

Evaluating Land Use Changes in Dhaka City's Growing Urban Areas: Causes and Consequences

Sahela Hoque¹
Md. Anamul Haque²
S M Salehin Ratul¹
Ummeh Saika³

Abstract: *Urbanization has increased dramatically in recent years, with Dhaka City serving as a prominent example. It's rapidly growing in size, presenting multifaceted challenges. Using a multidisciplinary approach, the study integrates GIS techniques, remote sensing analysis, and socio-economic surveys to assess the spatial transformations driven by urbanization. The findings aim to identify the key drivers of land use changes and evaluate their implications for urban planning and future growth in specific areas of the city. By offering insights into the dynamics of urban expansion, this research helps develop strategies for sustainably managing evolving land use patterns. Dhaka City's rapid urban expansion has significantly changed land use patterns in its peri-urban areas, posing substantial obstacles to sustainable development.*

Keywords: Multidisciplinary, Agricultural Productivity, Sustainable Strategies, Spatial Transformations.

Introduction

As a result of Dhaka City's rapid expansion, land use patterns in the surrounding areas have changed significantly. The study employs a multidisciplinary approach that combines remote sensing techniques, Geographic Information System (GIS) analysis, and socioeconomic surveys to fully evaluate the spatial transformation. The purpose of Dhaka's city expansion plan was to cope with the problems associated with urbanization and accommodate the city's expanding population. To relieve traffic in the city center, new residential neighborhoods, business districts, and transit facilities had to be built.

¹ Researcher, Department of Geography and Environment, Jahangirnagar University

² Research Consultant, Centre for Environmental and Geographic Information Services (CEGIS), Dhaka

³ Professor, Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka-1342. Email: usaikau@juniv.edu

** Corresponding author: Sahela Hoque, Email: sahelahoque8@gmail.com

However, Dhaka City's actual growth has been haphazard and unplanned, resulting in large slums, poor infrastructure, and heavy traffic. The city's growth has outpaced the provision of basic services, which has led to resource strain, pollution, and environmental degradation. Effective urban planning and policy measures are urgently needed to close the gap between the expansion plan and Dhaka City's current reality in order to achieve sustainable growth. Studies on urban expansion in Dhaka City have consistently indicated rapid and unplanned growth, especially in last two decades, resulting in substantial changes in land use patterns. Researchers ([Ahmed A. H., 2017](#); [Rahman M. M., 2020](#)) have employed remote sensing and GIS techniques to analyze urban land cover changes, identifying the conversion of agricultural land and natural areas to built-up urban infrastructure. These findings emphasize the need for sustainable urban planning to address the spatial implications of rapid urban expansion. The rapid urbanization in developing nations is causing profound shifts in land usage, particularly impacting transportation and energy consumption within cities ([Poumanyong et al., 2012](#)). An in-depth knowledge of sustainable development issues is necessary for urban planners to navigate the complex challenges of managing cities and navigating political dynamics. An important first step in tackling these issues is researching the effects of urban growth on sustainability. To develop sustainable development policies, this knowledge is essential. Numerous topics are covered by urban sustainability, such as the economy, infrastructure, public involvement, environmental initiatives, community well-being, and governance. ([Deakin and Lombardi, 2005](#); [Finco and Nijkamp, 2001](#)). The study focusing on evaluating the impacts on land-use patterns in the expanding areas of Dhaka City holds profound significance amidst the burgeoning urbanization and rapid expansion of megacities globally. Dhaka City, as a prime example of rapid urban growth, stands at the forefront of this phenomenon, facing unprecedented challenges regarding land-use dynamics and sustainability in its expanding peripheries. Justifying the undertaking of such a study encompasses multifaceted dimensions, necessitating comprehensive research to address critical issues and implications. By employing advanced techniques such as remote sensing, GIS analysis, and socio-economic surveys, the study endeavors to generate comprehensive data that can inform evidence-based decision-making and policy formulation. It seeks to offer valuable inputs for urban planners, policymakers, and stakeholders to devise sustainable land-use policies that reconcile the needs of urban development. Additionally, the study holds significance in the broader context of sustainable urbanization and environmental conservation. The growth of Dhaka City affects agricultural areas, alters ecological balances, worsens the environment also

poses challenges to biodiversity conservation. Understanding these interconnections is crucial for devising holistic strategies that promote sustainable urban growth, preserve ecosystems, and mitigate environmental risks associated with urban expansion. Addressing these issues requires comprehensive research and innovative solutions that balance urban development imperatives with sustainable urban planning strategies. Developing approaches to manage rapid urban expansion is crucial for ensuring balanced growth, mitigating the adverse impacts on infrastructure, preserving ecological integrity, and fostering resilient communities in the face of accelerating urbanization. Therefore, the study aims to examine how land use patterns in the peri-urban areas of Dhaka City are affected by urban expansion and determine the factors that are causing these changes. Further, it assess the changes in land use patterns resulting from urban expansion, identify the driving factors behind changes in land use and find out their implications for future urban growth in particular areas of the city.

It is crucial to investigate how land-use patterns are evolving in Dhaka City's growing neighborhoods, particularly given the world's ongoing rapid urbanization. Being among the fastest-growing cities, Dhaka faces many difficulties as a result of its quick development. Urban infrastructure expansion into neighboring areas has resulted in a number of problems, such as resource strain, environmental changes, and challenges in efficiently managing development. To plan and manage the city's growth sustainably, it is essential to comprehend these changes. There are several reasons to justify conducting such a study, and in order to address important concerns and implications, thorough research is required. Such a study would help shape policy to effectively manage urban sprawl, encourage sustainable urban planning techniques, and offer insightful information about how land-use changes and urbanization interact. To guarantee a balanced approach to urban development that promotes equitable growth while minimizing adverse effects on the environment and livelihoods, it is imperative to comprehend these dynamics. This expansion frequently results in unplanned growth, which causes traffic jams, wasteful land use, and a shortage of infrastructure and necessary services. It is also difficult to maintain open spaces and guarantee fair access to resources and land because of the quick speed of change. Policymakers and urban planners can learn a great deal about how urban growth is changing the geography of cities by examining these trends. This research can help direct more sustainable urban development by addressing important issues like housing needs, infrastructure planning, and the general well-being of inhabitants.

Literature Review

The correlation between land use and transport has emerged as a vital aspect in contemporary planning practices, offering a comprehensive perspective to tackle pressing sustainability challenges (Krizek and Levinson, 2005). In Bangladesh, a developing nation aiming for middle-income status, sustainable development is a priority, especially as it strives to transition from a low-income economy (General Economics Division, BD, 2012; Sarker, 2018). Through initiatives like the Second Perspective Plan "Vision 2041," Bangladesh aims to achieve upper middle-income and eventually high-income status while emphasizing sustainable cities, efficient transport systems, and reduced air pollution via low-carbon strategies (BSS, 2019a; BSS, 2019b). The country has experienced remarkable economic growth and rapid urbanization, projecting a substantial rise in urban population by 2040 (Jones et al., 2016). However, this growth has come at the cost of arable lands and forests, pressuring limited resources and challenging environmental sustainability (Dewan et al., 2012; Uddin et al., 2023). Maintaining a balance between urbanization and environmental preservation becomes imperative to sustain GDP growth while preserving the quality of the environment. Achieving this equilibrium is crucial for Bangladesh's journey towards sustainable development and economic growth. Bangladesh's successful accomplishment of 13 out of 33 Millennium Development Goals (MDGs) has bolstered its confidence in pursuing the Sustainable Development Goals (SDGs) (BSS, 2016). However, the nation faces significant challenges in achieving these goals, especially considering limitations in resources. Reports highlight Bangladesh's position at the bottom among BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) countries and second last among SAARC (South Asian Association for Regional Cooperation) countries concerning SDG index rankings (Sachs et al., 2018). To attain SDGs, substantial global investments, estimated at \$5-7 trillion per year until 2030, will be required (Department of Economic and Social Affairs, UN, 2014). Despite Bangladesh's need for substantial investment in infrastructure, rural development, and climate change mitigation, current investment trends in these sectors are suboptimal. Furthermore, the lack of integration of SDGs into the national planning process remains a significant hurdle (Das et al., 2021). Under these circumstances, a research initiative aims to evaluate the intricate relationship between land use and transportation, pivotal elements in economic development, and their environmental impact. This evaluation seeks to guide Bangladesh towards a balanced approach between urbanization, economic growth, and efficient allocation of resources to tackle multiple environmental challenges. Dhaka, the capital of

Bangladesh, situated at 23°43'0" North latitude and 90°24'0" East longitude, has undergone significant land use changes driven by rapid urbanization ([Ahmed et al., 2014](#)).

This study focuses on Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC), both of which were formerly part of Dhaka City Corporation (DCC). Dhaka, the largest city in Eastern South Asia and one of the Bay of Bengal countries, has grown organically since its founding ([Islam, 2005](#)). Its urbanization, which is growing at a rate of about 4% annually compared to the national population growth of 2.2%, highlights its rapid expansion since independence ([RAJUK, 2015](#)). By 2025, Dhaka is projected to be the 4th largest megacity globally, with a population of approximately 24.7 million. By 2025, Dhaka is projected to be the 4th largest megacity globally, with a population of approximately 24.7 million, reflecting its rapid urban expansion (Macrotrends, 2021). This underscores the critical importance of evaluating land use changes in the Dhaka City Corporation Area between 2010 and 2022 to inform national policymaking and align with the Sustainable Development Goals (Department of Economic and Social Affairs, UN, 2014).

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Remote Sensing and GIS on Urban Expansion Detection

Geographic Information Systems (GIS) and remote sensing have proven essential for identifying and analyzing urban development, offering valuable insights into the variables influencing the dynamics of urban growth. Current research emphasizes the changing approaches and the function of these technologies in comprehending and controlling urban growth, particularly between 2005 and 2023. The use of remote sensing methods for detecting urban expansion is examined by [Qihao Weng](#) in "Remote Sensing of Urban and Suburban Areas" (2005). The use of different remote sensing data, including satellite imaging and aerial photography, in conjunction with GIS tools is covered in Weng's effort to monitor geographical shifts, urban sprawl, and changes in land usage. Accurate urban expansion pattern analysis and delineation are made possible by the integration of these technologies. In "Urban Expansion Detection Using Multi-Temporal Satellite Imagery and GIS: A Case Study of Shanghai, China" (2018), [Xuecao Li](#) et al. explore the intricacies of identifying and evaluating urban expansion through the use of multi-temporal satellite data and GIS. Within the context of Bangladesh, studies by Bangladeshi authors like Rahman et al. in "Urban Expansion Detection Using Remote Sensing and GIS: A Case Study of Dhaka City" (2013) have highlighted the significance of remote sensing and GIS in assessing urban expansion in Dhaka. Their research demonstrates how these tools contribute to mapping urban sprawl, assessing land-use changes, and comprehending the causes impacting urban growth in the context of a quickly expanding city like Dhaka. Additionally, research by Hossain et al. in "Remote Sensing-Based Urban Expansion Detection and Analysis in Chittagong City, Bangladesh" (2021) showcases the application of remote sensing in monitoring urban expansion in Chittagong. Their research emphasizes how, in the Bangladeshi context, remote sensing and GIS support the identification of spatial patterns of urban growth, the evaluation of the dynamics of land-use changes, and the facilitation of well-informed urban planning methods.

Land Use and Land Cover and Change Detection

A thorough analysis of LULC change dynamics is given by Lambin and Geist in "Land-Use and Land-Cover Change: Local Processes and Global Impacts" (2006). Their research highlights how important it is to comprehend the local-scale mechanisms influencing land-use changes and how these are interrelated. Local changes that have implications worldwide, including socioeconomic transformations, biodiversity loss, and climate change. The use of remote sensing data and Markov chains for LULC change detection is highlighted in studies by [Xiao-Peng Song](#) et al. in "Land Use/Cover

Change Detection and Prediction in the Greater Mekong Subregion Using Remote Sensing Data and Markov Chains" (2019). Their study shows how well these methods work to identify and forecast changes in land use, facilitating proactive planning and sustainable resource management. Understanding LULC changes in particular metropolitan areas has been made easier by research conducted by Bangladeshi authors, such as [Rahman et al.](#) in "Land Use and Land Cover Change Detection Using Remote Sensing and GIS: A Case Study of Sylhet City" (2017). Their study demonstrates the use of GIS and remote sensing to identify and examine changes in land use, offering insights into the dynamics of urban growth in Bangladeshi cities. The environmental effects of LULC in Greater Dhaka are clarified by research by [Islam et al.](#) in "Assessment of Land Use and Land Cover Change and Its Impact on the Environment in Greater Dhaka, Bangladesh" (2021). Their research highlights the negative environmental effects of fast urbanization and the significance of tracking and controlling land-use changes for sustainable urban growth.

Study Area

Recognizing the fast urbanization and ensuing shifts in land use patterns that impact agricultural output, the study focuses on the growing regions of Dhaka City, Bangladesh. The capital city of Dhaka has seen tremendous growth and development, which has changed the city's geography and socioeconomic dynamics.

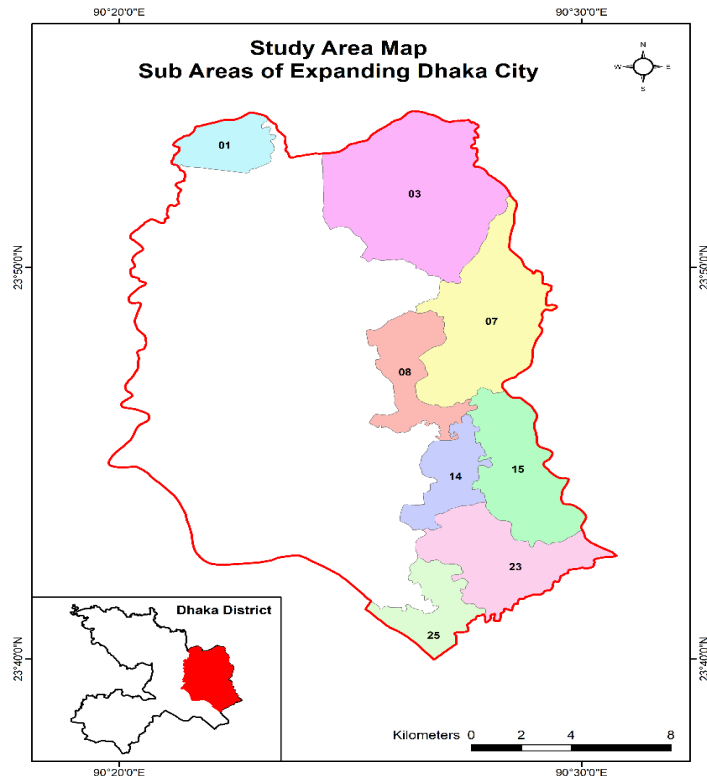
There are eight sub-regions within the expanding area, which covers an area of 1,528 km². According to the 2011 Census by the Bangladesh Bureau of Statistics, the population of this area was approximately 1.74 million (17,40,000). By 2025, the population is projected to increase significantly, with estimates indicating a range between 3.1 million (31 lakh) and 1.9 million (19 lakh) due to ongoing urban expansion, in line with the goals of the Detailed Area Plan (DAP) for 2022-2035.

These areas are listed below:

Table-1: Familiarity of the study area

Number of the area	Name of the area
Sub-Region -1	Northern part of Harirumpur Union
Sub-Region –3	Uttarkhan Union and Dakkhinkhan Union
Sub-Region –7	The union consists of Beraid, Dumni, Satarkul are located on the banks of Balu River
Sub-Region – 8	Badda and Vatara Union. (This union and some other areas have been included in Dhaka North City Corporation very recently)
Sub-Region – 14	Dakkhingaon and Manda Union
Sub-Region – 15	Nasirabad and Demra Union
Sub-Region – 23	Matuail and Sarulia Union
Sub-Region - 25	Dania and Shyampur Union

The study focuses on Dhaka City's peri-urban and outlying areas, where rural landscapes are changing due to urbanization. Rapid urbanization is causing major changes in land use in these areas, which act as transitional zones between urban and rural settings. As a result of the increasing pressures of urban growth, residential complexes, commercial centers, industrial zones, and infrastructural projects are replacing traditional farming methods and open spaces.



Map 1: Study Area

This study offers important insights for planning, resource management, and policy development to guarantee balanced growth in Dhaka's growing periphery by examining the effects of urbanization on land use and infrastructure. Several sub-regions

surrounding Dhaka City comprise the focus of the study area, and each one exhibits distinct urban and peri-urban dynamics. Harirampur Union's northern region, which borders Gazipur City Corporation and Uttara Residential Area, is bounded by the Tongi Canal and Turag River. The Uttarkhan and Dakshinkhan Unions are located close to Purbachal New Town, Uttara Model Town, and Shahjalal International Airport, between the Tongi Canal and the Balu River. Although they are sparsely populated, the Unions of Beraid, Dumni, and Satarkul around the Balu River are seeing the construction of private houses. Recently, the Badda and Bhatara Unions, which are now a part of the Dhaka North City Corporation, have integrated into the city. Near Kamlapur Railway Station, Dakshingaon and Manda Unions have a number of canals. Along the Balu River, the Nasirabad and Demra Unions are connected to canals and reservoirs such as Begunbari and Thulthulia. Canals like DND and Wapda are part of the Matuail and Sarulia Unions, which are crossed by the Balu River. Lastly, the Pagla water treatment plant and industry in the Dania and Shyampur Unions on the Buriganga River are noteworthy.

Analysis and Discussion

Class of 2010: The dataset from the Class of 2010 provides a comprehensive snapshot of the land use distribution within Dhaka City, unraveling a mosaic of diverse land categories encompassing green expanses, open spaces, settlements, and water bodies, collectively covering an extensive area of 33,432.44 acres.

Table 2: The Area of Different Features in 2010

Class of 2010	Area (Acre)
Green Expense	13644.95
Open Space	6836.53
Settlement	5601.62
Waterbody	7349.32
Total	33432.44

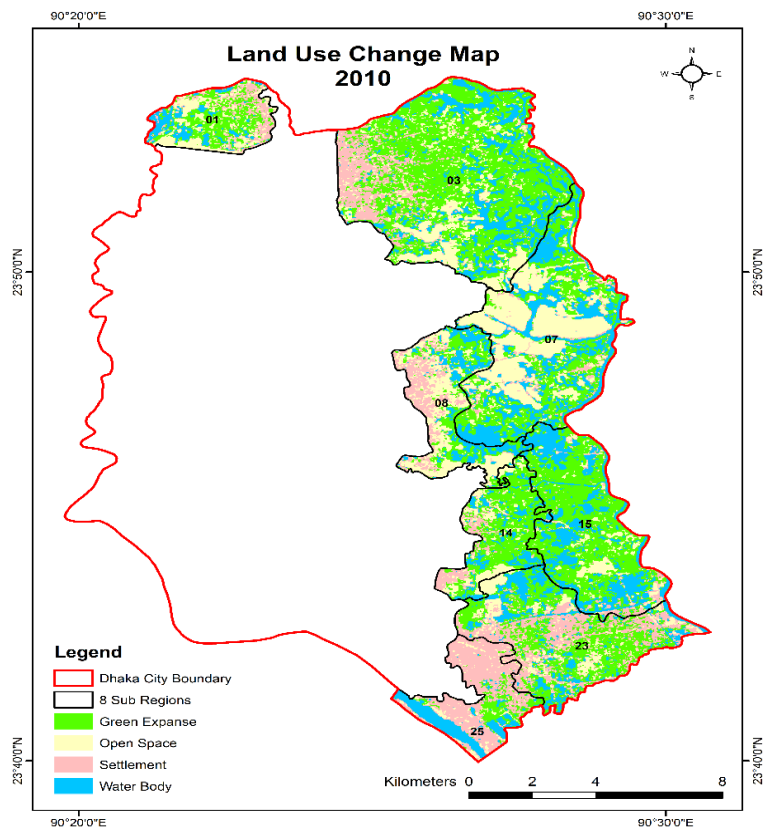
[Source: Landset 5 Tm, Landset 8 OLI/TIRS, Landsat 9 OLI-2/TIRS-2: Path 137, Row 44, 12/16/2010, 30m, <http://earthexplorer.usgs.gov>]

The dataset from the Class of 2010 provides a comprehensive snapshot of the land use distribution within Dhaka City, unraveling a mosaic of diverse land categories encompassing green expanses, open spaces, settlements, and water bodies, collectively covering an extensive area of 33,432.44 acres.

The observations gleaned from these changes serve as a clarion call for policymakers, urban planners, and environmental advocates to craft resilient strategies. These strategies should safeguard Dhaka City's greenery, fortify its ecological resilience, and maintain a delicate balance between urban development and environmental conservation for a sustainable and thriving future. The comprehensive examination of land use patterns in Dhaka City unveils a complex and dynamic urban fabric, intricately woven with the threads of urban growth, environmental sustainability, and the imperative requirements for development. This detailed understanding serves as a guiding beacon for the formulation of robust and adaptive urban planning frameworks. These frameworks need to intricately balance the relentless march of urbanization, the

indispensable need for environmental preservation, and the pressing demands for holistic development.

Such insight is paramount in crafting urban planning strategies that act as guardians of the city's green lungs, staunchly combating the tentacles of urban sprawl that threaten to devour swathes of natural habitats and essential green spaces.



Map 2: Landuse of growing urban areas in Dhaka city at 2010

These strategies become the architects of a harmonious coexistence between towering concrete structures and lush greenery, ensuring that the cityscape remains a testament to sustainability. Preserving these green expanses isn't just an aesthetic endeavor but a dire necessity, fostering ecological balance, purifying the urban air, and offering oases

of tranquility amid the bustling metropolis. It's about nurturing a city that thrives in synergy with nature rather than at its expense.

Table- 3: Area (Acre) of the Growing area in Dhaka at 2016

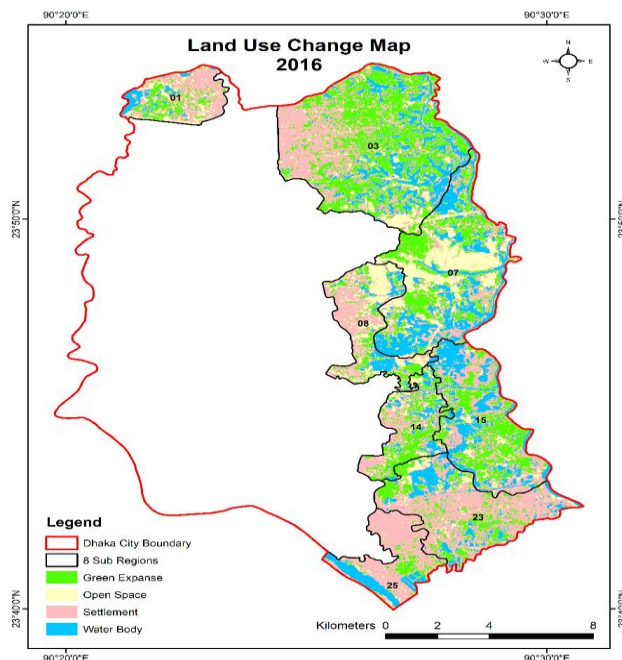
Class of 2016	Area (Acre)
Green Expense	9270.26
Open Space	4251.64
Settlement	13842.83
Total	33432.44

[Source: Landset 5 Tm, Landset 8 OLI/TIRS, Landsat 9 OLI-2/TIRS-2: Path 137, Row 44, 12/16/2016, 30m, <http://earthexplorer.usgs.gov>]

The observed changes highlight substantial transformations across diverse land use categories during this period. Notably, the transitions between settlements and green expanses and settlements and open spaces underscore the ongoing urbanization trends. The increase in settlements might indicate rapid infrastructural growth, catering to the city's burgeoning population and economic activities. The shifts observed could be attributed to numerous factors such as population growth, urbanization pressures, economic development, and evolving land use policies. The increased transitions from green expanses to settlements potentially signify encroachments upon ecological reserves, raising concerns about environmental sustainability. The outcomes of these changes could significantly shape Dhaka City's future landscape. Continued encroachments on green expanses and water bodies might diminish ecological resilience, exacerbate environmental degradation, and affect the city's overall livability. The transformations could also impact agricultural productivity, posing challenges to food security in the expanding areas.

The observed land use patterns in Dhaka City from 2016 to 2023 shed light on the complex balance between urban development, environmental preservation, and sustainability. These transitions emphasize the critical need for strategic urban planning that prioritizes the conservation of green spaces, curtails uncontrolled urban sprawl, and ensures the city's ecological sustainability for future generations. These insights call for proactive actions by policymakers, urban planners, and stakeholders. Actions that prioritize sustainable development,

integrate green infrastructure and balance urban growth with environmental conservation. They pave the way for a future Dhaka City that harmonizes urban expansion with ecological stewardship, ensuring a sustainable, resilient, and livable environment for its inhabitants.



Map -3: Landuse of growing urban areas in Dhaka city at 2016

Table- 4: Area (Acre) of the Growing area in Dhaka at 2023

Class of 2023	Area (Acre)
Green Expanse	8210.66
Open Space	3688.90
Settlement	17392.54
Waterbody	4140.33
Total	33432.44

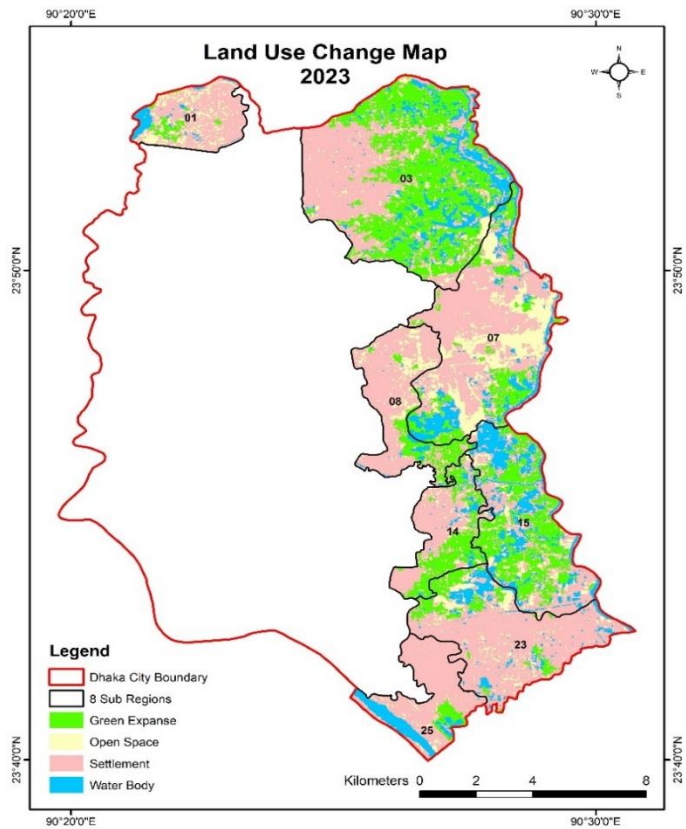
[Source: Landset 5 Tm, Landset 8 OLI/TIRS, Landsat 9 OLI-2/TIRS-2: Path 137, Row 44, 12/28/2023, 30m, <http://earthexplorer.usgs.gov>]

The land use patterns reflected in the Class of 2016 underline the intricate balance between urban expansion, environmental conservation, and the imperative for sustainable development in Dhaka City. Understanding these dynamics is crucial in formulating holistic urban planning strategies that prioritize environmental preservation, curb unchecked urban sprawl, and foster a sustainable future for Dhaka City and its expanding areas. This analysis serves as a clarion call for policymakers, urban planners, and stakeholders to adopt prudent strategies. Strategies that harmonize urban growth with environmental stewardship, ensuring a resilient and sustainable trajectory for Dhaka City's development in the years ahead.

The changes we've seen in how land is used in Dhaka City are pretty big. One thing that stands out is how

much the settlements have grown. They've taken up a lot of space—around 17,392.54 acres! This shows that the city is growing super-fast. People are moving here, and the city is trying to build more houses and buildings to fit everyone in. There's a big push to make more roads, buildings, and things like that because there are more and more people coming to live in Dhaka. This expansion of settlements means that more and more land is being used for buildings and homes. It's happening quickly because

the city is trying to keep up with all the new people coming here to live and work. This rush to build more stuff is because the city needs to handle the growing number of people and their needs, like places to live, work, and do business. The observations made regarding the land use patterns in Dhaka City for the Class of 2023 cast a



Map-4: Landuse of growing urban areas in Dhaka city at 2023

revealing light on the ongoing shifts occurring within the urban landscape. These changes signify more than just alterations in how land is used; they embody the intricate interplay between the city's growth, its natural environment, and the sustainability of its development. This insight underscores the crucial need for a carefully strategized approach to urban planning that prioritizes the safeguarding of green spaces, controls the unbridled expansion of urban areas, and secures the ecological balance for the forthcoming generations.

The Rate of Change and Comparison:

Table 5: Total area (in acres) of different classes in 2010 to 2016, 2016 to 2023 and 2010 to 2023.

2010 to 2016		2016 to 2023		2010 to 2023	
Land Changes	Area	Land Changes	Area	Land Changes	Area
Open Space - Open Space	2146.60	Open Space - Green Expanse	708.85	Open Space - Green Expanse	1612.51
Open Space - Settlement	1868.89	Open Space - Open Space	1073.33	Open Space - Open Space	1069.93
Open Space - Green Expanse	2753.28	Open Space - Settlement	2451.46	Open Space - Settlement	4062.54
Open Space - Water Body	67.77	Open Space - Water Body	18.00	Open Space - Water Body	91.55
Settlement - Open Space	351.11	Settlement - Green Expanse	2118.20	Settlement - Green Expanse	184.96
Settlement - Settlement	4752.79	Settlement - Open Space	1065.45	Settlement - Open Space	388.55
Settlement - Green Expanse	363.44	Settlement - Settlement	9892.30	Settlement - Settlement	4935.99
Settlement - Water Body	134.28	Settlement - Water Body	766.90	Settlement - Water Body	92.13
Green Expanse - Open Space	947.38	Green Expanse - Green Expanse	4238.57	Green Expanse - Green Expanse	4838.26
Green Expanse - Settlement	5868.83	Green Expanse - Open Space	808.36	Green Expanse - Open Space	1228.15
Green Expanse - Green		Green Expanse -		Green Expanse -	

Evaluating Land Use Changes in Dhaka City's

Expanse	5370.20	Settlement	3892.87	Settlement	6414.46
Green Expanse - Water Body	1458.55	Green Expanse - Water Body	330.46	Green Expanse - Water Body	1164.09
Water Body - Open Space	806.55	Water Body - Green Expanse	1145.04	Water Body - Green Expanse	1574.93
Water Body - Settlement	1352.33	Water Body - Open Space	741.77	Water Body - Open Space	1002.28
Water Body - Green Expanse	783.34	Water Body - Settlement	1155.91	Water Body - Settlement	1979.55
Water Body - Water Body	4407.11	Water Body - Water Body	3024.98	Water Body - Water Body	2792.57
Total	33432.44	Total	33432.44	Total	33432.44

The data represents the changes in different land use categories – Green Expanse, Open Space, Settlement, and Water Body – over time, reflecting the percentage variations from a reference period to subsequent years. Green Expanse witnessed a consistent downward trend, declining by 32.06% from the baseline and further decreasing by 11.43% in subsequent periods. This persistent reduction in Green Expanse signifies the ongoing transformation of natural green areas into urbanized spaces, possibly due to increased urbanization and infrastructural developments. Such decline may have adverse implications for the environment, biodiversity, and the overall aesthetic appeal of the

Table 6: The Rate of Changes (in percentage) of Different Class from 2010 to 2023

Feature Class	Area (Increase or Decrease)		
	2010	2016	2023
Green Expanse	100%	-32.06%	-11.43%
Open Space	100%	-37.81%	-13.24%
Settlement	100%	147.12%	25.64%
Water Body	100%	-17.44%	-31.76%

city. Open Space, akin to Green Expanse, followed a comparable declining trajectory, decreasing by 37.81% from the reference point and further dropping by 13.24% in subsequent assessments. The consistent reduction in Open Space reflects the conversion of undeveloped land into built-up areas or infrastructural projects. The diminishing availability of Open Space may pose challenges for recreational activities, greenery, and environmental sustainability within urban settings. In contrast, Settlement areas exhibited a starkly contrasting trend, increasing by 147.12% from the baseline and further expanding by 25.64% in subsequent periods. This dramatic surge underscores the rapid pace of urbanization, marked by a considerate growth in residential and commercial zones, aligned with the city's burgeoning population and economic demands. Water Body areas experienced fluctuations, declining by 17.44% initially and further decreasing by 31.76% in subsequent assessments. The reduction in Water Body areas might be attributed to urbanization, land reclamation projects, or alterations in natural waterways, potentially impacting ecological balance, water resources, and flood management in the city. Overall, these trends signal significant transformations in land use patterns in Dhaka City. The consistent decline in Green Expanse and Open Space, coupled with substantial growth in Settlement areas and reductions in Water Bodies, underscore the profound impact of urbanization, infrastructural development, and changing land-use dynamics on the city's landscape and environmental sustainability. Addressing these changes necessitates strategic urban planning, conservation efforts, and sustainable development initiatives to ensure a balanced and resilient urban environment for future generations.

Table-7: Total Area Conversion to Different Class from 2010 to 2023

Class	Area (Acre)			
	2010	2016	2023	Total
Green Expanse	13644.95	9270.26	8210.66	31125.88
Open Space	6836.53	4251.64	3688.90	14777.07
Settlement	5601.62	13842.83	17392.54	36837.00
Water Body	7349.32	6067.70	4140.33	17557.35
Total	33432.44	33432.44	33432.44	100297.31

The data presented illustrates the percentage change in various land use categories – Green Expanse, Open Space, Settlement, and Water Body – showcasing the rate of increase or decrease from the initial assessment to subsequent periods. The Green Expanse experienced a substantial decline of 39.83% from the initial measurement, indicating a significant reduction in green areas within the city. This drastic decrease points towards the accelerated conversion of natural landscapes or greenery into urbanized zones, possibly due to rapid urban expansion, infrastructure development, and increased land usage for construction purposes. Such a substantial reduction in green spaces raises concerns regarding ecological balance, biodiversity, and environmental quality. Similarly, the Open Space category witnessed a substantial decline of 46.04% from the initial measurement. This sharp decrease implies the conversion of open, undeveloped areas into built-up spaces or infrastructural developments. The diminishing availability of open spaces could potentially impact the city's environmental sustainability, recreational opportunities, and overall livability.

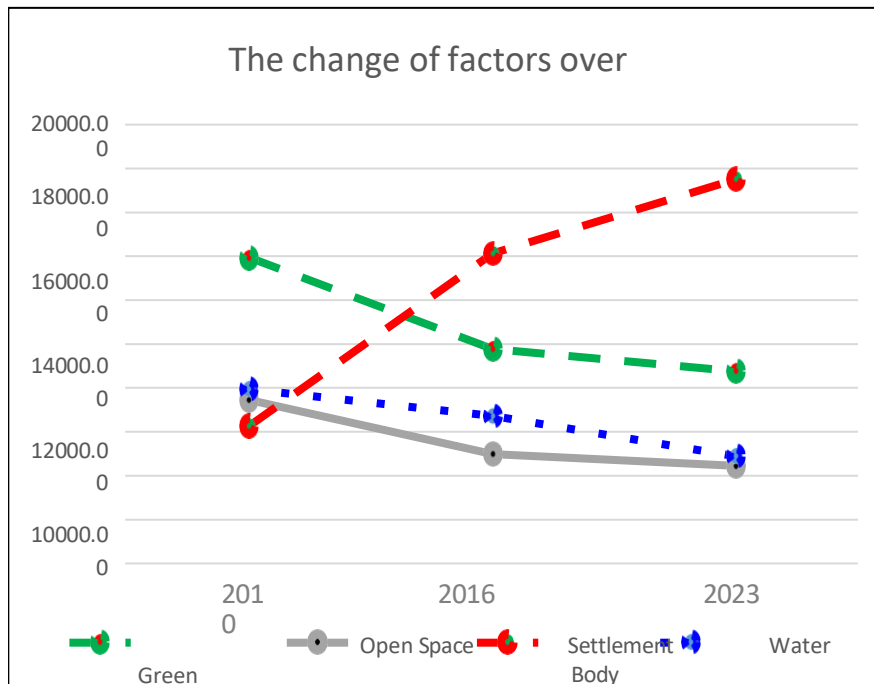
Table-8: The Rate of Increase or Decrease of Class

Feature Class	Area (Increase or Decrease)
	2010 to 2023
Green Expanse	-39.83%
Open Space	-46.04%
Settlement	210.49%
Water Body	-43.66%

In stark contrast, the Settlement area surged remarkably by 210.49% from the initial assessment. This exponential growth emphasizes the rapid pace of urbanization and infrastructural development, leading to an extensive expansion of residential, commercial, and industrial areas within Dhaka City. Such significant urban sprawl may pose challenges related to urban planning, infrastructure management, and environmental impact. The Water Body category experienced a substantial decline of 43.66% from the initial measurement. This notable reduction in water bodies might stem from factors like land reclamation, alterations in natural waterways, or infrastructure projects, potentially impacting water resources, hydrological balance, and environmental sustainability within the city. These changes depict a transformative shift in land use dynamics in Dhaka City, characterized by declining green and open

spaces, surging urban settlements, and reductions in water bodies. Addressing these changes requires a holistic approach to urban planning, emphasizing sustainability, green infrastructure initiatives, conservation efforts, and policy interventions to ensure a balanced, resilient, and ecologically sustainable urban environment.

The Trend of Analyzing Factors

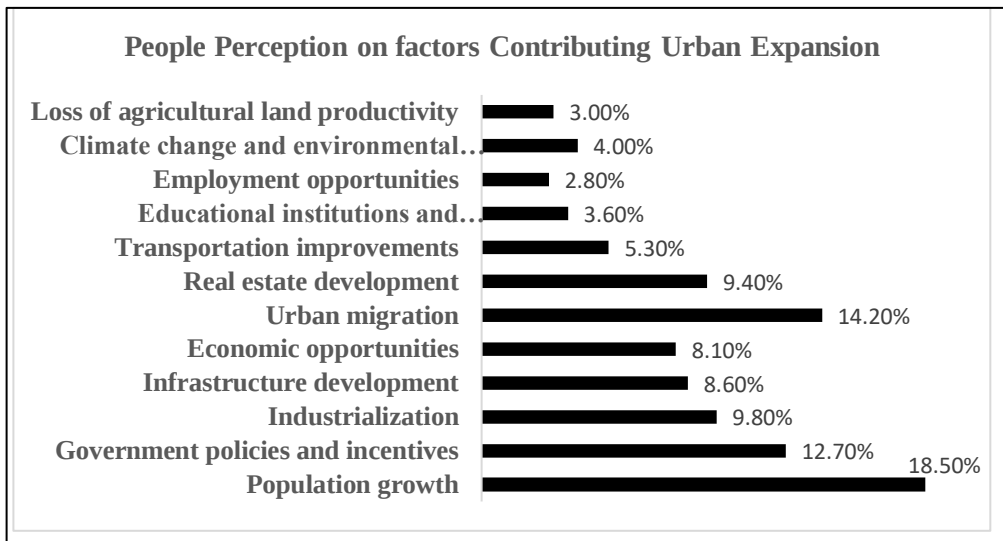


Graph 1: The Trend of Increase or Decrease of the Feature Class from 2010 to 2023

The graph presented to us paints a complex picture of the changing landscape of Dhaka, encompassing three vital elements: green space, open space, settlement, and water body. While each element undergoes its own trajectory, their interplay reveals a dynamic and evolving urban ecosystem.

Factors of Rapid Urban Expansion (People's Perception)

From the collection of primary data, the result shows the percentage that people believe the factors contributing to the Urban Expansion.



Graph 2: Factors Contributing Urban Expansion (People's Perspective)

Population growth stands as one of the primary drivers behind the relentless pace of urban expansion witnessed in Dhaka City and its peripheries. The surge in population exerts immense pressure on land resources, compelling the continuous expansion of urban areas to accommodate the escalating numbers of residents. The influx of people into urban centers, driven by factors like rural-urban migration, natural population growth, and the pursuit of better economic opportunities, fuels the ever-expanding urban boundaries. This demographic surge triggers a demand for housing, infrastructure, and services, leading to the conversion of rural and agricultural lands into urban settlements.

Government Policies and Expansion

Government policies and regulations wield considerable influence in steering the course of rapid urban expansion in Dhaka City's expanding areas. These policies, while intending to foster development, often inadvertently contribute to the acceleration of urban sprawl. Land use policies and zoning regulations set by the government

significantly impact the transformation of rural landscapes into urbanized zones. In some instances, these regulations might be lax, unclear, or outdated, leading to uncontrolled land-use changes. Additionally, policies related to urban development and expansion may prioritize economic growth, incentivizing the conversion of agricultural lands and green spaces for infrastructure projects, industries, or residential complexes. Bangladesh has several ongoing projects aimed at enhancing urban infrastructure, improving living conditions, and fostering sustainable urban development. Some of these projects include:

Dhaka Elevated Expressway: A project to construct an elevated expressway in Dhaka, aiming to ease traffic congestion and enhance transportation networks.

Dhaka Mass Rapid Transit Development Project: This project focuses on developing a mass rapid transit system in Dhaka to improve public transportation and reduce traffic congestion.

Urban Resilience Project: Aimed at strengthening the resilience of urban areas against natural disasters and climate change impacts, this project works on improving infrastructure and disaster response mechanisms.

City Regional Development Project: Focused on several cities outside Dhaka, this initiative aims to enhance urban infrastructure, sanitation, and service delivery in selected urban areas across Bangladesh.

Urban Governance and Infrastructure Improvement Project: Geared towards improving urban services, governance, and infrastructure in selected municipalities to enhance the quality of life for residents. These initiatives reflect Bangladesh's commitment to addressing urban challenges, including traffic congestion, inadequate infrastructure, environmental sustainability, and urban resilience, by implementing various development projects across its cities and municipalities. Over the past decade, the land use patterns in the expanding areas of Dhaka City have undergone notable transformations, reflecting the dynamic interplay between urbanization, economic growth, and infrastructure development. Multiple factors have contributed to these changes, resulting in a discernible shift in land utilization. Urbanization has been a dominant force reshaping the landscape, leading to the conversion of agricultural lands and green spaces into sprawling settlements. The rapid influx of people into the city

has triggered the expansion of residential and commercial zones, reducing the availability of agricultural land and open spaces. This trend aligns with the increasing demand for housing and commercial infrastructure to accommodate the growing population. Simultaneously, economic growth and infrastructure development have spurred changes in land use. Infrastructure projects, such as highways, expressways, and transportation networks, have facilitated accessibility to previously inaccessible areas. Inadequate land use planning and the absence of stringent regulations have led to haphazard development, encroachments on agricultural lands, and a reduction in open spaces

However, Dhaka's expansion isn't without its challenges. The surge in urbanization has led to the encroachment of agricultural lands and green spaces, posing threats to food security, environmental sustainability, and the overall livability of the city. This expansion has ramifications for the city's infrastructure, traffic congestion, pollution, and the availability of essential resources like water and land for cultivation. The influence of government policies and regulations on land use profoundly impacts Dhaka's expanding areas. The absence of robust planning measures and zoning regulations has allowed uncontrolled development, contributing to fragmented land uses and unplanned settlements. Understanding the intricate relationship between urbanization, economic growth, government policies, and changing land use in Dhaka City's expanding areas is critical. It underscores the urgent need for strategic urban planning that integrates sustainable development practices. Balancing urban expansion with the preservation of agricultural lands and green spaces is imperative for Dhaka's long-term resilience and the well-being of its residents.

Urbanization and Land Use: The rapid urban expansion in Dhaka City has significantly altered land use patterns, affecting agricultural lands, green spaces, and infrastructure development. ***Government Policies and Urban Growth:*** Government policies, or the lack thereof, have influenced the direction of urban expansion, often leading to unplanned settlements and encroachment on agricultural lands.

Challenges of Urban Expansion: The expansion poses challenges such as reduced agricultural productivity, increased environmental stress, and infrastructural inadequacies due to unplanned growth.

Sustainability Concerns: Sustainable urban planning strategies are essential to balance urban growth while preserving agricultural lands and green spaces to ensure long-term environmental and economic sustainability.

Impact on Livability: The changes in land use patterns affect the livability of expanding areas, impacting residents' access to essential resources and compromising their quality of life.

Need for Strategic Planning: The complexities of urban expansion necessitate strategic planning that accounts for agricultural productivity, environmental conservation, and infrastructure development for sustainable city growth.

Conclusion

While the master plan serves as a crucial foundation for guiding Dhaka City's growth, it is insufficient on its own to address the complexities of urban expansion in a dynamic environment. To achieve sustainable development, the city needs a more comprehensive and adaptive approach. Regular monitoring, flexible regulatory frameworks, and the use of advanced technologies are essential for ensuring that urban planning keeps pace with socio-economic and technological changes. Active community involvement and participatory planning approaches are equally important, as they help shape a collective vision that reflects the needs and aspirations of diverse populations. By integrating these elements, urban development can become more inclusive, responsive, and sustainable.

Moreover, fostering interdisciplinary collaboration among urban planners, policymakers, environmental experts, and social scientists is key to addressing the multifaceted challenges of a growing city. Embracing innovation, resilient infrastructure designs, and data-driven decision-making will empower Dhaka City to anticipate future growth patterns, allocate resources effectively, and safeguard environmental and societal well-being. While the master plan sets the groundwork, its success hinges on a dynamic, inclusive, and forward-thinking framework that ensures Dhaka evolves into a sustainable, livable, and future-ready city for all its residents.

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