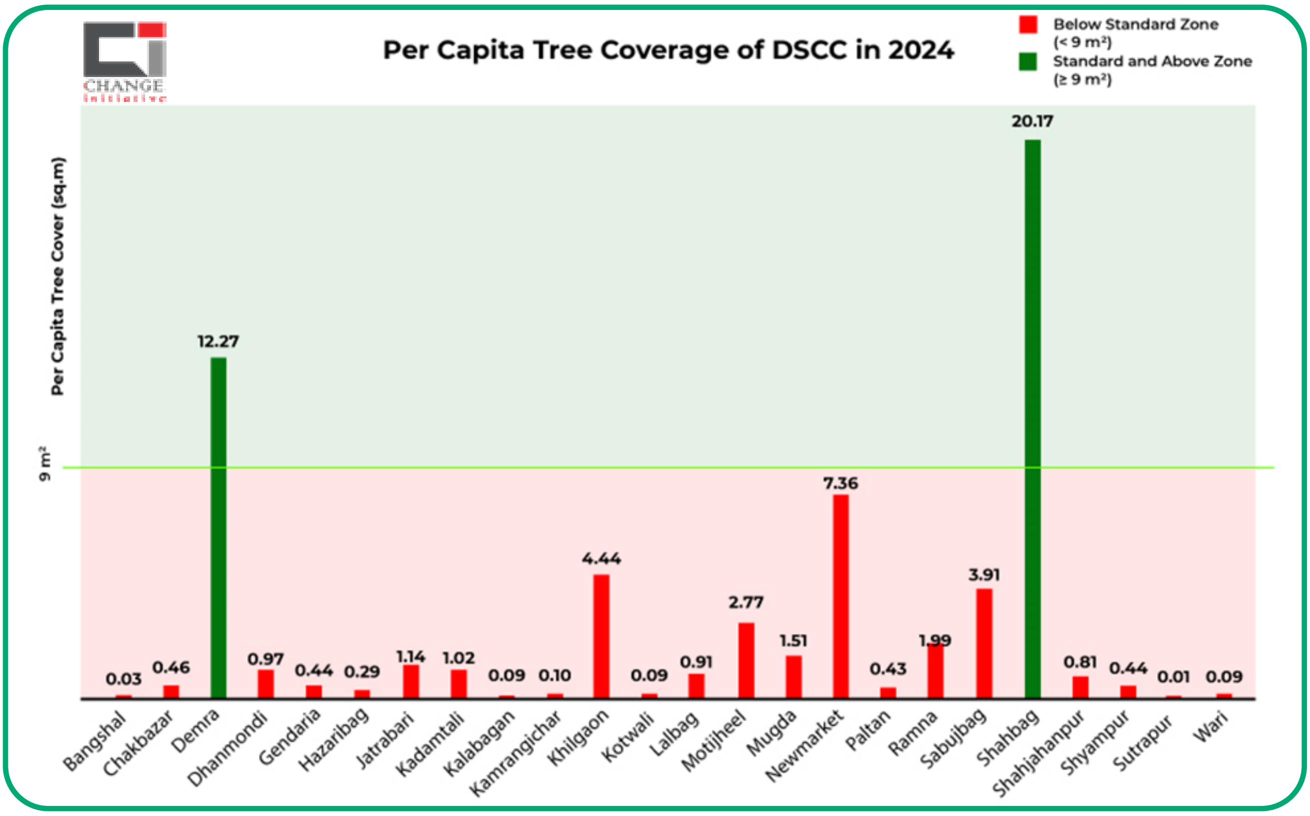

Figure 8: Per Capita Tree Coverage of DSCC in 2024

This distribution demonstrates significant variations within DSCC, highlighting the need for targeted urban planning to ensure that green space access is equitably distributed across the entire city.

3.3 Grass & Agricultural Land Change (1980-2024) Direction Pattern of Dhaka City

Between 1980 and 2024, Dhaka witnessed significant losses in grass and agricultural land,

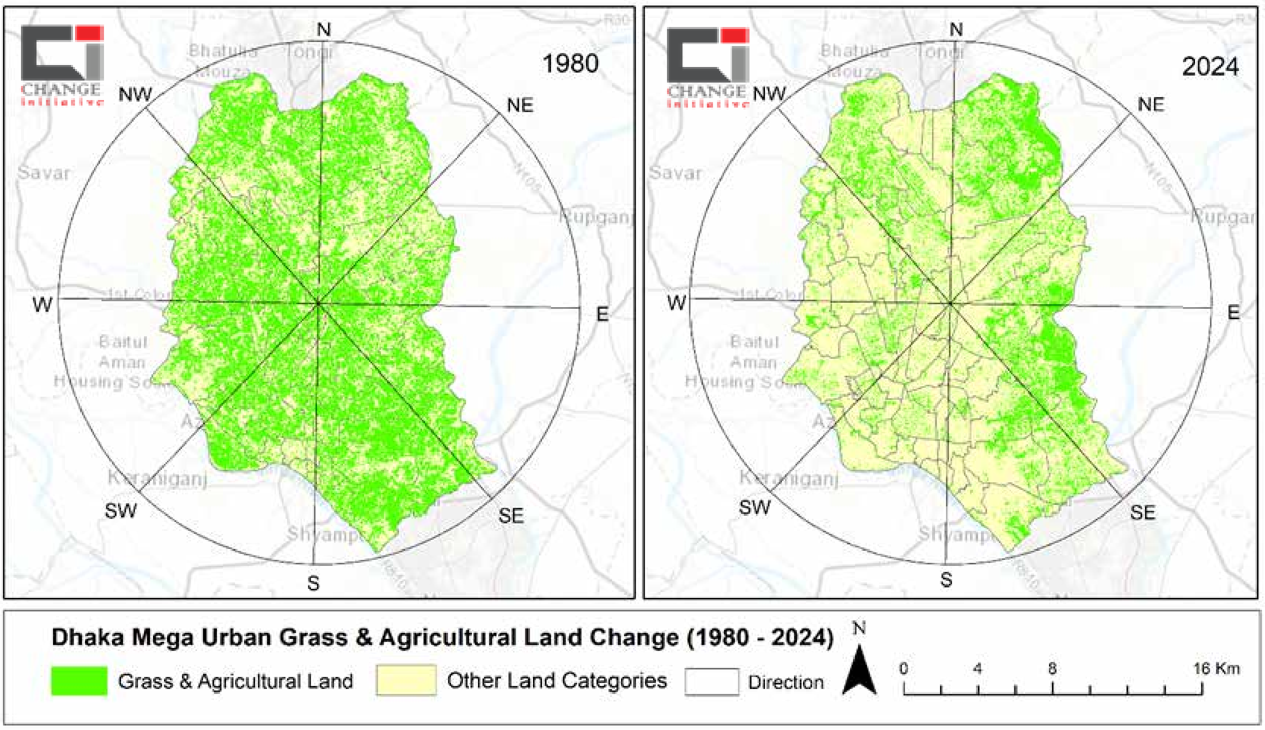

Figure 9: Urban Grass & Agricultural Land Change Directional Pattern of Dhaka City

particularly in the southeast and south directions. The SE direction saw the highest absolute reduction, losing 25.9 sq.km (70.4%), primarily due to urban expansion in areas like Demra, Shyampur, and Jatrabari. The South experienced the highest proportional loss, with an 82.8% decrease in G&A land. Other areas, such as the southwest and west, followed closely with reductions of 72.8% and 74.2%, respectively. The northern and eastern regions exhibited more moderate losses of 19.1% and 24%, respectively, while the northeast experienced an intermediate 42.9% decrease (Annex-7).

3.3.1 Thana Wise Grass/Agricultural Land of DNCC

The availability of grass and agricultural land across DNCC thanas shows stark variation. While the average percentage is modest, some thanas hold relatively large proportions of green open spaces. Uttarkhan has the highest share, with 56% of its 20.2 sq.km area under grass or agricultural land, followed by Turag (33%), Badda (32%), and Khilkhet (30%), all of which demonstrate significant preservation of open land. Cantonment (26%) and Dakkhinkhan (28%) also reflect strong green space presence.

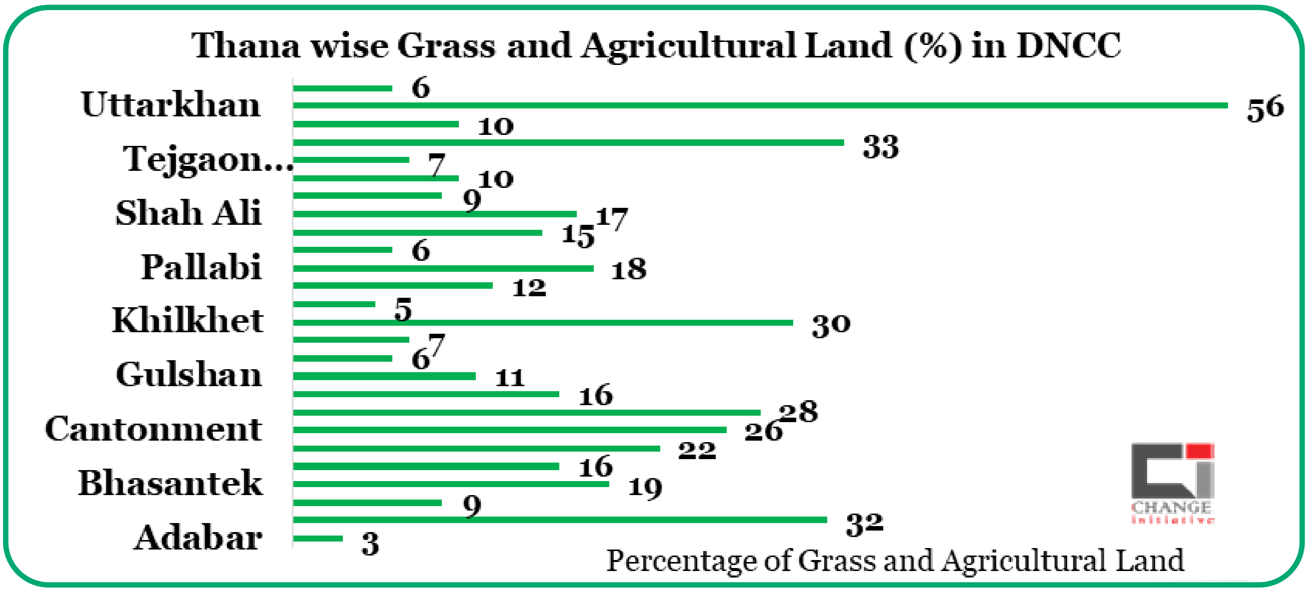

Figure 10: Thana Wise Grass/Agricultural Land of DNCC

Conversely, thanas like Adabar (3%), Mirpur (5%), Rampura (6%), Hatirjheel (6%), and Uttra Pashchim (6%) report very limited grass or agricultural land coverage.

3.3.2 Thana Wise Grass/Agricultural Land of DSCC

Green land distribution in DSCC reveals large disparities across thanas. Khilgaon (44%), Sabujbag (36%), and Demra (35%) stand out with the highest share of grass and agricultural land. These areas, due to their larger size and peripheral location, retain more open, vegetated spaces. Mugda (32%) and Newmarket (22%) also reflect relatively higher green land ratios.

In contrast, older and denser areas like Bangshal (1%), Sutrapur (2%), Wari (2%), and Kalabagan (2%) report extremely limited grass/agricultural land. Several central urban thanas, including Kotwali (4%), Gendaria (4%), and Paltan (7%), similarly lag behind.

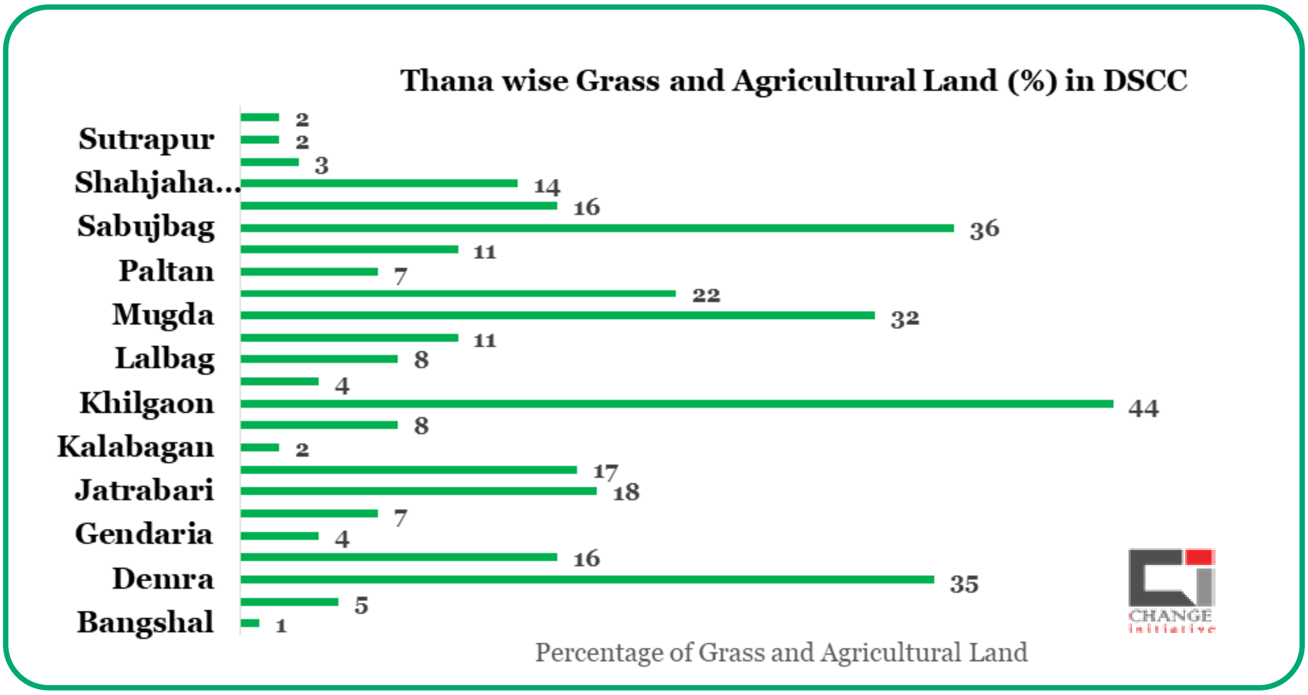

Figure 11: Thana Wise Grass/Agricultural Land of DSCC

3.4 Waterbodies Change of Dhaka City (DNCC, DSCC)

Between 1980 and 2024, Dhaka experienced significant waterbody loss, especially in the northern, northeastern, and northwestern zones, with the northern zone suffering an 85.9% decline. The southern and southeastern zones showed slight gains, while the western and southwest zones saw moderate losses. This dramatic shift reflects urban encroachment and land conversion for development(Annex-10).

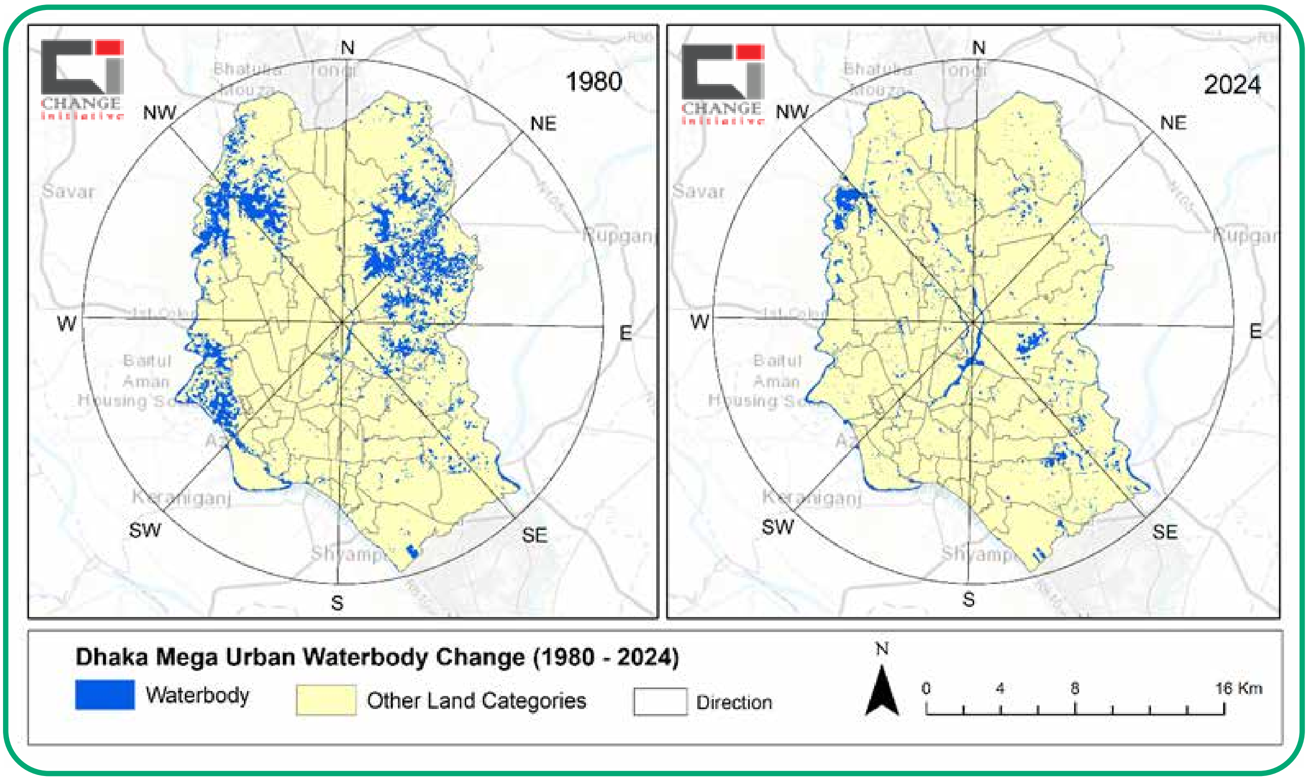

Figure 12: Waterbodies Change Pattern of Dhaka City

In the DNCC, waterbody coverage dropped sharply from 32.7 sq.km (15.9%) in 1980 to 10.6 sq.km (5.1%) in 2024. The western and eastern sectors experienced the largest declines, with the western zone falling from 7.8 sq.km (24%) to 2.9 sq.km (27.1%) and the eastern zone reducing sharply from 7.7 sq.km (23.4%) to 0.9 sq.km (8.9%) (Annex-11).

In the DSCC, waterbody areas remained relatively stable, decreasing slightly from 4.6 sq.km (4.6%) in 1980 to 4.1 sq.km (4.1%) in 2024. The eastern and northeastern sectors saw increases, while the northern and western sectors experienced reductions. Other zones showed minimal changes, with some slight declines in the southwestern sector (Annex-12).

3.4.1 Thana Wise Per Capita Waterbody Coverage of DNCC

To assess the adequacy of waterbody distribution in DNCC, thanas have been categorized into two zones based on a benchmark value of 4.5 m² per capita: the Below Standard Zone (< 4.5 m²) and the Standard and Above Zone (≥ 4.5 m²). The data from 2024 shows that most thanas fall into the Below Standard Zone, reflecting limited access to waterbodies.

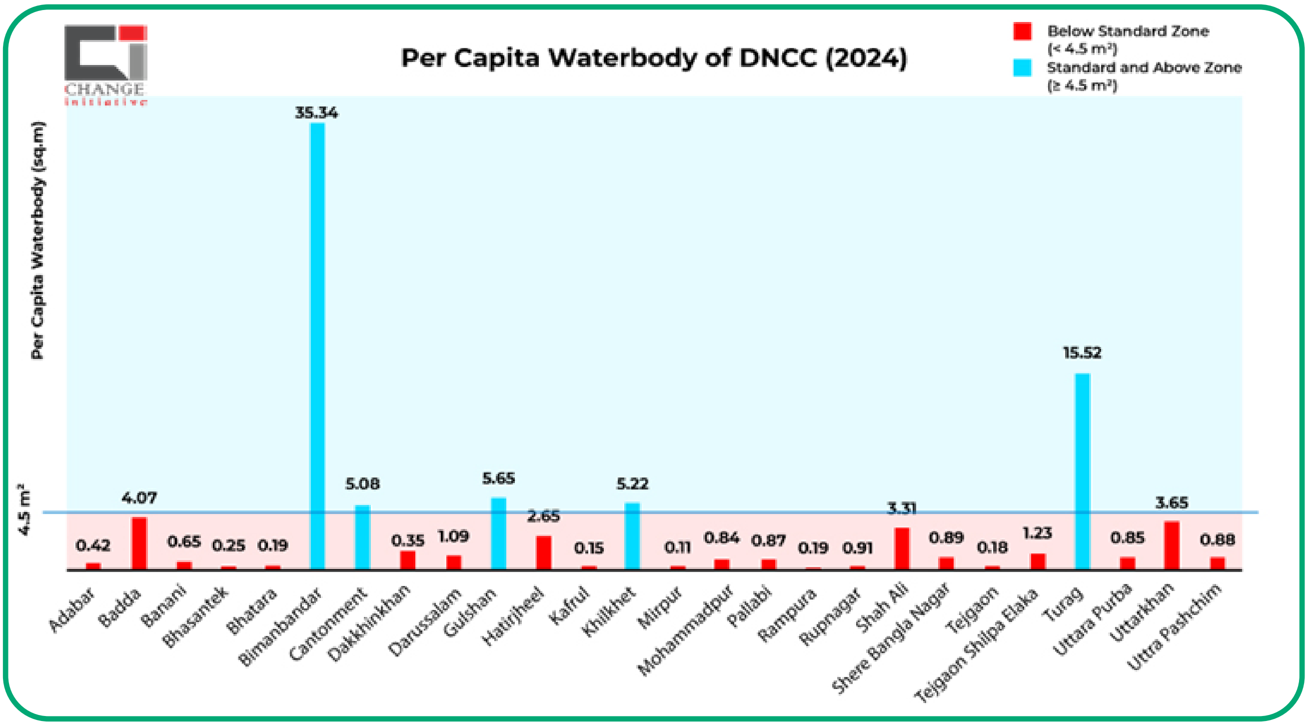

Figure 13: Per Capita Waterbody of DNCC in 2024

Areas such as Adabor (0.42 m²), Bhashantek (0.25 m²), Dakkhinkhan (0.35 m²), and Khilkhet (0.11 m²) demonstrate critical deficits. Only a few thanas, Dhanmondi (5.08 m²), Mohammadpur (5.22 m²), and Mirpur (5.65 m²) cross the standard threshold, while Uttara Paschim (15.52 m²) and Cantonment (35.34 m²) stand out as isolated cases of high access.

3.4.2 Thana Wise Waterbody Coverage of DSCC

In 2024, the majority of DSCC thanas fall into the Below Standard Zone (< 4.5 m² per capita), indicating widespread deficiency in waterbody access. Areas such as Wari (0.1 m²), Sutrapur (0.2 m²), Kotwali (0.3 m²), and Chakbazar (0.3 m²) exemplify the acute scarcity in central, densely built-up zones.

Only Hazaribag (13.3%) qualifies under the Standard and Above Zone (≥ 4.5 m²), offering waterbody access that meets thermal regulation and ecological benchmarks.

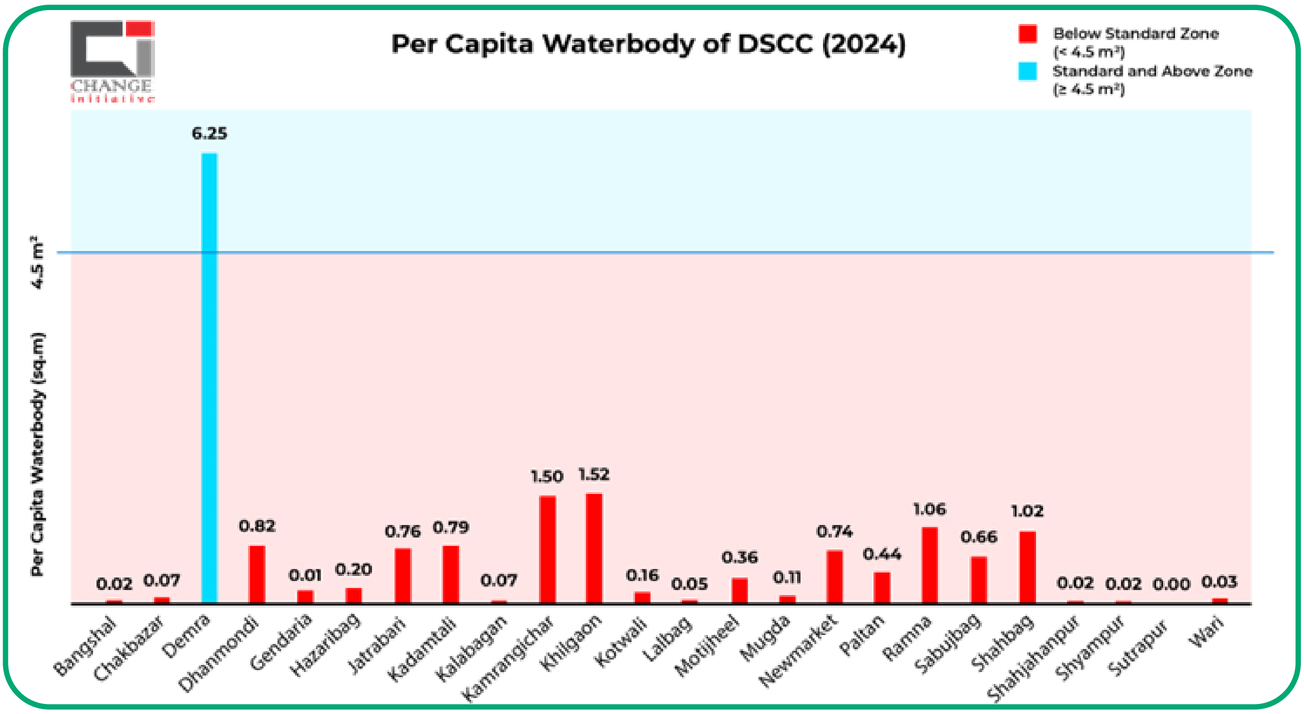

Figure 14: Per Capita Waterbody of DSCC in 2024

3.5 Built-up Area Change of Dhaka Mega City (1980-2024)

Between 1980 and 2024, Dhaka City experienced widespread expansion of built-up areas across all directions, illustrating rapid urban growth and transformation. The southeastern zone saw the largest increase, with built-up land growing from 4.9 sq.km to 35.9 sq.km, driven by extensive residential and industrial developments. Similarly, the southern sector expanded significantly, rising from 7.4 sq.km to 24.2 sq.km.

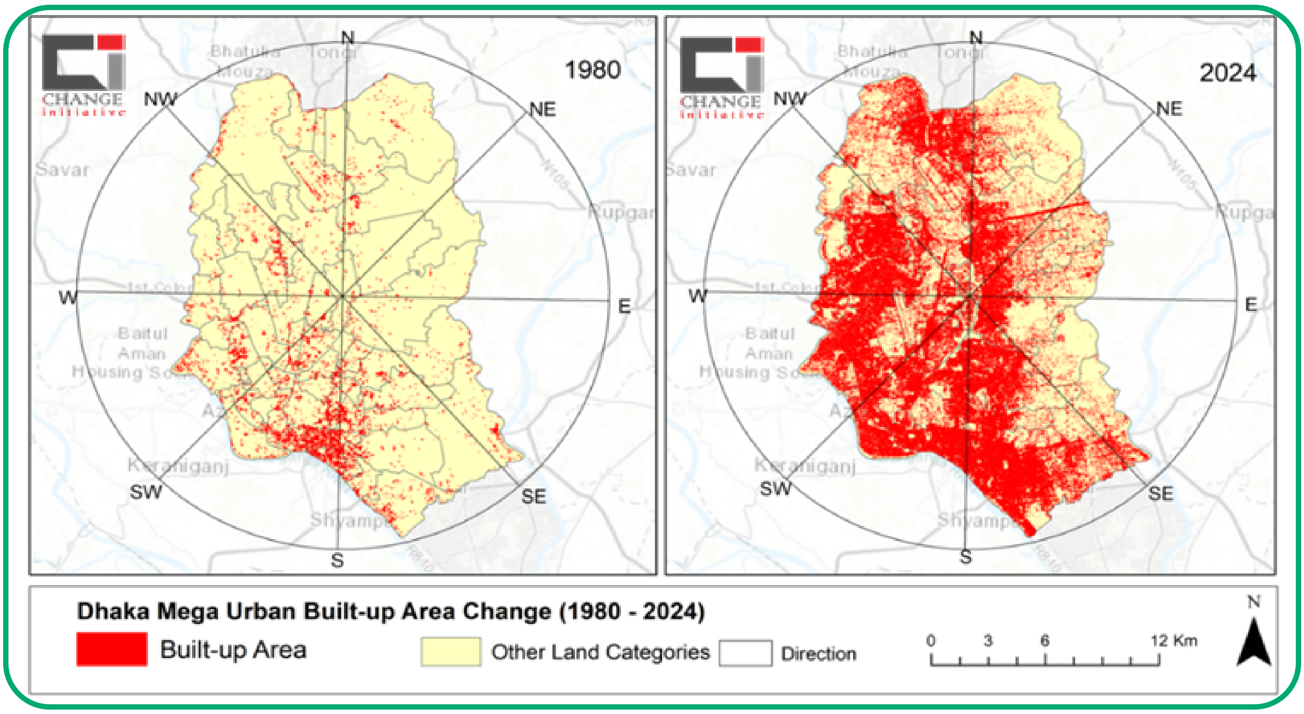

Figure 15: Built-up Area Change Pattern of Dhaka Mega City

The northwestern direction also witnessed notable growth, increasing from 1.8 sq.km to 22.5 sq.km. The southwestern and western zones followed closely, with built-up areas rising to 19.7 sq.km and 19.4 sq.km, respectively.

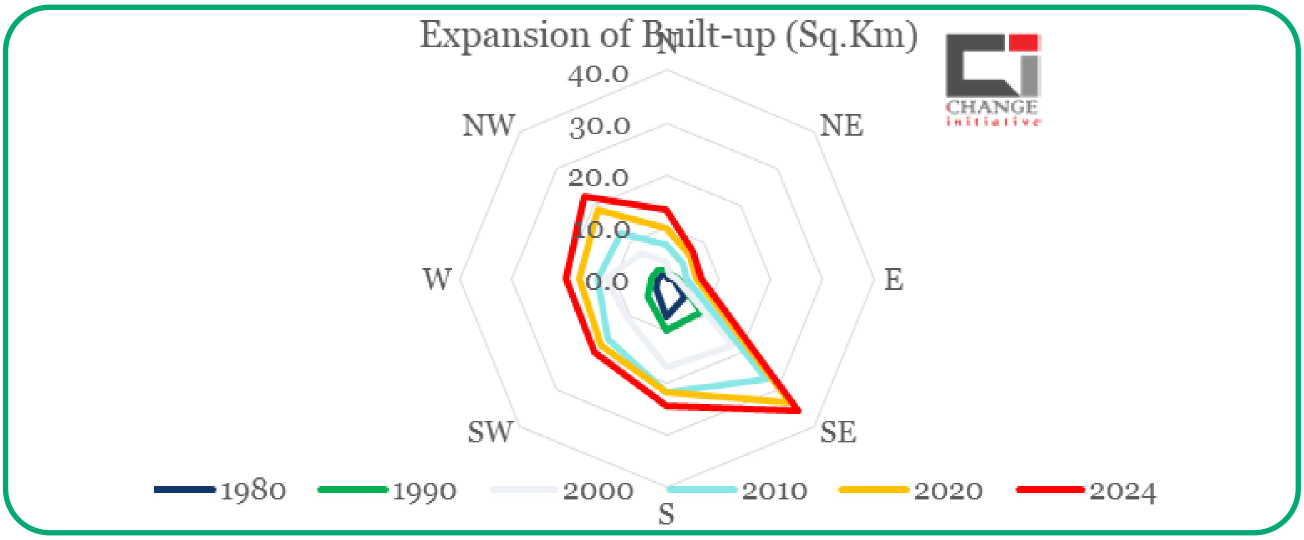

Figure 16: Built-up Area Change Direction of Dhaka City

Moderate growth occurred in the northern and northeastern zones, where built-up land increased from 1.0 sq.km to 13.4 sq.km and 0.2 sq.km to 7.2 sq.km, respectively. The eastern zone experienced steady growth as well, with built-up land expanding from 1.0 sq.km to 6.5 sq.km. This directional pattern reveals an uneven but extensive urban expansion, predominantly concentrated in the southeastern and peripheral areas of Dhaka (Annex-13).

3.5.1 Built-up Area Change of DNCC (1980-2024)

Between 1980 and 2024, the built-up area in DNCC expanded markedly across all directions. The southern and southwestern zones experienced the largest increases, with built-up land growing from 2.9 sq.km to 18.0 sq.km and 1.9 sq.km to 18.8 sq.km, respectively.

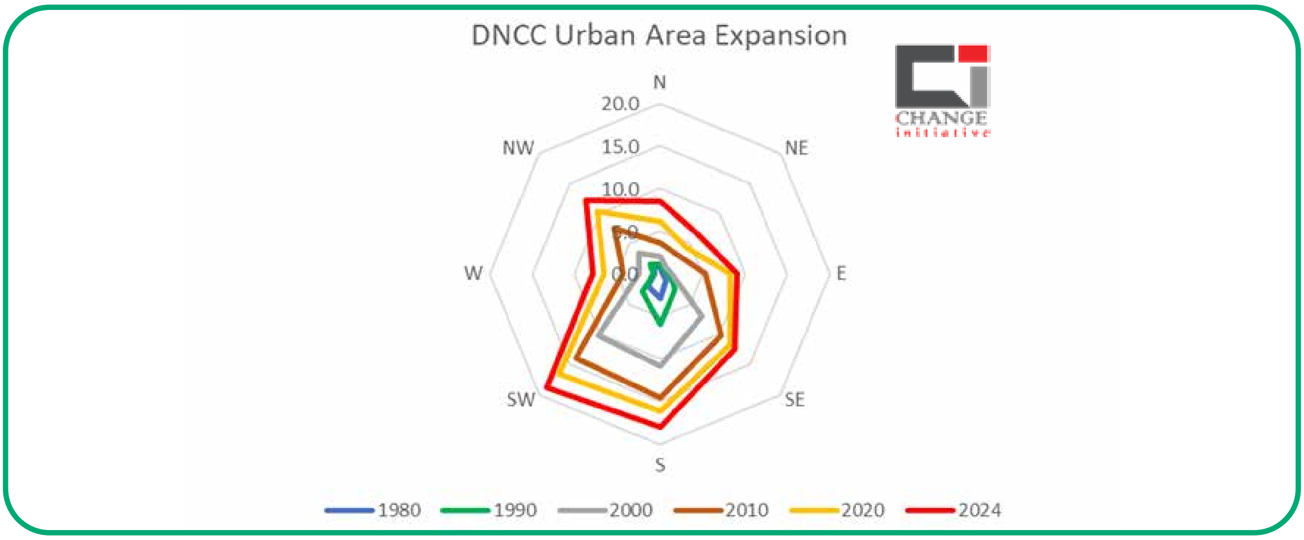

Figure 17: Built-up Area Change Direction of DNCC

The south easternand northwestern zones also saw substantial growth, expanding from 1.1 sq.km to 12.5 sq.km and 1.1 sq.km to 12.2 sq.km, respectively. The eastern zone increased significantly from 0.3 sq.km to 9.0 sq.km, while the northern and northeastern zones rose from 0.9 sq.km to 8.6 sq.km and 0.4 sq.km to 6.4 sq.km, respectively.

The westernzone showed the smallest increase but still expanded from 0.6 sq.km to 7.8 sq.km (Annex-14).

Buil-tup areas are considered manageable when they account for less than 50% of total urban land, as exceeding this threshold can lead to significant urban health risks (Ahmed et al., 2013). In the DNCC, built-up area percentages reveal a varied distribution of urban expansion. Eight thanas (highlighted in green) have built-up areas below the 50% threshold, representing 30.77% of the total thanas. These areas are considered more manageable in terms of urban health and sustainability, though they still face challenges such as the need for improved infrastructure and green space.

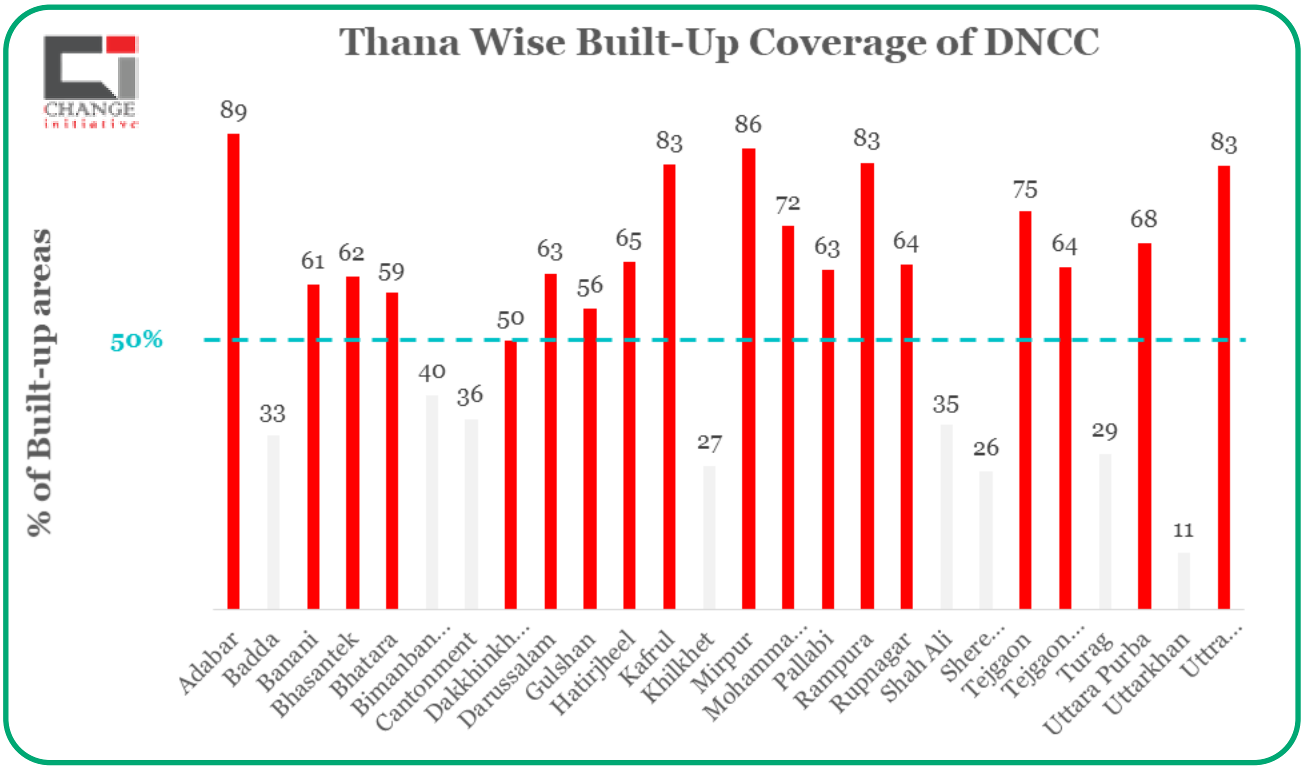

Figure 18: Thana Wise Built-Up Coverage of DNCC in 2024

On the other hand, 18 thanas (highlighted in red) have built-up areas exceeding the 50% threshold, accounting for 69.23% of DNCC. These areas face higher risks, including urban heat island effects, ecological degradation, and reduced livability. Notable thanas with high built-up coverage include Adabar (89%), Banani (61%), Bhasantek (62%), Kafrul (83%), Mirpur (86%), Mohammadpur (72%), Pallabi (63%), Rampura (83%), Rupnagar (64%), Darussalam (63%), Gulshan (56%), Hatirjheel (65%), Tejgaon (75%), Tejgaon Shilpa Elaka (64%), Uttarkhan (11%), and Uttara Pashchim (83%). The disproportionate expansion in DNCCunderscores the urgent need for sustainable urban planning strategies to mitigate environmental impacts and ensure long-term resilience.

3.5.2 Built-up Area Change of DSCC (1980-2024)

Between 1980 and 2024, DSCC saw substantial growth in built-up areas across all directions, marking a clear trend of urbanization and expansion. The southwestern and western zones experienced the most significant increases, with built-up land growing from 4.8 sq.km to 11.8 sq.km and 2.8 sq.km to 12.1 sq.km, respectively.

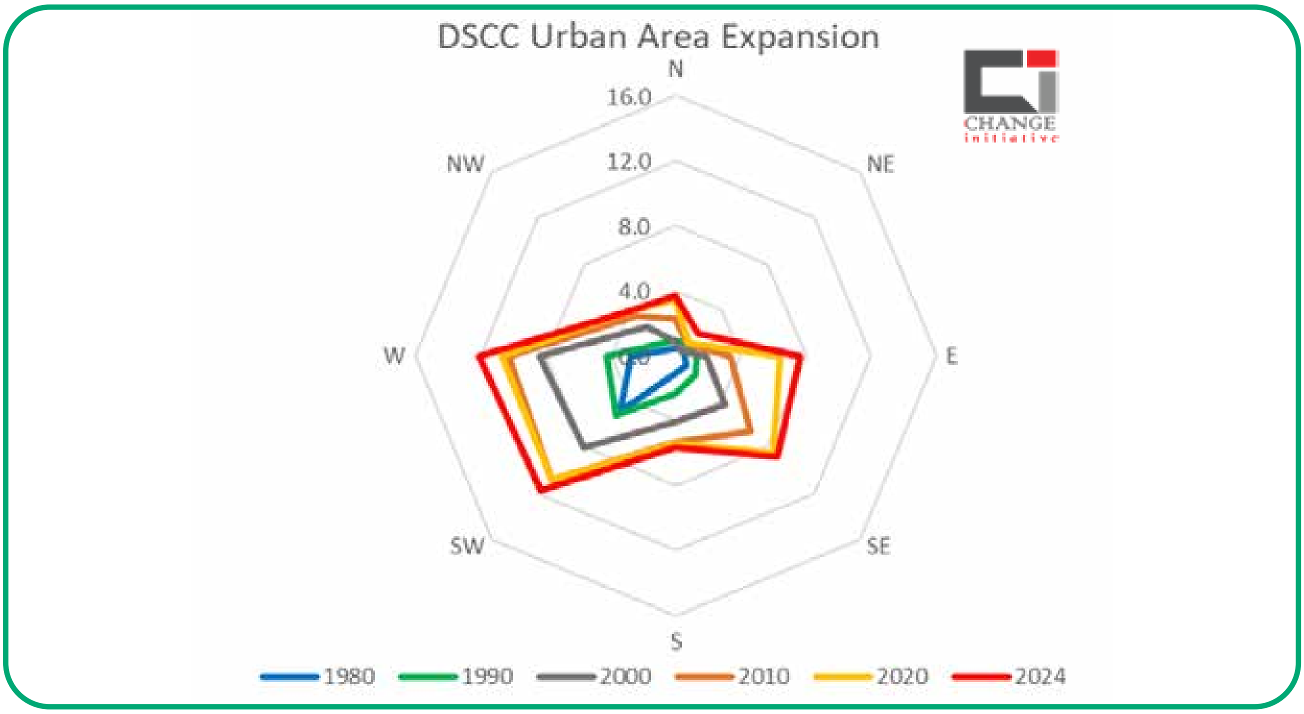

Figure 19: Built-up Area Change Direction of DSCC

The southeasternzone also saw notable growth, expanding from 0.8 sq.km to 8.8 sq.km. Similarly, the eastern zone grew considerably, from 0.5 sq.km to 7.6 sq.km, reflecting increased development in the city's commercial and residential areas.

The northernand northeastern zones experienced moderate growth, rising from 0.5 sq.km to 3.7 sq.km and 0.5 sq.km to 1.9 sq.km, respectively. The northwestern zone, while initially smaller, expanded from 0.6 sq.km to 4.0 sq.km (Annex-15).

A review of the built-up area percentages across the DSCC thanas reveals that many areas have experienced extensive built-up expansion, which could pose sustainability risks.

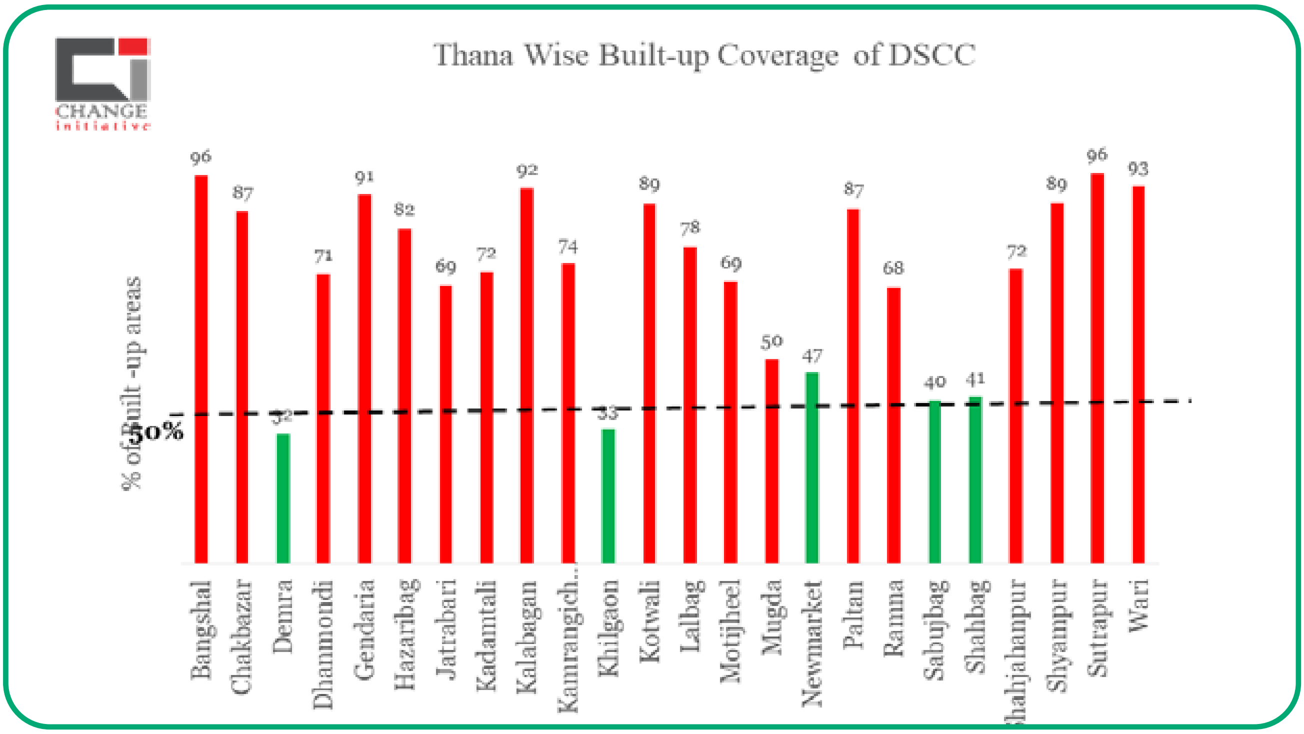

Figure 20: Thana Wise Built-Up Coverage of DSCC in 2024

In DSCC, five thanas (Green Colored) have built-up areas below the 50% threshold, representing 21% of the total, that are considered manageable, but these zones still face challenges in terms of sustainability and long-term urban resilience. In contrast, 19 thanas (Red Colored) have built-up areas exceeding 50%, making up 79% of the total. These areas with higher built-up coverage face increased risks such as urban heat islands, ecological degradation. Bangshal (95.5%), Chakbazar (86.6%), Gendaria (90.8%), Hazaribag (82.3%), Kalabagan (92.4%), Kotwali (88.6%), Paltan (87.4%), Shyampur (88.8%), Sutrapur (100%), and Wari (92.9%), are areas that represent 75% of DSCC, indicating extremely high proportions of built-up land. Such hyper-built environments contribute to elevated local temperatures, and degraded livability, especially in the absence of sufficient vegetation or waterbodies.

3.6 Impact of Environmental Amenities on Property Prices

The relationship between environmental amenities and property prices has been a key subject in urban economics, with substantial evidence suggesting that the availability and quality of natural resources, such as green spaces and water bodies, significantly influence housing market dynamics. Numerous studies have employed hedonic pricing models to quantify the value of these amenities and dis-amenities in shaping property values.

Chen, Jones, Dunse, Li, and Liu (2023) examined the effects of green space characteristics in Beijing and found that larger, more complex green spaces, measured by the Landscape Shape Index (LSI), were associated with higher housing prices. The proximity to these green spaces also increased housing premiums, with the effect decaying as the distance from green spaces increased. In the Bangladesh context, some studies found that in Khulna, properties closer to open spaces and with better ventilation had higher rents, while waterlogging and landfills decreased rents (Islam, Hossain, Morshed, & Afrin, 2020). Similarly, Ardeshiri, Ardeshiri, Radfar, and Shormasty (2016) reported that environmental amenities like parks and green spaces positively impacted property values, while pollution and noise reduced them.

In addition to examining the relationship between environmental amenities and property values, our study also sought to explore how these factors influence land prices specifically within DNCC and DSCC. To gain deeper insights, this analysis investigates the relationship between land prices and ecological features across 49 thanas in Dhaka; 26 under DNCC and 23 under DSCC. Using harmonized geospatial and municipal valuation data, it assesses tree cover, waterbody extent, and average land price per square meter. All variables were standardized through log-scaling to generate comparable indices: tree cover (T), waterbody extent (W), and land price (LP). An interaction term (TreeWater = T × W) was included to capture potential combined ecological effects. The objective is to evaluate whether land values reflect environmental quality and how this relationship varies between DNCC and DSCC, offering insights into urban planning, land valuation reform, and equitable development in Dhaka's rapidly changing landscape.

Table 5: Mean Comparison of Key Environmental and Economic Indicators Between DNCC and DSCC

City Corporation	Land Price (LP)	Tree Coverage (T)	Waterbody (W)
DNCC	57877.37	1742302.12	399230.77
DSCC	88222.26	855131.55	186500.00
Total	146099.63	2597433.67	585730.77

The analysis shows that DNCC has a significantly lower average land price (57,877.37 taka) compared to DSCC (88,222.26 taka), despite DNCC having higher tree cover (T = 1,742,302.12 square meters) and waterbody extent (W = 399,230.77 square meters) than DSCC (T = 855,131.55 square meters; W = 186,500 square meters). This inverse relationship suggests that land prices in DSCC may be more driven by urban or commercial factors, while DNCC's ecological features do not directly correlate with higher land values. To explore the joint impact of these natural features, a composite indicator (Treewater = T × W) will be used in further analysis to assess interactive effects. These patterns prompt a reconsideration of urban valuation and planning priorities in Dhaka.

Table 6: Regression Analysis: Relationship Between Land Price and Environmental Features

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval Lower]	[95% Conf. Interval Upper]
Tree Coverage	-0.0376647	0.3935383	-0.1	0.924	-0.8313104	0.755981
Waterbody	0.1482935	0.4609362	0.32	0.749	-0.7812729	0.07786
TreeWater	-0.0099726	0.0345173	-0.29	0.774	-0.079583	0.0596382
_cons	11.3225	4.998233	2.27	0.029	1.242606	21.4024

The regression results show that the model, with three independent variables (Tree cover, Waterbody, and the composite indicator - TreeWater), has an R-squared value of 0.0987, meaning that the model explains only about 9.87% of the variation in the LP. This suggests a weak relationship between land price and the predictors included in the model. The F-statistics of 1.57 with a p-value of 0.2107 indicate that the overall model is not statistically significant at the conventional 0.05 significance level.

Regarding the individual coefficients, none of the independent variables, including Tree cover and Waterbody , show a statistically significant relationship with land price as their p-values exceed the 0.05 threshold. The coefficient for T is negative, indicating a slight negative association with land price, though the effect is not significant. The Wvariable has a positive coefficient, suggesting a weak positive association with land price, but it too is statistically insignificant. The composite indicator Tree-Water has a negative but very weak relationship with LP. The only statistically significant variable is the constant term, with a p-value of 0.029, indicating that, on average, land prices are significantly different from zero when all predictors are excluded from the model.

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3.7 LST Analysis of Dhaka Metropolitan Area

The LST analysis from 1990 to 2024 shows a dramatic deviation from the standard thermal benchmark (26–30°C). In 1990, 56.3% of the area fell within this standard range, but by 2024, it dropped to 21.7%, indicating growing thermal discomfort. Areas below the standard (<26°C), which accounted for 38.3% in 1990, have completely disappeared.

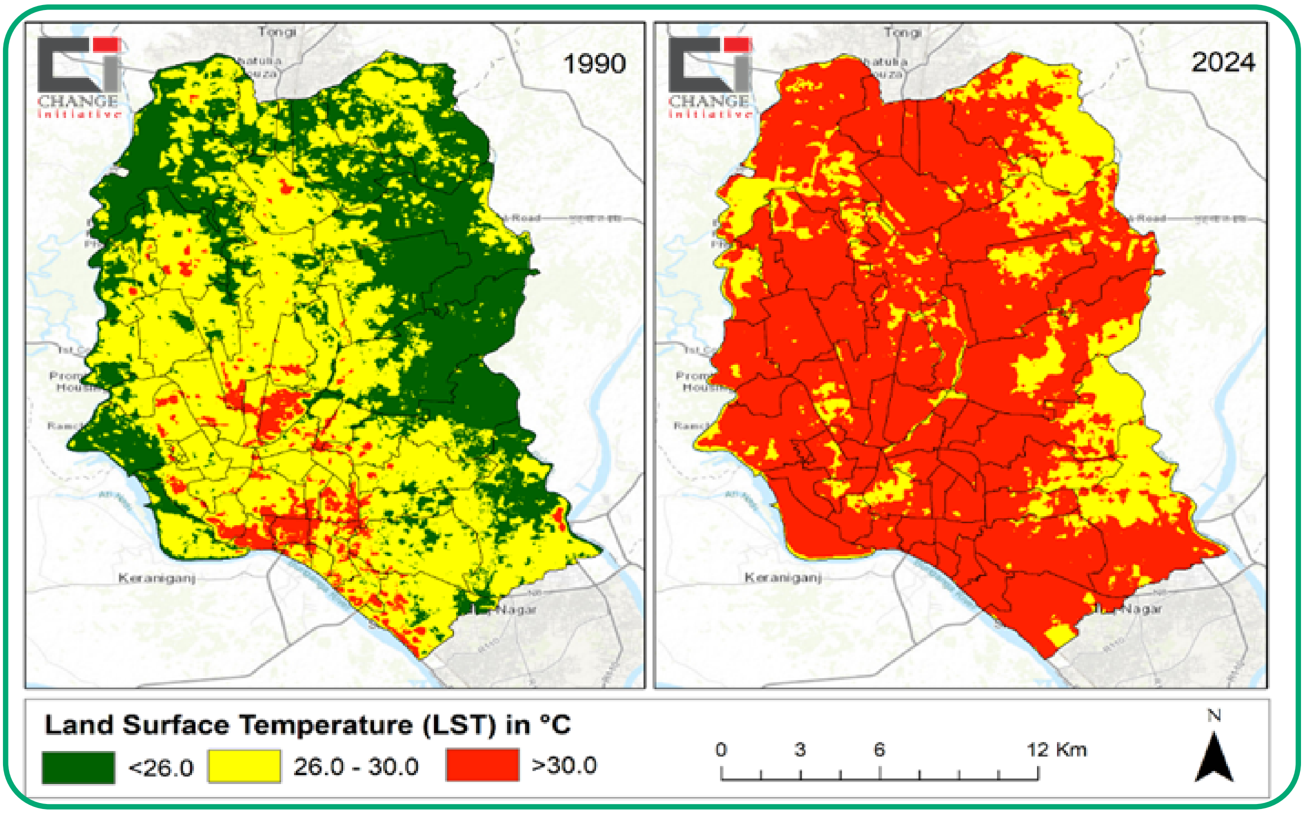


Figure 21: LST of Dhaka Metropolitan Area

Meanwhile, zones exceeding the standard (>30°C) expanded sharply from 5.3% in 1990 to 78.3% in 2024, illustrating an alarming intensification of the Urban Heat Island (UHI) effect. This shift, clearly visible in the spatial distribution, reflects unplanned urban growth and vegetation loss, emphasizing the need for immediate green and climate-resilient urban interventions.

The LST in DNCC has undergone a striking transformation from 2000 to 2024. In 2000, the majority of the area (51.4%) fell within the standard benchmark range of 26–30°C, while 45.7% remained in the below-standard category (<26°C), indicating a relatively comfortable urban thermal environment. By 2024, cooler zones had completely disappeared (0%), and the standard range reduced drastically to just 20.8%. The most alarming change is the sharp increase in abovestandard LSTs (>30°C), which rose from only 2.9% in 2000 to a staggering 79.2% in 2024.

DSCC has experienced a drastic rise in LST from 2000 to 2024. In 2000, 45.7% of the area was classified as below standard (<26°C), and 51.4% remained within the standard benchmark range (26–30°C), indicating a predominantly thermally balanced urban environment. By 2024, cooler zones (<26°C) had completely vanished, while the standard zone shrank to only 20.8%. In contrast, areas with LST above 30°C surged from a minimal 2.9% in 2000 to a dominant 79.2% in 2024.

3.8 Land use vs. Heat: A Thana-Wise Battle
3.8.1 Thana Wise Land use vs Surface temperature of DNCC

Thanas with high built-up area percentages and low vegetation cover (tree cover and agricultural land) consistently record LST values of more than31.5°C. For instance, Tejgaon Shilpa Elaka—with 63.91% built-up area and only 9.69% tree cover—has the highest recorded LST of 33.08°C. Similarly, Rampura (83.40% built-up, 3.09% tree cover) and Darussalam (62.80% built-up, 5.66% tree cover) also experience high LSTs of 32.14°C and 32.19°C, respectively.

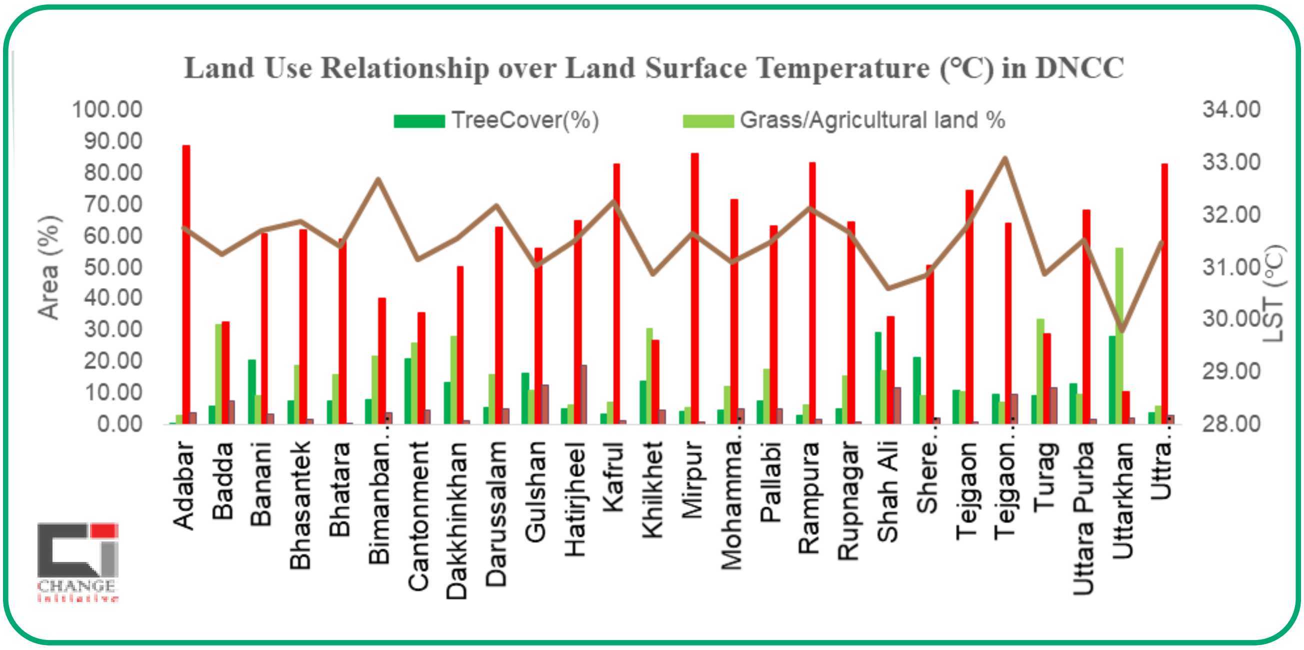


Figure 22: Land Use Relationship over Land Surface Temperature (℃) in DNCC

Conversely, thanas with higher tree cover and lower urban density show significantly lower mean LST. Notably, Uttarkhan, with the highest tree cover (27.92%) and lowest built-up area (10.45%), records the lowest LST of 29.80°C. Shah Ali (29.39% tree cover) and Cantonment (20.75% tree cover) also maintain lower temperatures, around 30.59°C and 31.16°C, respectively.

The data demonstrate that tree cover and agricultural land have a cooling effect, while intensive urbanization (built-up area) contributes to heat intensification. Waterbodies, although limited in most thanas, also appear to moderately buffer LST, as seen in Gulshan and Turag, where higher waterbody percentages correlate with relatively lower LST values.

3.8.2 Thana Wise Land use vs Surface temperature of DSCC

The land use composition across DSCC thanas shows a clear pattern of how vegetation, waterbodies, and built-up areas influence local LST. Thanas with high urban density and low vegetation cover experience consistently higher LSTs, with areas like Shyampur (88.8% built-up, 3.3% LST) and Hazaribag (82.3% built-up, 32.7°C) showing the highest surface temperatures.

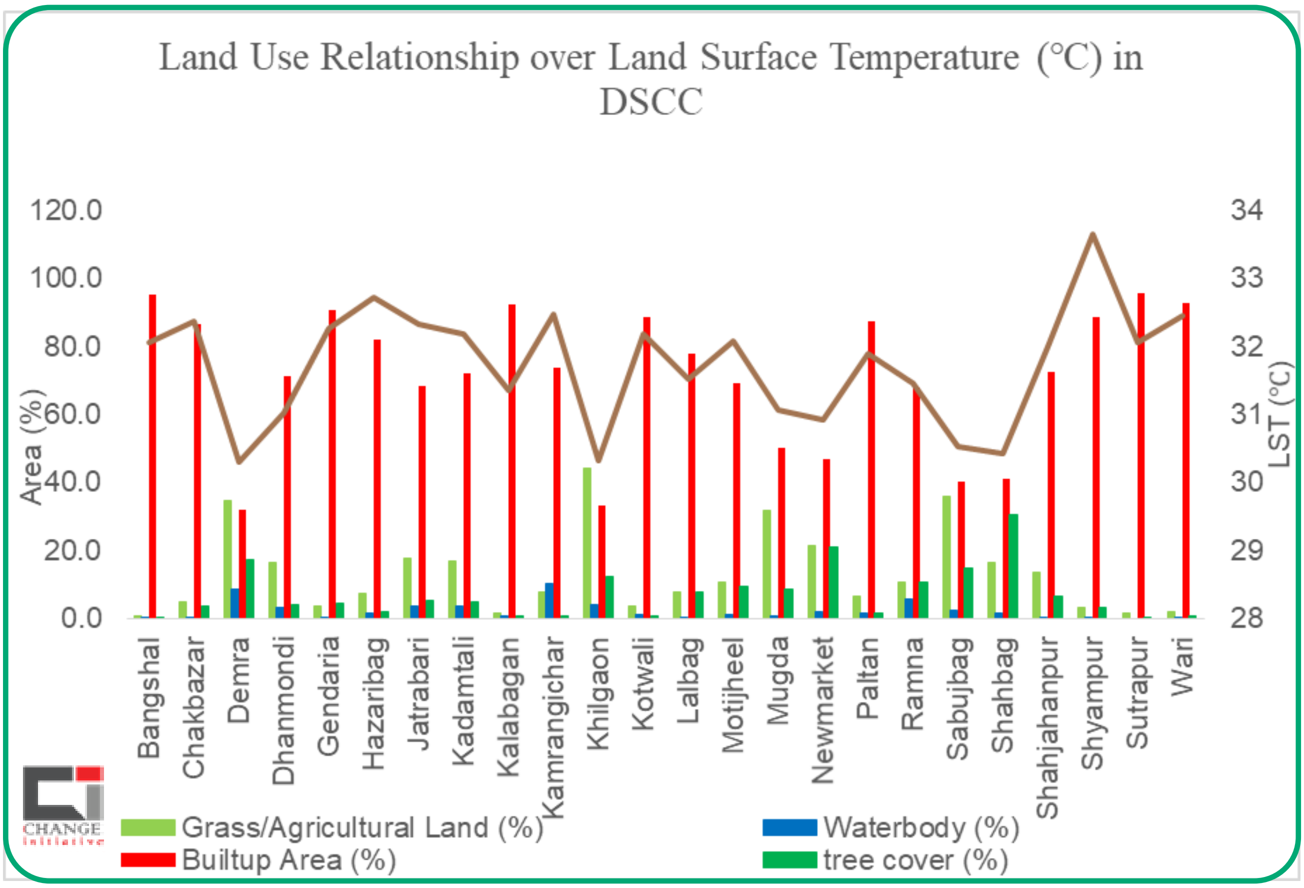


Figure 23: Land Use Relationship over Land Surface Temperature (°C) in DSCC

On the other hand, thanas with larger proportions of tree cover and open land, such as Shahbag (30.4% tree cover, 20.17 sq.m per capita tree coverage) and Sabujbag (14.9% tree cover), maintain significantly lower LSTs, around 30.4°C–30.5°C. Thanas like Demra, Khilgaon, and Shahbag, with a higher presence of grass/agricultural land and waterbodies, exhibit LSTs 2–3°C lower than hyper-urbanized centers like Chakbazar, Bangshal, and Sutrapur, where tree cover is less than 0.5% and built-up areas exceed 90%.

3.8.3 Relationship Between Land Use Pattern and LST

To understand how LST relates to different features of the landscape, we performed a bivariate correlation analysis between LST and three key indices: built-up index (NDBI), greenery index (NDVI), and water index (NDWI).

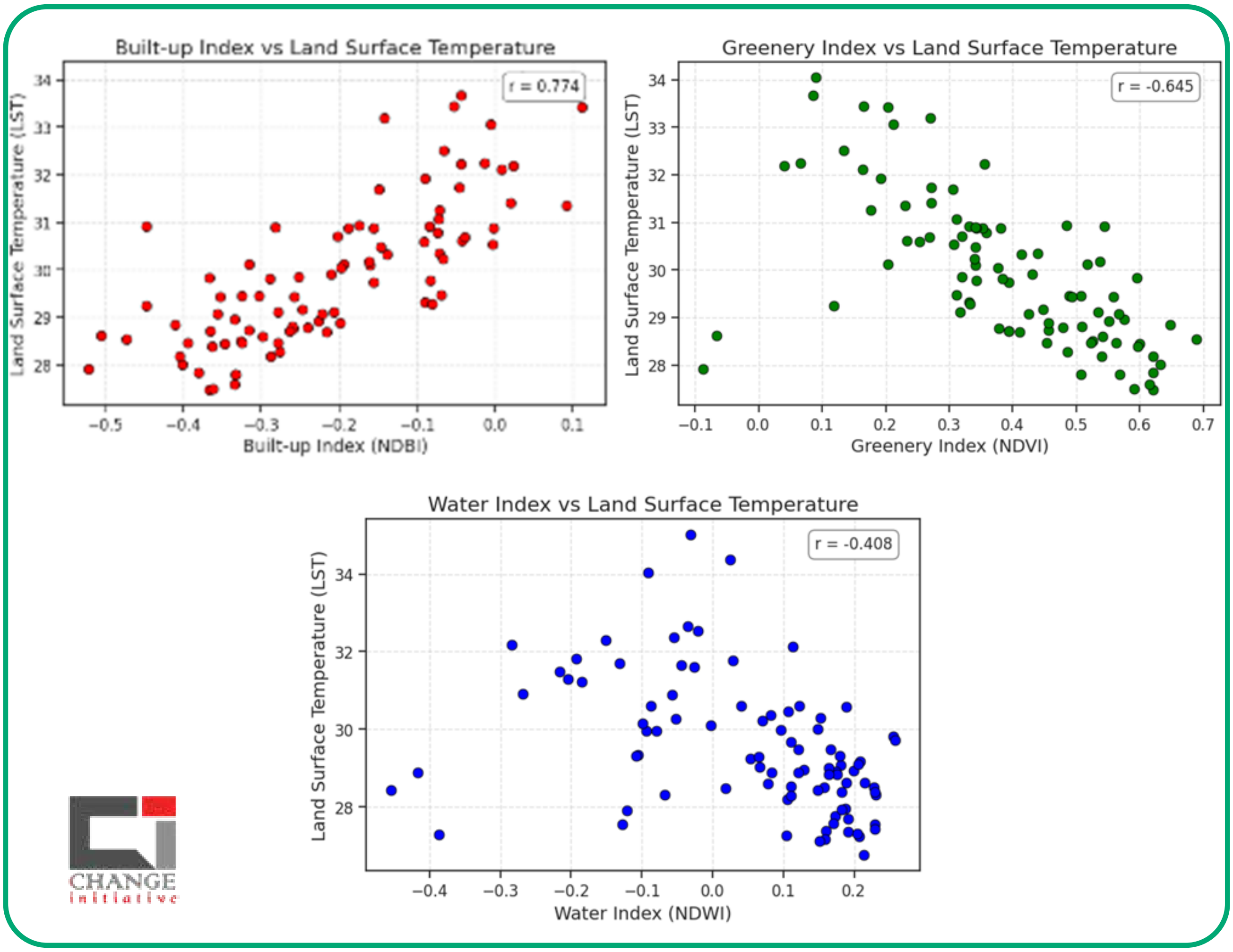


Figure 24: Regression Analysis; Relationship Between Land USe Pattern snd LST

The results show a strong positive relationship between LST and NDBI, with a correlation value of r = 0.774. This means that areas with more built-up surfaces like roads, buildings, and infrastructure tend to have much higher temperatures.; simply put, the more urban the area, the hotter it gets. This supports the well-known urban heat island effect, where cities are noticeably warmer than their surrounding rural areas.

In contrast, there is a moderate negative relationship between LST and NDVI, with a correlation of r = -0.645. This indicates that areas with more vegetation, such as trees, grass, or farmland, tend to be cooler as vegetation may provide shade and releasing moisture into the air through a process called evapotranspiration.

Lastly, the correlation between LST and NDWI was weaker, with a value of r = -0.408. This still shows a negative relationship, meaning that places with more surface water tend to have lower temperatures, but the effect is less pronounced compared to greenery. This may be because water-covered areas are less widespread or less influential on temperature in the study area.

Overall, the analysis highlights that urbanization significantly increases surface temperature, while vegetation and water help cool the land. These findings emphasize the importance of maintaining green and blue (water) spaces in city planning to reduce heat and improve environmental comfort.

3.9 Urban Heat Mitigation through Green and Blue Infrastructure in Dhaka City Corporation

Component	Current Area (km²)	Target Area (km²)	Required Increase (km²)	Cooling Rate (°C/km²)	Estimated Cooling (°C)
Tree Cover	35.3	91.8	+56.5	0.008	**~0.45°C**
Waterbody (15%)	14.7	45.9	+31.2	0.018	**~0.56°C**

Figure 25: Urban Heat Mitigation through Green and Blue Infrastructure in Dhaka City Corporation

Total Estimated Average LST Reduction
• If 9 m² tree cover/person + 14.5 m² water/person:
→ ~1.01°C LST reduction
Meeting at least the global best-practice green (9 m² tree cover per person) and blue (4.5 m² waterbody per person) infrastructure standards in Dhaka could reduce average LST by approximately 1°C. This minimum threshold of ecological coverage would significantly mitigate urban heat island effects, enhance thermal comfort, and bolster climate resilience in the city.

3.10 Cooling benefits of Urban Parks

3.10.1 A Case study on Ramna Park

This case study focuses on Ramna Park in Shahbagh Thana, a major urban park in Dhaka, to examine how vegetation and waterbodies affect LST in the surrounding environment. The study uses LST data and visual profiles to compare temperature differences over green areas (vegetation) and blue areas (waterbodies).

Two transect lines were drawn:

• One line, 755.35 meters long, crosses the vegetated (green) part of the park.
• The second line, 788.52 meters long, crosses the waterbody inside the park.
These lines help to clearly show temperature changes when entering the park, and this distance is also used to understand the LST profile graph.

From the map and LST profile graph, it is clear that:

• Urban areas surrounding the park have higher surface temperatures, often exceeding 32°C.
• When the transects enter Ramna Park, especially over green and blue zones, the LST drops noticeably.
• The green area of the park shows LST values mostly around 29.5–30.5°C, about 1.5°C lower than the surrounding built-up zones.
• The waterbody inside the park shows the lowest LST, dropping below 28.5°C in some areas, showing a cooling effect of more than 3°C compared to nearby urban surfaces.

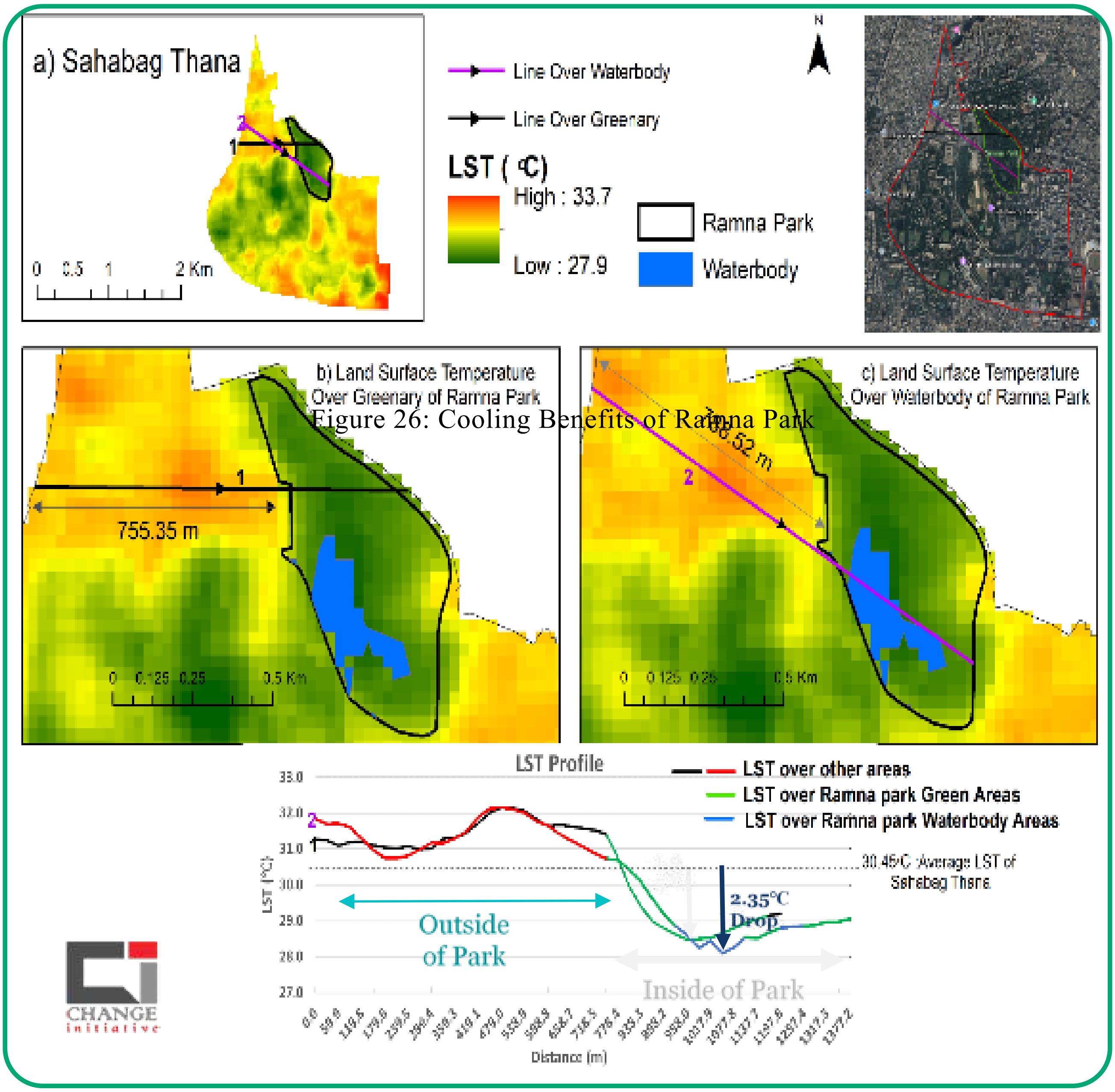


Figure 26: Cooling Benefits of Ramna Park

Figure 26: Cooling Benefits of Ramna Park

The LST line graph clearly reflects this pattern:

• The black line shows higher temperature over the built-up area.

• The green line (vegetation) and blue line (waterbody) show consistent temperature drops when passing through the park.

• The waterbody line has the most significant cooling, followed by the vegetated area.

These results show that urban parks significantly reduce land temperature, and within them, waterbodies provide a stronger cooling effect than vegetation. This cooling benefit not only helps regulate urban microclimate but also makes the area more comfortable and livable, especially during hot summer months.

3.10.2 A Case study on Botanical Garden

This case study investigates the cooling effects of urban green and blue spaces by analyzing the Botanical Garden located in Shah Ali Thana, Dhaka. Using LST data from 2024 and a Land Use map, this analysis evaluates the temperature differences across built-up, vegetated, and water-covered areas.

Transect Profiles and Distances

Two transects are used to understand the spatial variation of LST:

- A black line of approximately 1470 meters, running over dense vegetation inside the Botanical Garden.
- A purple line of 149.89 meters, crossing the waterbody.

These lines help in clearly identifying the cooling performance of different land cover types and make it easier to interpret the LST profile graph. The LST map shows values ranging from 27.04°C to 39.84°C across Shah Ali Thana, with the average LST being 30.80°C. The built-up areas (especially in the southeast) register the highest temperatures, while vegetated and water-covered zones inside the garden show significantly lower values.

- Over green areas, the temperature drops well below the average, reaching around 28–29°C.
- Over waterbody areas, the LST is even lower, falling close to 27°C, showing a cooling effect of more than 3°C compared to the average.

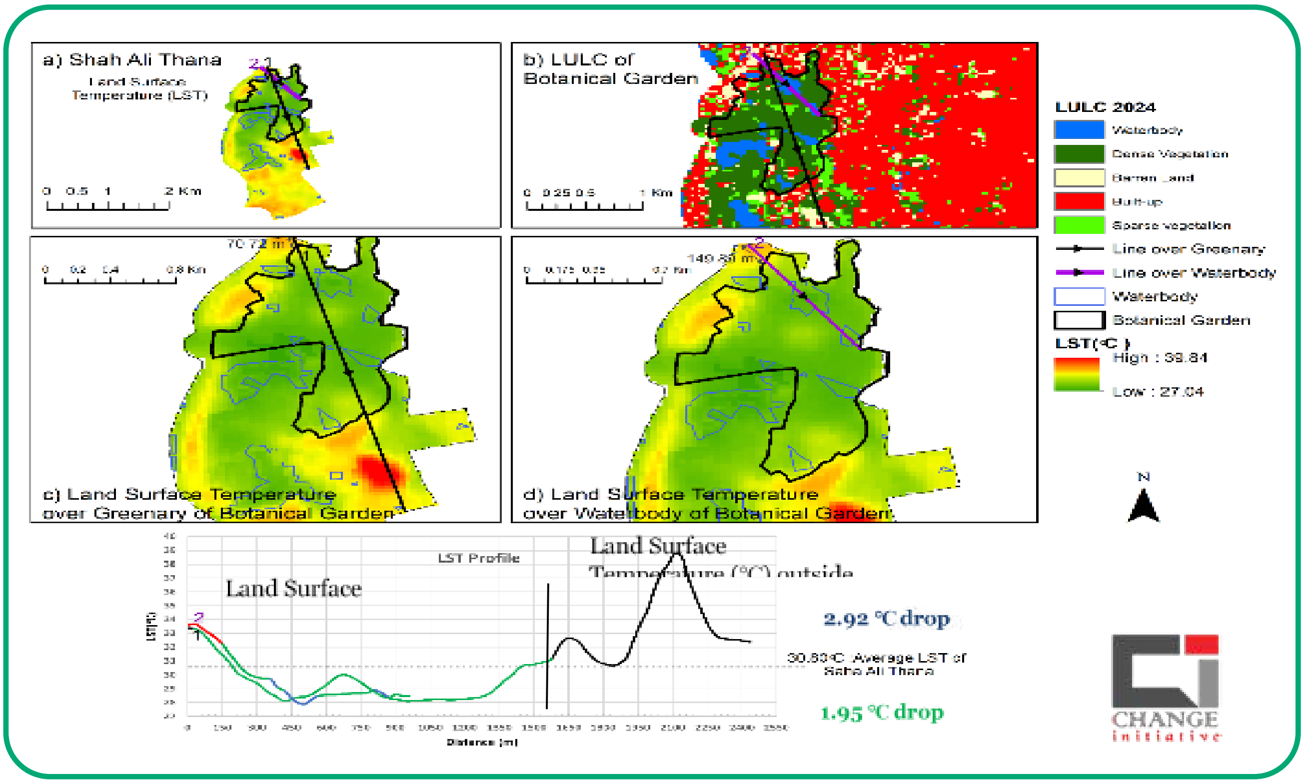


Figure 27: Cooling Benefits of Botanical Garden

The LST profile graph visually demonstrates these cooling differences:

- The black line represents LST over built-up or other surrounding areas, showing sharp peaks above 36°C, especially in non-vegetated zones.
- The green line, representing the greenery of the Botanical Garden, maintains a steady drop in temperature and remains consistently below 30°C across the entire transect.
- The blue line, representing the waterbody, dips even lower, confirming the greater cooling capacity of surface water compared to vegetation.

These cooling patterns align with ecological principles—vegetation provides shading and evapotranspiration, reducing heat buildup, while waterbodies have a higher heat capacity, maintaining lower surface temperatures through evaporative cooling.

Discussion

4. Discussion

This study offers a spatially grounded, rights-based analysis of Dhaka's ecological transformation over the past four decades. The empirical evidence reveals a stark shift in land use patterns, characterized by the rapid expansion of built-up areas and corresponding depletion of green and blue spaces. As the urban population has surged, so too has the pressure on land, triggering the conversion of ecologically vital spaces—including forests, agricultural fields, and wetlands—into concrete infrastructure. This pattern of growth, though common in many developing megacities, takes on particular urgency in Dhaka due to the city's limited ecological buffers and fragmented governance structure, which together pose critical risks to long-term sustainability, public health, and environmental equity.

Compared to other major cities, Dhaka's ecological indicators are deeply concerning. With 59.1% of its land already built-up and only 11.6% tree cover and 4.8% water bodies, the city is far below the minimum standards for environmental health. In contrast, cities like Singapore and Copenhagen have managed to integrate high levels of green and blue infrastructure, Singapore maintains 47% tree cover and around 9% water bodies with only 47% built-up area, while Copenhagen balances 40–45% built-up area with up to 40% green space and 12% water coverage.

City (in 2024)	**Existing Built-up (%)**	**Existing Tree Cover/ Green Space (%)**	**Existing Water Bodies (%)**	**Comparative Remarks**
Dhaka	59.1%	11.6%	4.8%	Urban expansion is too high; green and water spaces are insufficient for a healthy environment
Singapore	47%	47%	~9%	World-leading model for nature-integrated urban planning.
Copenhagen	40–45%	35–40%	10–12%	Balances growth with strong environmental protection
Seoul	55–60%	25–30%	10–12%	Example of successful ecological restoration in a dense city
Delhi	60-65%	20-23%	~4–6%	Faces serious air pollution; green space per capita is improving but unequal across districts
Karachi	65–70%	<10%	~3%	Severe ecological imbalance, poor zoning enforcement, and extreme heat vulnerability

Figure 28: Urban Heat Mitigation through Green and Blue Infrastructure in Dhaka City Corporation

Even in densely populated Seoul, ecological restoration has achieved 25–30% tree cover and up to 12% water space despite 55–60% built-up pressure. Delhi and Karachi, though more comparable to Dhaka in terms of density and governance challenges, still highlight the danger of neglect Karachi's <10% green space and 3% water coverage point to severe ecological collapse and heat vulnerability. These comparisons show that Dhaka is at a critical point, where further urban expansion without ecological safeguards could push the city into irreversible environmental decline

Dhaka's ecological mosaic is now heavily fragmented. The reduction of green infrastructure, urban forests, community parks, grasslands has sharply diminished the city's capacity to buffer heat, regulate water, and support urban biodiversity. Directional expansion patterns reveal that the southern and southeastern parts of the city have experienced the most intense encroachment, with massive conversion of agricultural lands and disappearance of waterbodies.LST data reinforces this observation: areas with minimal tree cover and vegetative density record average surface temperatures exceeding 32°C, with local hot spots 2-4°C warmer than adjacent greener areas. This trend is especially pronounced in DSCC, which shows significantly lower green space coverage (0.10 m² per capita) and canopy cover compared to DNCC (1.2 m² per capita). Major parks like Ramna and the Botanical Garden serve as critical micro-climate stabilizers, offering temperature reductions of up to 3.5°C. However, such spaces are unevenly distributed, inaccessible to most residents, and insufficient in scale to mitigate city-wide thermal stress.
Waterbody loss has been particularly severe. Between 1980 and 2024, more than 94.3 km² of water-dependent agricultural land and wetlands were lost, especially in northern and central Dhaka. Functional canals and drainage systems, including the Khidir Canal, have been encroached, filled, and converted into solid waste dumping zones. Despite intermittent clean-up and restoration campaigns, many of these waterways remain clogged or degraded due to inadequate monitoring and coordination among institutions. This loss of hydrological infrastructure not only increases flood vulnerability but undermines the ecosystem services essential for climate adaptation.

This study further identifies stark spatial disparities in ecological resilience. While DNCC retains relatively higher vegetation density due to its peripheral geography and presence of institutional land (e.g., military, education, and diplomatic zones), DSCC suffers from acute ecological deprivation. Densely populated thanas such as Bangshal, Shyampur, and Wari record the lowest tree cover, highest LST, and limited green space access. These neighborhoods are ecologically marginalized and disproportionately exposed to the risks of heatwaves, flooding, and poor air quality. Such disparities constitute more than planning failures;they reflect a systemic denial of basic environmental entitlements to low-income communities.

Institutional and governance failures lie at the heart of this ecological decline. While oversight bodies like Ministry of Environment, Forest and Climate Change (MoEFCC), DNCC, and DSCC have regulatory mandates, it is RAJUK through its planning and development authority—and REHAB—through its implementation of housing projects—that exercise the greatest influence on Dhaka's urban form. RAJUK's building approval process often bypasses thorough environmental scrutiny, enabling construction in flood-prone areas, canal zones, and vegetated lands. The institutional fragmentation across agencies like the Dhaka Water Supply and Sewerage Authority (WASA), Titas Gas, Fire Service, Department of Environment, and Dhaka traffic and police departments generates incoherent policy actions. The lack of a legally binding coordination framework perpetuates this fragmentation.

A key governance gap is the absence of environmental risk internalization in urban development decisions. The Strategic Environmental Assessment (SEA) conducted in 2007 by RAJUK had already flagged critical weaknesses: poor inter-agency collaboration, opaque decision-making, and collusion between regulatory bodies and vested interests. Yet, reforms remain piecemeal. Amendments to the Detailed Area Plan (DAP), often made under pressure from real estate developers, have further eroded institutional commitments to protect natural assets. Wetland and waterbody encroachment continues with impunity, undermining both the legal framework and public trust.

The erosion of ecological spaces in Dhaka is not only an environmental crisis but a rights-based violation as defined by the NRLG framework. The dramatic decline in green space and waterbody coverage directly illustrates the violation of Nature's Right to Exist, as entire ecosystems are eliminated without institutional recognition of their intrinsic value. The obstruction and artificial modification of rivers, canals, and natural hydrology, coupled with rigid infrastructure replacing organic systems, reflect the violation of Nature's Liberty or Freedom. Disparities in access to green cover, ecological services, and climate safety between DNCC and DSCC expose the violation of Social Harmony and Justice, particularly for heat-vulnerable, low-income residents. Finally, the marginalization of community knowledge and stewardship evident in the displacement of peri-urban agricultural traditions and the erasure of nature-dependent livelihoods underscores the violation of Indigenous Knowledge and Culture.

In sum, Dhaka's trajectory of growth is not merely ecologically unsustainable but structurally unjust. The fourfold rights violations, as identified through the Natural Rights lens, expose governance failures rooted in institutional design, political economy, and planning practice. Addressing these issues will require a multi-pronged reform strategy: integrating natural rights into urban regulatory frameworks; strengthening inter-agency coordination and legal mandates; enforcing ecological safeguards in all phases of urban planning; and embedding community-based, participatory approaches into land and resource governance. Without such structural shifts, Dhaka's environmental decline will continue to deepen, threatening both human well-being and the natural systems that sustain it.

Policy Recommendation

5. Policy Recommendation

Dhaka's ecological transformation has been swift and severe, with rapid urbanization leading to the significant loss of green spaces, water bodies, and natural habitats. As the city's surface temperatures rise and environmental degradation accelerates, it becomes increasingly evident that the current model of urban growth cannot continue without dire consequences for both the environment and the population. This report proposes a comprehensive set of actions aimed at realigning Dhaka's development with Natural Rights-Led Governance (NRLG), a framework that recognizes nature not only as a resource to be used but as a living entity that has the right to exist, regenerate, and flourish.

The following recommendations are organized into short-term and long-term priorities that focus on immediate interventions as well as sustainable urban transformation. These actions aim to mitigate the growing ecological crisis while promoting a more equitable and resilient urban environment.

5.1 Short-Term Priorities (0–3 Years)

In the immediate term, it is essential to establish foundational policies and frameworks that recognize and protect the city's natural assets. These measures focus on legislative and institutional reforms, aimed at halting further environmental degradation and laying the groundwork for future interventions.

Actions	Concerned Stakeholders
Following the recent judgement of the International Court of Justice, legislate Nature's Rights in Bangladesh.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
Ban filling of natural forests, canals, ponds, and wetlands and declare such actions as crimes against nature.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
Reform the Detailed Area Plan (DAP) with clear ecological buffers; declare Urban Ecologically Critical Zones; and legally restrict Floor Area Ratio (FAR) in eco-sensitive zones.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
Form community stewardship (guardianship) models to protect natural resources.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
Enact mandatory green zoning and eco-compensation; embed equity metrics into DAP and zoning laws.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC
Implement tree census, ecological audit, afforestation zones, and green rooftop laws.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC MoWR, DNCC, DSCC
Impose at least 5 times higher holding tax for concrete structures compared to nature-friendly structures.	DNCC, DSCC

Medium- to Long-Term Priorities (3+ Years)

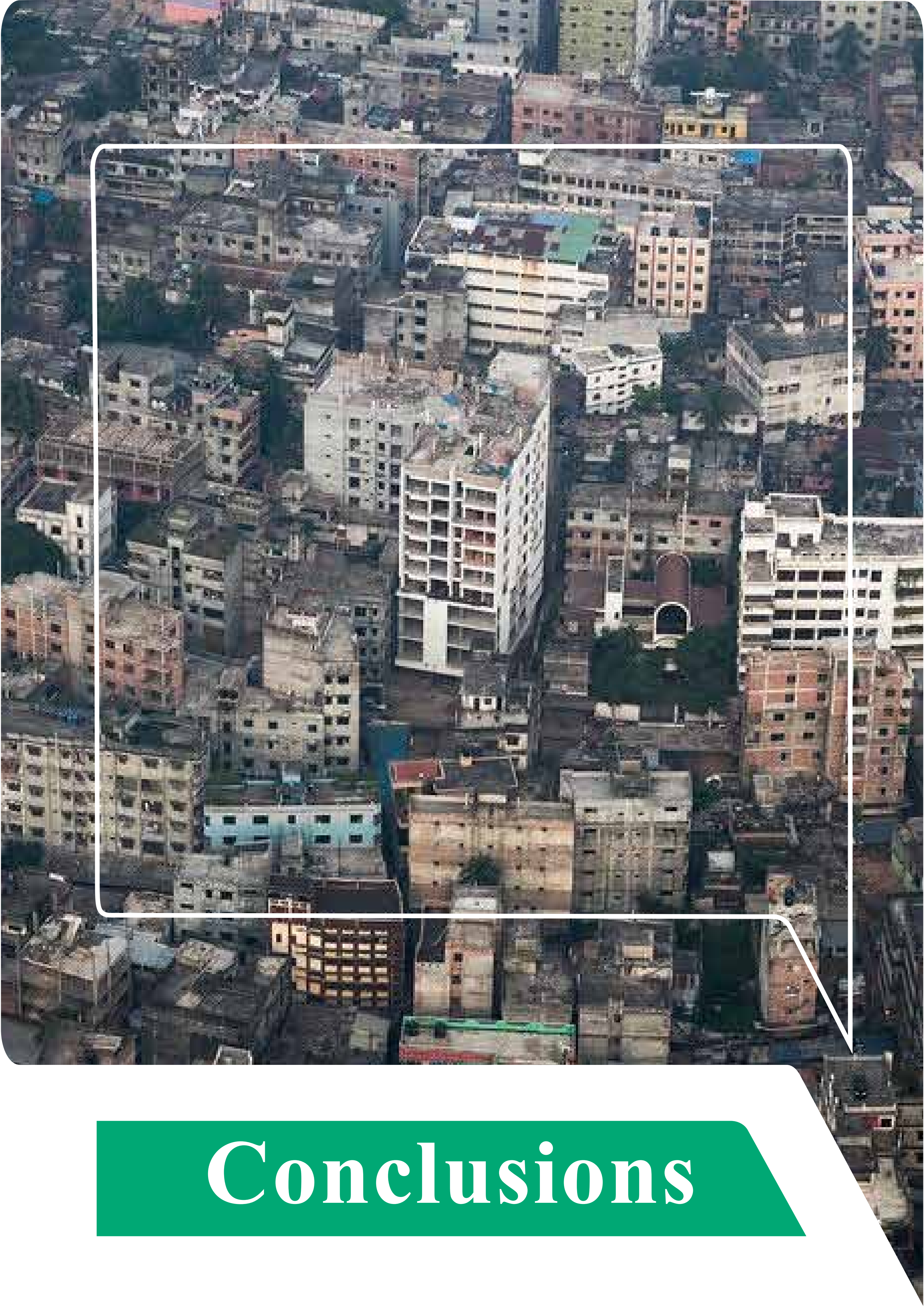
Looking ahead, Dhaka must integrate nature-based solutions into its urban planning to create a balanced and sustainable cityscape. These long-term strategies focus on large-scale ecological restoration, the implementation of green infrastructure, and the prioritization of vulnerable communities.

Actions	Concerned Stakeholders
Prioritize low-income and high-density areas for nature protection-related bio-investment.	MoEFCC, MoLGRD, MoF, DNCC, DSCC
Plant 56.5 km^2 of trees, targeting ecologically deprived zones.	DoForest, DNCC, DSCC, DCCI, Community
Greening and wetland restoration to reduce temperatures by ~1°C.	DoForest, DNCC, DSCC, DCCI, Community
Reintroduce buffer zones and community water stewardship programs.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC, Private Sectors
Prioritize heat-vulnerable zones and water-stressed thanas in climate adaptation strategies.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC, Private Sectors
Develop a digital system for stakeholder-wide natural accountability.	MoEFCC, MoLGRD, MoLaw, RAJUK, DNCC, DSCC, Private Sectors

The urgency of these recommendations is underscored by the accelerating environmental challenges facing Dhaka. Without decisive action, the city risks becoming increasingly uninhabitable, especially for its most vulnerable populations. These proposed actions, grounded in the Natural Rights framework, offer a comprehensive approach to urban sustainability that can both address the current ecological crisis and foster long-term resilience.

Implementing these recommendations will require coordinated efforts from government agencies, local authorities, civil society, and the private sector. While the short-term actions lay the foundation for protecting and restoring the city's ecological integrity, the medium- to long-term strategies will help ensure that Dhaka evolves into a green, resilient, and sustainable urban center—one where nature is not only preserved but is recognized as a critical partner in the city's future.

This vision of Dhaka can only be realized by embracing a holistic approach to urban planning—one that views the environment not as an obstacle to development but as an essential component of a thriving, equitable, and just city.



Conclusions

6. Conclusions

This study provides a comprehensive spatial and temporal analysis of Dhaka's land use transformation between 1980 and 2024, with a particular focus on the interaction between tree cover and LST, and the role of urban green spaces in mitigating heat stress. The findings clearly demonstrate that rapid urban expansion across both DNCC and DSCC has resulted in substantial losses of tree cover, grasslands, and waterbodies, contributing to the intensification of the urban heat island effect.

The strong inverse relationship between vegetation cover and LST highlights the critical importance of urban greenery in enhancing climate resilience. Thanas with higher tree cover consistently exhibit cooler temperatures, while low-cover, densely built zones suffer from elevated heat exposure. Case studies of key urban parks further confirm that strategically located green spaces provide measurable cooling benefits, improving thermal comfort and public health outcomes.

However, the analysis also reveals widening spatial disparities between DNCC and DSCC in both ecological resilience and green infrastructure. Peripheral DNCC retains important green buffers, while DSCC's older urban core faces acute deficits in tree cover and escalating heat risks. These patterns underscore the urgent need for differentiated, area-specific planning approaches.

Moving forward, integrating green infrastructure into Dhaka's urban development strategy is essential. Targeted greening of heat-stressed thanas, preservation of remaining green assets, expansion of urban park networks, and stronger governance of land use change are key priorities. Without such interventions, Dhaka risks further deepening spatial inequalities in climate resilience and urban livability.

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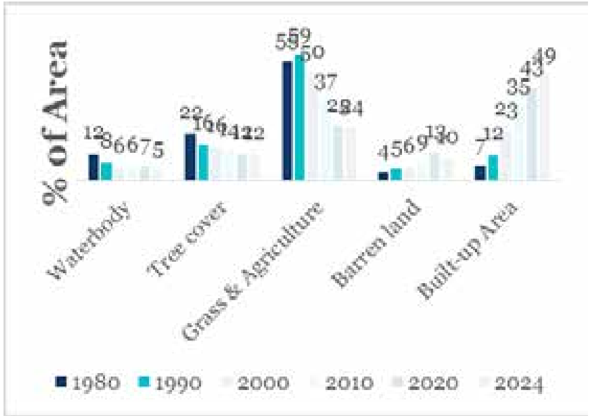
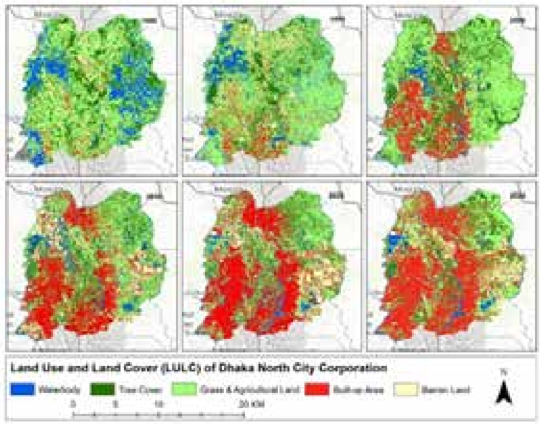
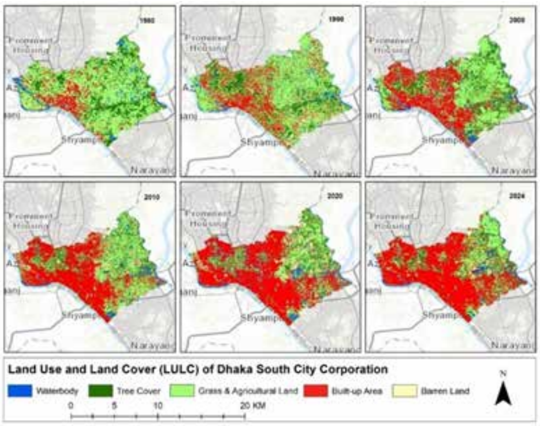
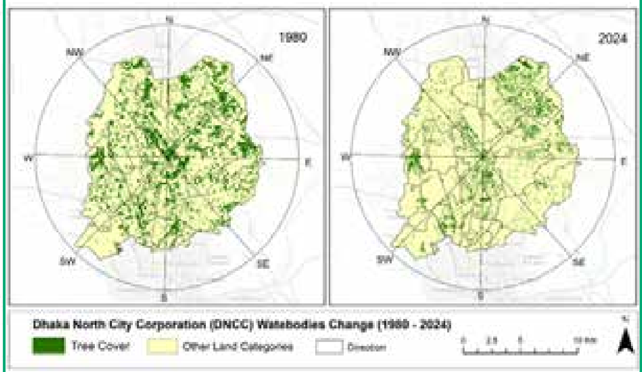
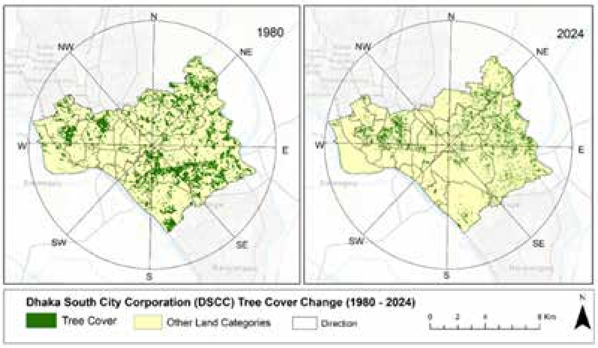
Annex

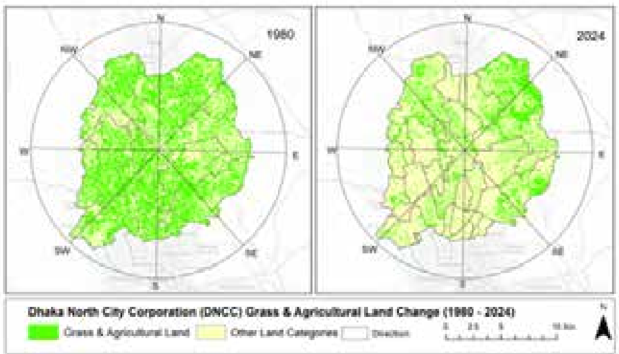

% of Area
Waterbody
Tree cover
Grass & Agriculture
Barren land
Built-up Area
1980
1990
2000
2010
2020
2024

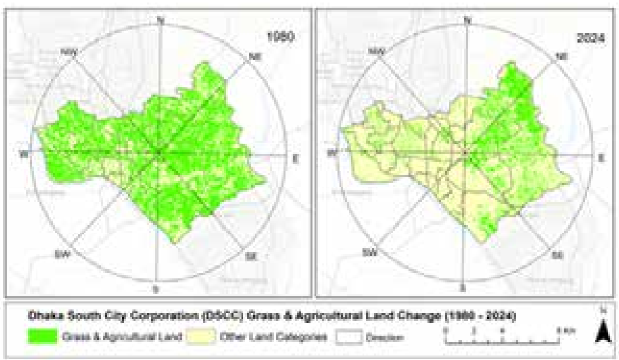

Land Use and Land Cover (LULC) of Dhaka North City Corporation
Waterbody
Tree Cover
Grass & Agricultural Land
Built-up Area
Barren Land


Land Use and Land Cover (LULC) of Dhaka South City Corporation
Waterbody
Tree Cover
Grass & Agricultural Land
Built-up Area
Barren Land


1980
2024
Dhaka North City Corporation (DNCC) Waterbodies Change (1980 - 2024)
Tree Cover
Other Land Categories
Direction


1980
2024
Dhaka South City Corporation (DSCC) Tree Cover Change (1980 - 2024)
Tree Cover
Other Land Categories
Direction


1980
2024
Dhaka North City Corporation (DNCC) Grass & Agricultural Land Change (1980 - 2024)
Grass & Agricultural Land
Other Land Categories
Direction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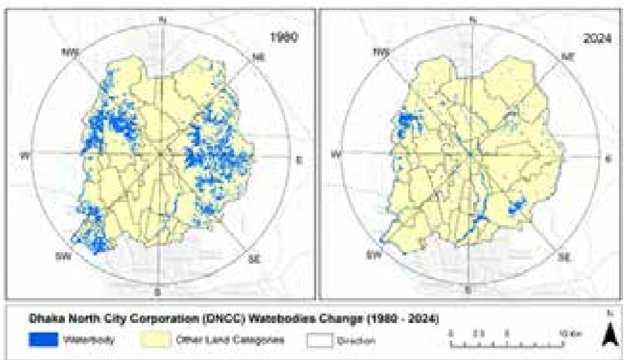
2024
Dhaka South City Corporation (DSCC) Grass & Agricultural Land Change (1980 - 2024)
Grass & Agricultural Land
Other Land Categories
Direction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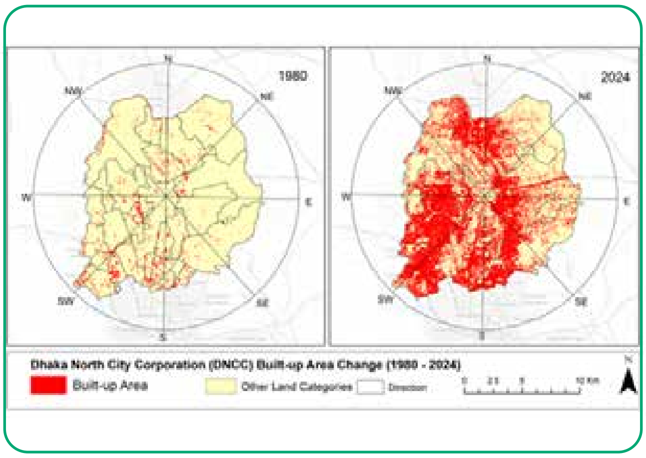
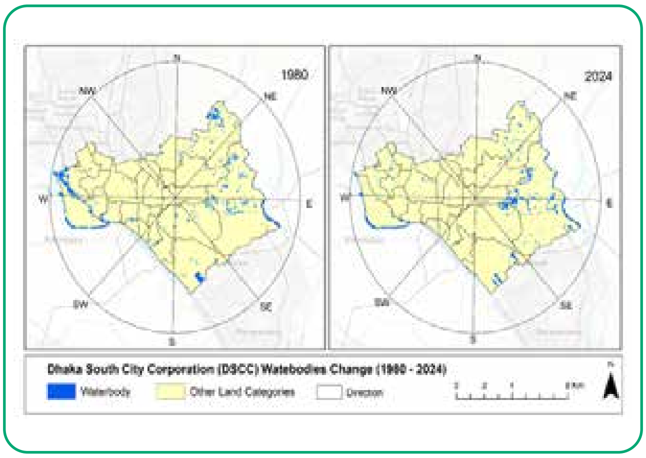
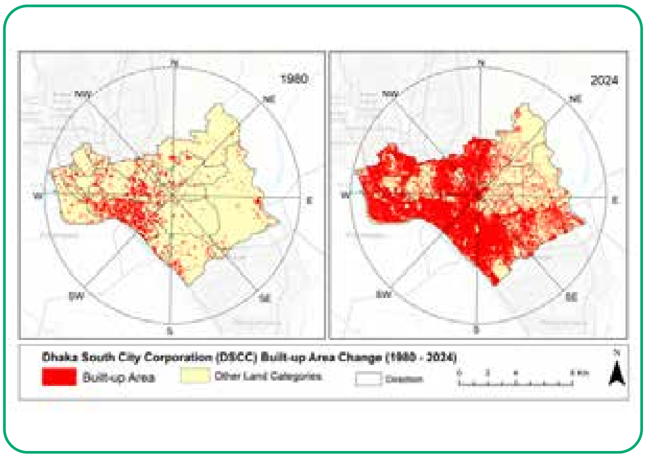
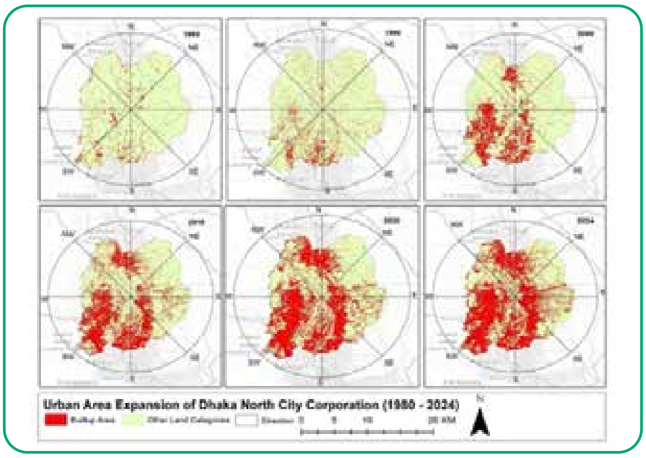
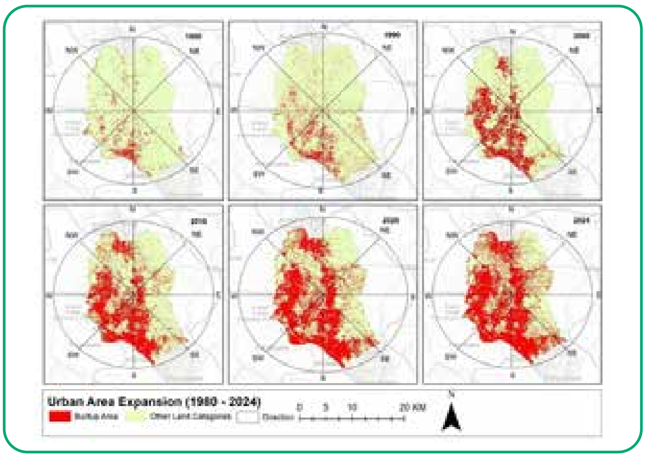
2024
Dhaka North City Corporation (DNCC) Waterbodies Change (1980 - 2024)
Waterbody
Other Land Categories
Direction

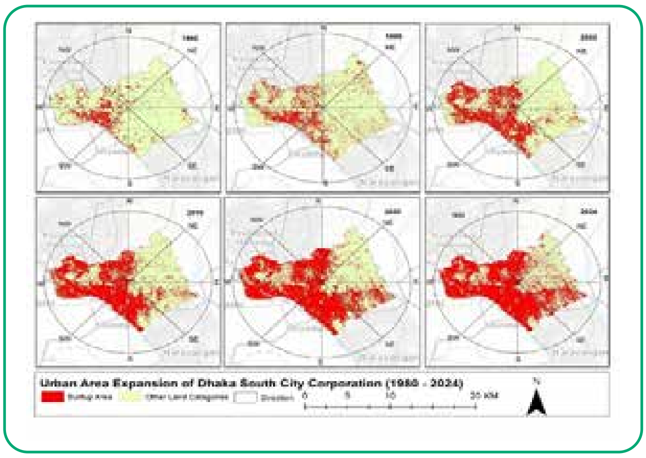

1980
2024
Dhaka North City Corporation (DNCC) Built-up Area Change (1980 - 2024)
Built-up Area
Other Land Categories
Direction

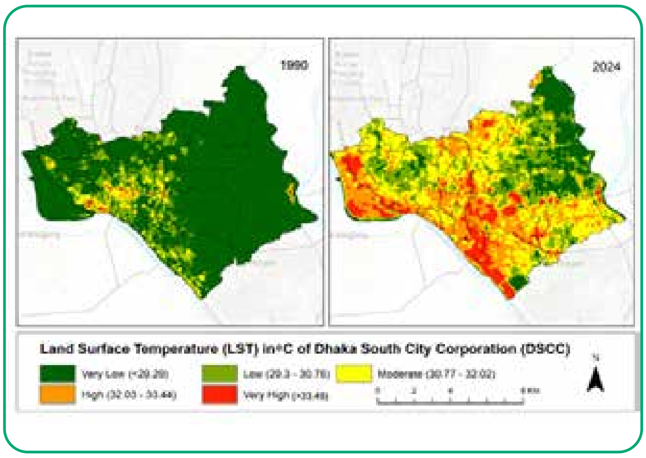

1980
2024
Dhaka South City Corporation (DSCC) Watebodies Change (1980 - 2024)
Waterbody
Other Land Categories
Direction

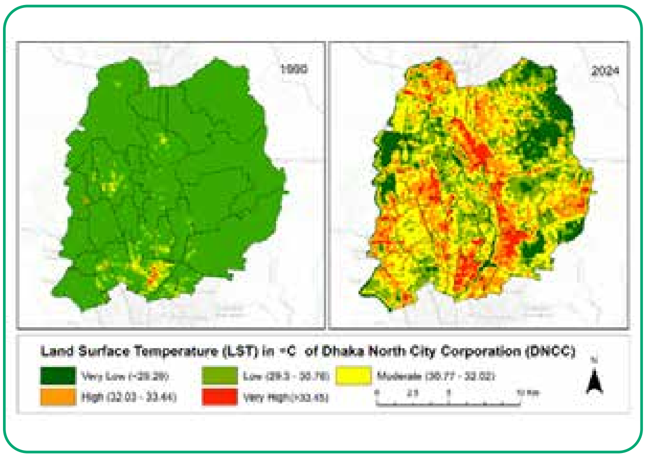

1980
2024
Dhaka South City Corporation (DSCC) Built-up Area Change (1980 - 2024)
Built-up Area
Other Land Categories
Direction


Urban Area Expansion of Dhaka North City Corporation (1980 - 2024)


Urban Area Expansion (1980 - 2024)


Urban Area Expansion of Dhaka South City Corporation (1980 - 2024)


1990
2024
Land Surface Temperature (LST) in°C of Dhaka South City Corporation (DSCC)
Very Low (<29.29)
Low (29.3 - 30.76)
Moderate (30.77 - 32.02)
High (32.03 - 33.44)
Very High (>33.45)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2024
Land Surface Temperature (LST) in °C of Dhaka North City Corporation (DNCC)
Very Low (<29.29)
Low (29.3 - 30.76)
Moderate (30.77 - 32.02)
High (32.03 - 33.44)
Very High (>33.45)

1. Land Use change Estimation of Dhaka Mega Urban

Class	Waterbody		Tree cover		Grass & Agriculture		Vacant land		Built-up Area	
Year	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%
1980	37.3	12.3	65.7	21.6	168.8	55.4	11.7	3.8	20.7	6.8
1990	24.1	7.9	49.9	16.4	178.3	58.5	16.5	5.4	35.8	11.8
2000	16.8	5.5	47.1	15.5	152.1	50	18.1	5.9	70.2	23.1
2010	19.3	6.3	41.9	13.8	111.3	36.6	26.2	8.6	105.7	34.7
2020	20.1	6.6	37.5	12.3	76.6	25.2	39.3	12.9	130.6	42.9
2024	14.7	4.8	35.3	11.6	74.4	24.4	31.1	10.2	148.8	48.9

2. Land Use Estimation of DNCC

	Waterbody		Tree cover		Grass & Agriculture		Vacant land		Built-up Area	
Year	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%
1980	32.7	15.9	45.8	22.3	108.4	52.8	9.3	4.5	9.1	4.4
1990	20.1	9.8	33.6	16.3	122.4	59.6	12.6	6.1	16.8	8.1
2000	11.8	5.7	31.2	15.2	110.3	53.7	12.1	5.9	39.9	19.4
2010	14.7	7.2	30.5	14.8	74.9	36.4	22.6	11	62.7	30.5
2020	13.9	6.8	27.1	13.2	53.6	26.1	30.3	14.7	80.3	39.1
2024	10.6	5.1	25	12.2	51.2	24.9	25.3	12.3	93.2	45.4

3. Land Use Estimation of DSCC

Dhaka South City Corporation Land Use

	Waterbody		Tree cover		Grass & Agriculture		Vacant land		Built-up Area	
Year	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%	Area (Sq.Km)	%
1980	4.6	4.6	19.9	20.1	60.3	61	2.4	2.5	11.7	11.8
1990	4	4	16.3	16.4	55.87	56.4	3.9	3.9	19	19.2
2000	5	5.06	15.9	16	41.8	42.2	6	6.04	30.3	30.6
2010	4.6	4.6	11.4	11.5	36.4	36.7	3.6	3.7	43	43.4
2020	6.2	6.2	10.4	10.5	23	23.3	9	9.1	50.3	50.8
2024	4.1	4.1	10.3	10.4	23.2	23.4	5.8	5.8	55.6	56.2

4. Tree Cover Change Directional Estimation of Dhaka City

Direction	Tree Cover Area in 1980 (sq.km)	Tree Cover Area in 2024 (sq.km)	Area Lost (sq.km)	% Change
E	7.7	4.4	-3.3	-42.9%
N	13	9.5	-3.5	-26.9%
NE	5.2	2	-3.2	-61.5%
NW	12.4	5.7	-6.7	-54.0%
S	5	3.1	-1.9	-38.0%
SE	11.5	4.2	-7.3	-63.5%
SW	4.6	3	-1.6	-34.8%
W	6.4	3.4	-3	-46.9%

5. Tree Cover Change Directional Estimation of DNCC

Direction	Tree Cover Area in 1980 (sq.km)	Tree Cover Area in 2024 (sq.km)	Area Lost (sq.km)	% Change
E	7.7	4.4	-3.3	-42.9%
N	13	9.5	-3.5	-26.9%
NE	5.2	2	-3.2	-61.5%
NW	12.4	5.7	-6.7	-54.0%
S	5	3.1	-1.9	-38.0%
SE	11.5	4.2	-7.3	-63.5%
SW	4.6	3	-1.6	-34.8%
W	6.4	3.4	-3	-46.9%

6. Tree Cover Change Directional Estimation of DSCC

Direction	DSCC Tree Cover Area Change (Sq.Km)			
	1980	%	2024	%
E	4.7	23.8	2	19.7
N	3.3	16.8	1.6	15.6
NE	3	15.2	3	28.8
NW	0.7	3.4	0.1	1
S	1.4	6.8	0.2	1.6
SE	2.9	14.4	0.6	5.8
SW	0.9	4.7	0.6	5.5
W	3	14.9	2.3	21.9

7. Directional Change in Grassland and Agricultural Land (1980–2024) of Dhaka City

Direction	G&A Land 1980 (Sq.Km)	G&A Land 2024 (Sq.Km)	Net Change (Sq.Km)	% Loss	Decadal Loss (Sq.Km)
East (E)	17.5	13.3	-4.2	24.0%	-0.95
North (N)	23.5	19.0	-4.5	19.1%	-1.02
Northeast (NE)	11.2	6.4	-4.8	42.9%	-1.09
Northwest (NW)	26.1	12.4	-13.7	52.5%	-3.11
South (S)	18.6	3.2	-15.4	82.8%	-3.50
Southeast (SE)	36.8	10.9	-25.9	70.4%	-5.89
Southwest (SW)	16.9	4.6	-12.3	72.8%	-2.79
West (W)	18.2	4.7	-13.5	74.2%	-3.07

8. Directional Change in Grassland and Agricultural Land (1980–2024) of DNCC

Direction	DNCC Grass & Agricultural land Area Change (Sq.Km)			
	1980	%	2024	%
E	12.4	11.4	6.7	13.2
N	16.4	15.1	10.6	20.6
NE	10.4	9.6	10.4	20.3
NW	14.3	13.2	6.7	13.1
S	17.7	16.3	4.6	9.1
SE	12.8	11.8	3.3	6.4
SW	15.2	14	2.8	5.5
W	9.3	8.5	6	11.8

9. Directional Change in Grassland and Agricultural Land (1980–2024) of DSCC

Direction	DSCC Grass & Agricultural Land Area Change (Sq.Km)			
	1980	%	2024	%
E	10.4	17.3	4.4	18.9
N	7	11.7	5.1	22
NE	10.4	17.2	7.9	34.2
NW	3.3	5.5	0.4	1.6
S	3.6	6	0.3	1.2
SE	7.6	12.6	1.9	8.3
SW	6.9	11.5	0.8	3.6
W	11	18.2	2.4	10.1

10. Directional Change in Waterbody (1980–2024) of Dhaka City

Direction	Waterbody Area 1980 (km²)	Waterbody Area 2024 (km²)	Absolute Change (km²)	Decadal Change Rate (km²/decade)
N	7.8	1.1	-6.7	-1.52
NE	7.2	1.4	-5.8	-1.31
NW	6.4	1.6	-4.8	-1.09
E	3.5	0.7	-2.8	-0.63
SW	5.2	2.8	-2.4	-0.55
W	4.2	3.1	-1.1	-0.25
SE	1.8	2.1	+0.3	+0.07
S	1.4	2.1	+0.7	+0.16

11. Directional Change in Waterbody (1980–2024) of DNCC

Direction	DNCC Waterbodies Area Change (Sq.Km)			
	1980	%	2024	%
E	7.7	23.4	0.9	8.9
N	0.9	2.7	0.5	5
NE	7.2	21.9	1.1	10.7
NW	2	6.1	1.1	10.1
S	2.7	8.1	0.9	8.1
SE	1.9	5.7	2	19.2
SW	2.7	8.1	1.2	10.9
W	7.8	24	2.9	27.1

12. Directional Change in Waterbody (1980–2024) of DSCC

Direction		DSCC Waterbodies Area Change (Sq.Km)		
	1980	%	2024	%
E	0.9	19.8	1.3	32.3
N	0.7	15.9	0.4	10.8
NE	0.7	15.3	1	23.8
NW	0	0.9	0	1
S	0.1	2.9	0.1	1.4
SE	0.4	9.1	0.4	8.7
SW	0.8	18.3	0.6	13.8
W	0.8	17.8	0.3	8.2

13. Built-up Area Change Estimation of Dhaka Mega City

Direction	Area 1980	Area 2024
E	1.0	6.5
N	1.0	13.4
NE	0.2	7.2
NW	1.8	22.5
S	7.4	24.2
SE	4.9	35.9
SW	2.9	19.7
W	1.6	19.4

14. Built-up Area Change Estimation of DNCC

Direction	1980	2024
N	0.9	8.6
NE	0.4	6.4
E	0.3	9.0
SE	1.1	12.5
S	2.9	18.0
SW	1.9	18.8
W	0.6	7.8
NW	1.1	12.2

15. Built-up Area Change Estimation of DSCC

Direction	1980	2024
N	0.5	3.7
NE	0.5	1.9
E	0.5	7.6
SE	0.8	8.8
S	1.1	5.6
SW	4.8	11.8
W	2.8	12.1
NW	0.6	4.0

16. Built-up Area Expansion by Direction in Dhaka City (1980–2024) [in Sq. Km]

Direction	1980	1990	2000	2010	2020	2024
N	1.0	1.6	3.2	6.6	9.9	13.4
NE	0.2	0.9	0.9	4.5	6.4	7.2
E	1.0	2.2	1.8	3.8	5.6	6.5
SE	4.9	9.2	17.8	27.0	33.4	35.9
S	7.4	9.9	16.9	21.9	21.9	24.2
SW	2.8	5.0	10.9	16.1	17.9	19.7
W	1.6	3.1	11.7	13.4	16.8	19.4
NW	0.9	2.5	7.0	12.6	18.7	22.5

17. Built-up Area Expansion by Direction in DNCC (1980–2024) [in Sq. Km]

Direction	1980	1990	2000	2010	2020	2024
N	0.9	1.1	2.0	3.6	6.2	8.6
NE	0.4	0.6	1.0	3.1	4.5	6.4
E	0.3	1.1	1.4	5.4	8.3	9.0
SE	1.1	2.5	7.0	10.2	11.7	12.5
S	2.9	6.0	10.8	14.6	16.1	18.0
SW	1.9	2.8	10.2	13.9	16.7	18.8
W	0.6	0.8	2.4	4.3	6.5	7.8
NW	1.1	1.5	3.5	7.5	10.4	12.2

18. Built-up Area Expansion by Direction in DSCC (1980–2024) [in Sq. Km]

Direction	1980	1990	2000	2010	2020	2024
N	0.5	0.9	0.9	2.3	3.4	3.7
NE	0.5	1.0	0.4	1.0	1.1	1.9
E	0.5	1.3	1.8	3.4	6.4	7.6
SE	0.8	1.6	4.2	6.5	8.4	8.8
S	1.1	2.4	4.1	5.3	5.4	5.6
SW	4.8	5.2	8.0	10.8	10.9	11.8
W	2.8	4.2	8.4	10.3	10.7	12.1
NW	0.6	1.1	2.5	3.4	3.9	4.0

19. Land Surface Temperature (LST) Analysis of Dhaka Mega City

LST Class	LST Range (°C)	Area (Sq. Km) in 1990	Area (Sq. Km) in 2024	Area Change (Sq. Km)	Change Direction
Very Low	< 29.2939	301.5891	42.0543	-259.5348	Decreased
Low	29.3 – 30.8	23.7123	77.9031	+54.1908	Increased
Moderate	30.8 – 32.0	6.5106	109.9197	+103.4091	Increased
High	32.0 – 33.4	1.8864	78.4980	+76.6116	Increased
Very High	33.4 – 39.8	0.2817	25.6050	+25.3233	Increased

20. Thana Wise Built-up (DNCC)

Thanas of DNCC	Total Area (Sq. Km)	Built-up Area (sq.Km)	% of Built-Up	considered manageable below 50% (Red- More than 50%, Green- Bellow 50%)
Bangshal	1.5	1.4	95.5	
Chakbazar	1.6	1.4	86.6	
Demra	19.7	6.3	32	
Dhanmondi	2.5	1.8	71.3	
Gendaria	1.4	1.3	90.8	
Hazaribag	2.6	2.1	82.3	
Jatrabari	10	6.8	68.5	
Kadamtali	8.8	6.3	72	
Kalabagan	1.2	1.1	92.4	
Kamrangichar	5.3	3.9	73.9	
Khilgaon	13.7	4.5	33.2	
Kotwali	0.7	0.6	88.6	
Lalbag	2.1	1.6	78	
Motijheel	2.4	1.7	69.4	
Mugda	3.7	1.9	50.2	
Newmarket	1.9	0.9	46.9	
Paltan	1.3	1.1	87.4	
Ramna	3.7	2.5	67.9	
Sabujbag	6.8	2.7	40.4	
Shahbag	4.1	1.7	41.2	
Shahjahanpur	1.4	1	72.4	
Shyampur	2.3	2	88.8	
Sutrapur	0.8	0.8	100	
Wari	1.5	1.4	92.9	

21. Land Surface Temperature (LST) Analysis of DNCC

Class	LST Range	DNCC			
		Area(SqKm) 1990	~~%~~	Area (Sq.Km) 2024	%
Very Low	<29.29	193	94	24.3	11.8
Low	29.3 - 30.8	9.8	4.8	50	24.4
Moderate	30.8 - 32.0	2	1	69.6	33.9
High	32.0 - 33.4	0.5	0.3	47.2	23
Very High	33.4 - 39.8	0.1	0	14.2	6.9

22. Land Surface Temperature (LST) Analysis of DSCC

Class	LST Range	DSCC			
		Area (SqKm) 1990	%	Area (Sq.Km) 2024	%
Very Low	<29.29	81.7	82.6	13.9	14.1
Low	29.3 - 30.8	11.9	12	20.9	21.1
Moderate	30.8 - 32.0	4	4	30.7	31
High	32.0 - 33.4	1.2	1.2	24.3	24.5
Very High	33.4 - 39.8	0.2	0.2	9.1	9.2