Temporal mapping of vegetation cover change in Gazipur district, Bangladesh: a framework for environmental sustainability

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Temporal Mapping of Vegetation Cover Change in Gazipur District, Bangladesh: A Framework for Environmental Sustainability

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Abstract

This study investigates the intricate dynamics of land transformation and its correlation with rising surface temperatures in Gazipur District, Bangladesh, amid rapid urbanization and climate change. As urban areas attract more inhabitants, Gazipur experiences alarming rates of urbanization, contributing significantly to the Urban Heat Island (UHI) phenomenon. The depletion of water bodies exacerbates this effect, posing severe consequences for the regional climate and environment. Conducted as an integrated study utilizing Geographic Information System (GIS) and Remote Sensing (RS), this research spans the years 2000 to 2021. Landsat 7 & 8 satellite imagery products were employed to analyze land cover changes and recover Land Surface Temperature (LST). Remote sensing techniques enabled the examination of the impact of vegetation cover changes on surface temperature, revealing a strong correlation between LST and land cover classes. Results indicate a substantial reduction in water bodies, decreasing from 33% to 0.01%, and a parallel decline in vegetation cover. These areas are increasingly converted into built-up spaces, contributing to rising temperatures that fluctuate between 28℃ and 35℃. The findings underscore the significance of land cover classes in influencing surface temperature variations. The study not only adds depth to the understanding of Gazipur's evolving landscape but also contributes valuable insights into the intricate relationship between land transformation, urbanization, and climate change.

Keywords: Vegetation coverage, Land Surface Temperature, Environmental Sustainability, Climate Change, Urbanization

JEL classification: Q23, Q24, Q25, Q56, Q57, R14, R52

Introduction:

Land transformation is a critical process that shapes the environment and nature. It involves changing the physical characteristics of land, such as converting agricultural land into urban areas or deforesting land for industrial purposes (Yang et al., 2018). These transformations have significant implications for society, including impacts on ecosystems, human health, and the economy. Urban expansion can lead to habitat loss, increased pollution, and changes in local climate patterns (Khamchiangta & Dhakal, 2021, Son et al., 2020) Understanding the factors that drive land transformation and their consequences is essential for making informed policy decisions and ensuring sustainable development in the face of rapid economic growth.

Several factors play a role in the complex process of land transformation. Human activities, such as urbanization, agriculture, and industrial development, play a significant role in shaping land cover (Su et al., 2022). The expansion of cities leads to the conversion of natural habitats into built-up areas, resulting in the loss of biodiversity. The natural environment, including factors like climate, topography, and soil fertility, also influences land transformation (Lindell et al., 2010). For instance, areas prone to flooding may be less suitable for agricultural activities. Additionally, the economic environment, including market demands and government policies, can drive changes in land use. The demand for biofuel crops may lead to the conversion of forests into agricultural land. Understanding the complex interactions between these factors is crucial for effectively managing land resources and minimizing negative impacts (Pimentel, 2008).

The impact of human and natural forces on land transformation is well documented. Studies have shown that deforestation rates have accelerated due to human activities such as logging and clearing land for agriculture (Buriti & Barbosa, 2022). The conversion of forests into agricultural land has significant consequences, including habitat loss, soil degradation, and increased greenhouse gas emissions. Additionally, natural forces such as erosion and climate change can also contribute to land transformation. Climate change induced vulnerability poses high risk in food security of households (Hasan, 2014). Rising sea levels, for instance, can result in the loss of coastal land and the displacement of communities (Mishra et al., 2022). The combination of these human and natural forces creates a complex and dynamic landscape where land is constantly being transformed.

Change detection techniques are widely used to identify and analyze variations in land cover over time. These techniques involve the comparison of satellite imagery or aerial photographs taken at different time points to detect changes in land use and land cover (Iovanna & Vance, 2007). Remote sensing technologies, such as multispectral imaging and LiDAR, are often employed to capture detailed information about vegetation, built-up areas, water bodies, and other land features. These data are then processed using algorithms and analytical tools to quantify and map changes in land cover (Ghaseminik et al., 2021). By utilizing these observational techniques, researchers and public agencies can gain valuable insights into the extent and patterns of land transformation, which can inform land management strategies and policy decisions.

Land has been a crucial and valuable resource on Earth since its beginning. The complicated process of changing the type of land involves several variables, including human activity, the natural environment, and the economic environment. These factors interact with one another and have a combined impact on the land transformation (Jianzhong et al., 2002; Lianqi et al., 2004). Change detection is a technique used to identify variations in land cover over a period. Given the ongoing impact of human and natural forces on the globe, there is a growing recognition among public

agencies of the need to create observational techniques for evaluating these changes (Levien, Roffers, Maurizi, Suero, Fischer, & Huang, 1999). Modifications in vegetation lead to alterations in animal habitat, aesthetic historical values, ambient air quality, and other resources, hence influencing policy choices. Gazipur, located in Bangladesh, has become a significant urban area for the growth of Dhaka City. This has drawn the attention of several academics who want to understand the ongoing changes and developments that have been taking place for several decades and how these changes are impacting the respiratory health of the local population.

Urbanization is a major factor in the conversion of natural land into contemporary land characterized by the presence of buildings, roads, and other surfaces that cannot be penetrated (Zhou et al., 2022). This transformation has a significant impact on the quality of life in metropolitan areas. The conversion of land use has led to the formation of an urban heat island (UHI) (He et al. 2007), resulting in an increase in temperatures surrounding the city by around 5–6 °C. According to Trenberth's 2004 description of the environmental phenomenon known as "urban heat island," the air and land surface temperature (LST) inside an urban area is higher than the temperature outside (Trenberth, 2004). Various causes contribute to the formation of the Urban Heat Island (UHI) phenomenon. The primary cause of the change in land surface temperature (LST) is the alteration of land cover resulting from urbanization. This is attributed to the distinct qualities and features of each kind of land (Ahmed et al., 2013). Nevertheless, the solar energy that is captured is released throughout the night as infrared radiation. Due to several factors, the land cover type's Local Standard Time (LST) undergoes modifications at some point. Furthermore, the correlation between the type of land cover and the land surface temperature (LST) allows researchers to examine the impact of changes in land cover on LST (Lo and Quattrochi 2003). The intensity of this investigation has increased owing to several factors.

Located in the heart of a nation characterized by the Pleistocene uplift phenomenon and significantly altered by recent rapid urban development, The increasing urbanization is causing a widespread reduction in natural vegetation, as well as the loss of open space and the fragmentation and isolation of wetlands and animal habitats. The root cause of these issues may often be ascribed to the increase in population (Khan, 2000). The region's flora and wildlife have been endangered since the 1990s due to an increasing population. Urban vegetation has a crucial role in promoting sustainable development, safeguarding the environment, and facilitating the urban planning process of a city (Rahman, 2009). Diverse techniques in this domain contribute to the devastation of plant life, including building and the expansion of infrastructure. The green space in Gazipur district is rapidly diminishing at an unparalleled rate. Currently, the region retains a diverse array of green spaces and plants. The district of Gazipur is situated in the northern region of Dhaka city and is one of the closest districts to the capital city. The Sal Forest, often referred to as the Madhupur forest, is an asset of Bangladesh, spanning over the Dhaka and Gazipur districts. The Sal forest in Gazipur district accounts for around 86% of the total Sal forest area in the nation. Gazipur Sadar sub-district once accounted for 20% of the forest area; however, there has been a gradual decrease in forest cover (Fazal et al., 15). Agriculture in Gazipur is in greater challenges as the land and waterbodies are being converted to industrial production. Bangladesh agriculture policy reform and several structural changes for the agricultural sector has clearly emphasized on the restoration of agricultural land and waterbodies (Hasan, 2012).

Gazipur has emerged as a significant industrial center in Bangladesh. In the past, Gazipur district has been renowned for its abundant forest resources. However, in recent decades, growing urbanization has led to considerable changes in land use and land cover (LULC). It is now confronted with several

complex issues, including excessive urbanization, industrial pollution, and contamination of water bodies due to industrial waste disposal. (Nduwayezu et al., 2021) The ongoing pattern of land use and land cover change demonstrates the adverse effects of human activities on the extent of vegetation in an area. Over the last 44 years, there has been a significant decrease of 199.75% in plant cover, posing a serious environmental risk for the region. The district of Gazipur is situated in the northern region of Dhaka metropolis. The Sal Forest, often referred to as the Madhupur forest, is an asset of Bangladesh, spanning over the Dhaka and Gazipur districts. The Sal Forest in Gazipur district accounts for around 86% of the country's total. Human activities such as excessive land use, deforestation, urbanization, agriculture, and industry are endangering the forest. The fast changes in land use in the area are impacting the surface temperature of the region. The land surface temperature is rising due to changes in land usage. The temperatures have shown periodic variations between 26 and 30 degrees Celsius over a duration exceeding 10 years. The conversion of land usage into built-up areas or open spaces has resulted in greater temperatures compared to prior years. This suggests a correlation between land surface temperature and changes in land cover. Vegetation and other natural areas have lower surface temperatures compared to built-up regions or open spaces with less vegetation.

Using historical land cover changes using remote sensing datasets and geographic information system (GIS) methods, the paper observes and assesses the impact of changes in land cover on the temperature of the land surface in the Gazipur district from 2000 to 2021. The objective of this work is to include the transient reliance on multi-temporal picture data to identify the evolving patterns of vegetation cover and enhance the capacity for interpretation. Moreover, the integration of satellite data from several sensors and time periods significantly enhances the temporal characteristics and dependability of the multi-data (S.O. & B., 2003). This research aims to identify temporary and multi-sensor approaches for detecting changes in vegetation cover & land surface temperature in Gazipur District, utilizing remote sensing and GIS techniques.

Data and Methods

Study Area

The study area, Gazipur district of Bangladesh, was selected because of its significant population influx, mostly driven by immigration. Additionally, its near proximity to the main city of Dhaka played a role in the decision. Gazipur, Bangladesh is positioned at the geographical coordinates of 23° 59' 59.7876'' N and 90° 25' 12.9828'' E. It has a substantial number of locations suitable for the construction of urban centers. Due to population pressure and unregulated development, the local populace is removing wood, vegetation, and important arable land to construct different businesses and brickfields. This is leading to deforestation and substantial alterations to the environment. The rapid urbanization of Gazipur has resulted in a surge in pollution and a deterioration in the quality of both air and water. The deforestation has also disturbed the indigenous environment of several species, resulting in a decline in biodiversity. Furthermore, the transformation of arable lands into industrial zones has adversely affected the local economy by diminishing the accessibility of agricultural land for cultivation.

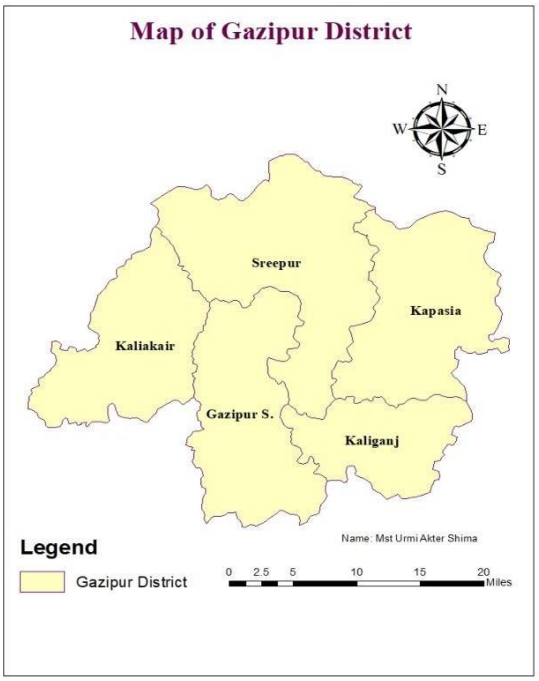

Figure 1: Map of study area

Research Method

In ENVI, vegetation delineation works quickly to identify the presence of vegetation and to visualize its level of intensity. During the analysis, the Landsat images are converted to an NDVI output and density-sliced according to the brightness values without performing atmospheric correction. The density slicing ensures correctly identifying and visualizing the presence of certain features, in this case vegetation. The intensity that is used to classify the vegetation cover can be displayed below. For carrying out the study, Landsat 7 and 8 data from Landsat satellite imagery were collected from three different years, which are 2000, 2010, and 2021. The cloud coverage of all this data is less than 2%. The study also collected the land surface temperature and then converted it into radiance and then temperature in Kelvin units and degrees Celsius. After this, the data is prepared for analysis.

The NDVI calculations uses multi temporal data and land surface temperature from three decades for generating analysis vegetation coverage in Gazipur District. It provides a base for Temporal Mapping of Vegetation Cover Change in Gazipur District which has implication for biodiversity and environmental sustainability.

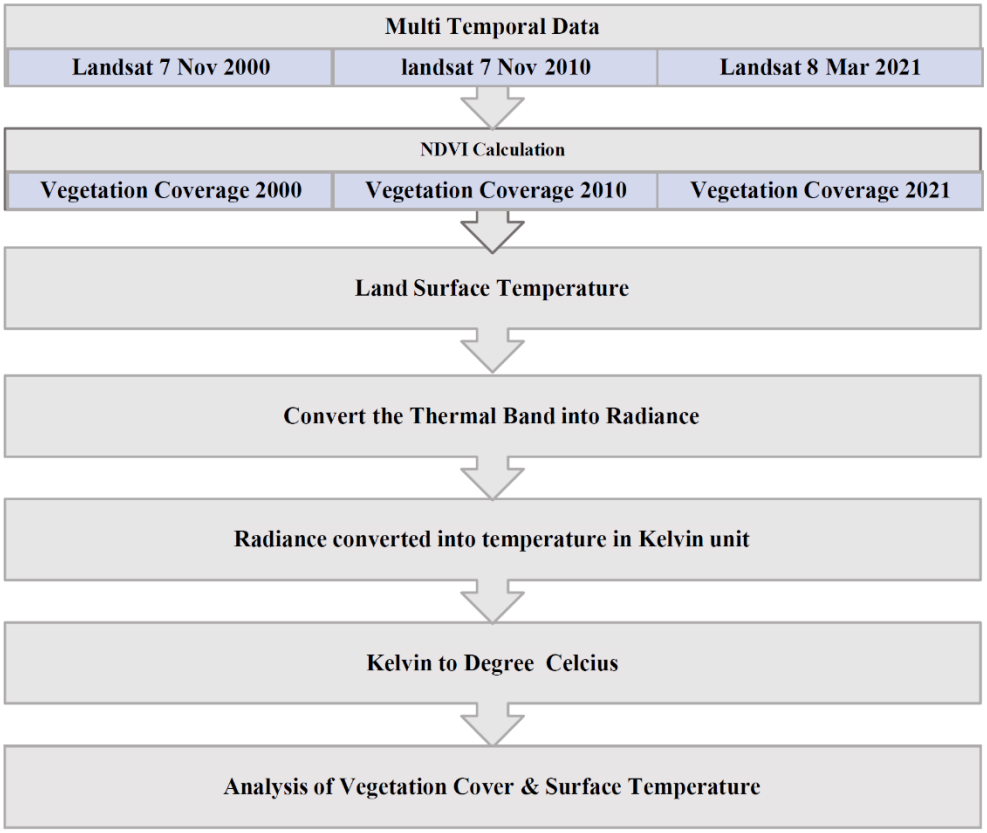

Figure 2: Flowchart of the NDVI & LST Analysis

Results

The study's findings clearly show after 2000, Gazipur's vegetation cover drastically decreased. The Gazipur District region has had the most dramatic loss of vegetation among the Five Thanas. The computation's outcome may be seen in the following table.

Vegetation Coverage Changes

Table 1: Summary of the vegetation Areas and the percentages of Vegetation coverage in 2000, 2010, and 2021

	2000 (November)		2010 (November)		2021 (March)	
Vegetation Type	Sum of Area (Hectare)	Percentage (%)	Sum of Area (Hectare)	Percentage (%)	Sum of Area (Hectare)	Percentage (%)
Barren Land	41825.22	24.9	12652.64	7.53	12378.65	7.37
Dense Vegetation	1366.97	0.8	4169.57	2.48	0.58	0.00
Shrubs and Grassland	68916.09	41.1	135172.14	80.50	155517.60	92.61
Waterbodies	55813.33	33.2	15927.99	9.49	30.53	0.02
Grand Total	167921.60	100	167922.36	100	167927.36	100

In the year 2000, in Gazipur district, the area of barren land accounted for 41,825 hectares, which is equivalent to 24.90% of the total land. Waterbodies covered an area of 55,813 hectares, making up 33.23% of the total land. Shrubs and other grassland occupied 68,916 hectares, representing 41.04% of the total land. Lastly, the area covered by dense vegetation, also known as healthy vegetation, was 1,366 hectares, accounting for 0.81% of the entire land. In 2000, the prevalence of vegetation such as bushes, grassland, and waterbodies were higher compared to other types of vegetation covering, such as thick vegetation and bare terrain. However, by 2010, the prevalence of dense vegetation had significantly decreased due to factors such as deforestation and urbanization. By 2010, deforestation and urbanization had led to a significant decrease in the prevalence of dense vegetation. Only 1,366 hectares of healthy vegetation remained, making up just 0.81% of the entire area. This decline in dense vegetation was concerning, as it indicated the loss of biodiversity and habitat for various plant and animal species. Efforts to conserve and restore dense vegetation became crucial to mitigate the negative impacts of deforestation and urbanization on the ecosystem.

In 2010, the amount of barren land decreased to 12652 hectares, accounting for 7.5% of the total land area. The data reveals a notable rise in the extent of thick vegetation, namely from 0.81% to 2.48%. This translates to an increase of 2802.60 hectares during a span of 10 years. The percentage of waterbodies decreased from 33.23% to 9.48%, indicating a decrease in the amount of water-covered land. Water bodies and barren land regions had the largest land usage in that year, although they still occupied a relatively small fraction of the total area. Shrubs and grassland increased almost double (80.5% of the total land) in 2010 compared to 2000 (Table 1). The increase in thick vegetation can be attributed to various factors, such as climate change, conservation efforts, and reforestation initiatives. This rise in vegetation coverage is a positive sign for biodiversity and ecosystem health. However, the decrease in waterbodies indicates a potential threat to aquatic habitats and water resources. The significant expansion of shrubs and grassland suggests a shift in land use patterns, possibly due to agricultural practices or urbanization. Overall, these changes in land usage highlight the dynamic nature of ecosystems and the need for sustainable land management strategies.

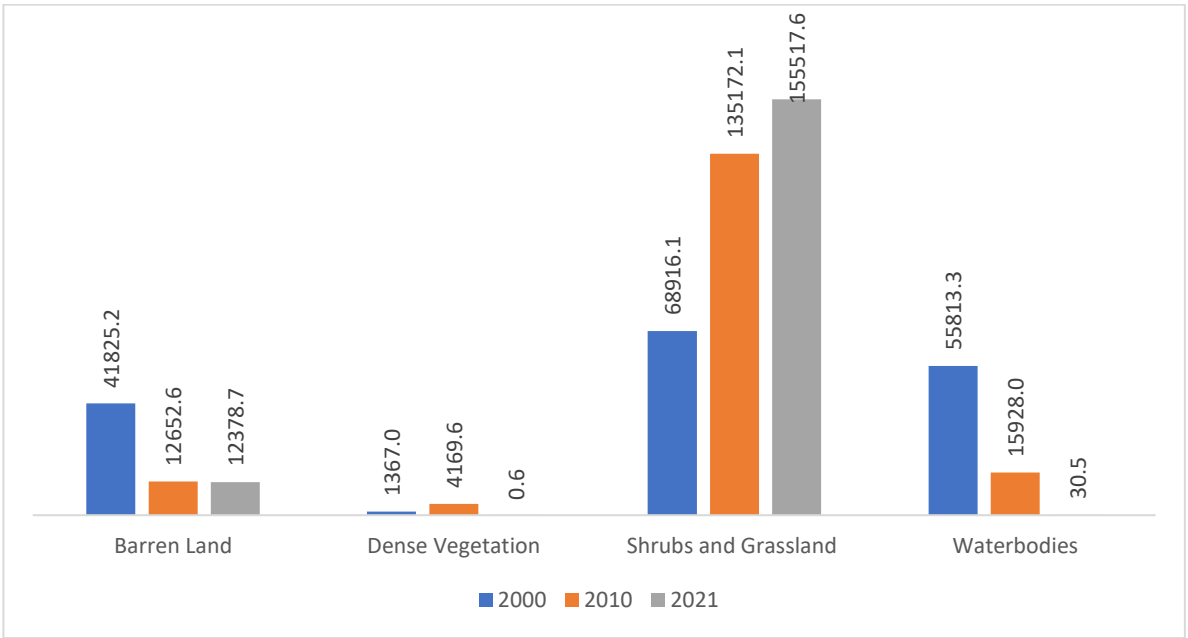

Figure 3: Vegetation areas (Hectare) in Gazipur district over time.

In 2021, the percentage of barren land in this area was 7.3%, waterbodies covered 0.01% of the land, thick vegetation was completely absent, and the overall percentage of barren land was 7.37%. These three vegetation types exhibited a substantial change in vegetation coverage when compared to the pictures from 2000 and 2010 (Figure 3). The expansion of shrubs and grassland seen in the pictures from 2021 indicates a significant transformation in the landscape over the past two decades. This shift in vegetation coverage suggests that the area has undergone notable environmental changes, which could be attributed to various factors such as climate change, human activities, or natural disturbances. It is crucial for land managers and policymakers to closely monitor and adapt to these changes in order to maintain the ecological balance and ensure the sustainability of the land in the future.

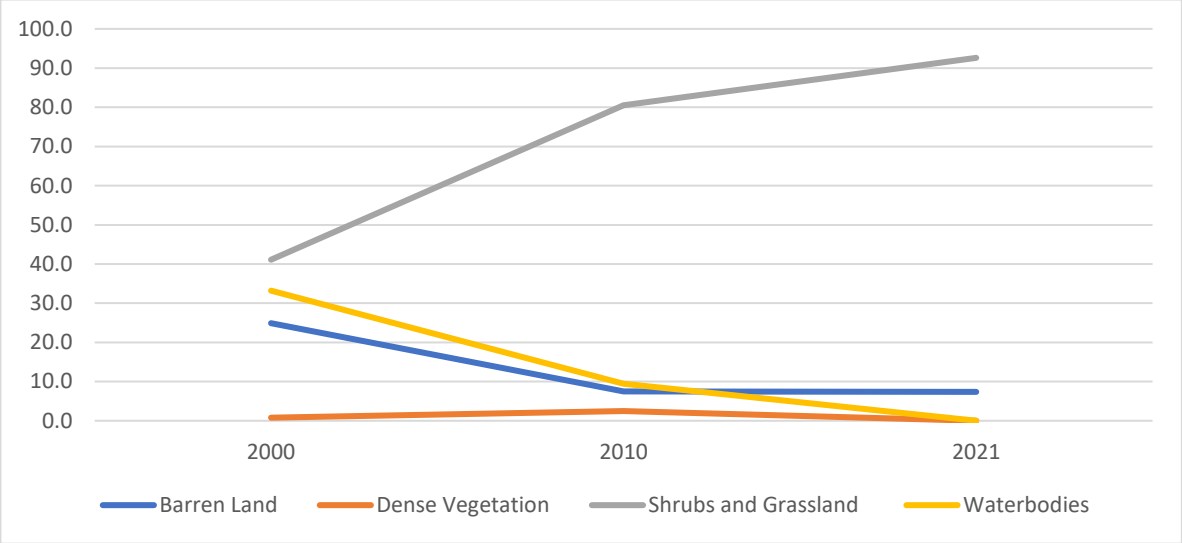

Figure 4: Vegetation areas (percentage) in Gazipur district over time.

Figure 4 demonstrates a substantial decrease in barren land from 2000 to 2021, while there was a corresponding increase in shrubs and grassland. The abundant vegetation, symbolizing the flourishing woodland, was almost eradicated. The percentage of barren land decreased from 24.9% in 2000 to 7.5% in 2010, and further to 7.37% in 2021. The density of vegetation saw a minor rise from 0.8% in 2000 to 2.48% in 2010, but thereafter declined to 0% in 2021. The proportion of shrubs and grassland saw significant growth from 33.2% in 2000 to 80.5% in 2010, and further rose to 92.6% in 2021. The proportion of waterbodies decreased from 33.2% in 2000 to 9.49% in 2010 and further declined to 0.01% in 2021.

These changes in the composition of the grassland ecosystem have had a significant impact on the overall biodiversity and ecological balance of the area. With the disappearance of the abundant vegetation, many species of animals that relied on it for food and shelter have been forced to adapt or migrate to other habitats. The rise in barren land and the decline in vegetation density also increase the risk of soil erosion and the loss of fertile soil, further affecting the sustainability of the grassland ecosystem. Additionally, the decrease in waterbodies poses a threat to the availability of water resources for both wildlife and human populations in the area. The vegetation coverage change map displays the aggregate extent of land use alteration in Gazipur from 2000 to 2021, including a time span of 20 years. The prevailing land use change during this time period is the conversion of waterbodies into open space. Shrubs and grassland account for the majority of land use change, occupying around 92.61% of the area. The district's vegetation index map makes it evident that, in just

20 years, the waterbodies and dense vegetation coverage were nearly completely gone in 2021 as compared to 2000. This significant loss of water bodies and vegetation has likely contributed to the increase in land surface temperature in Gazipur over the past two decades.

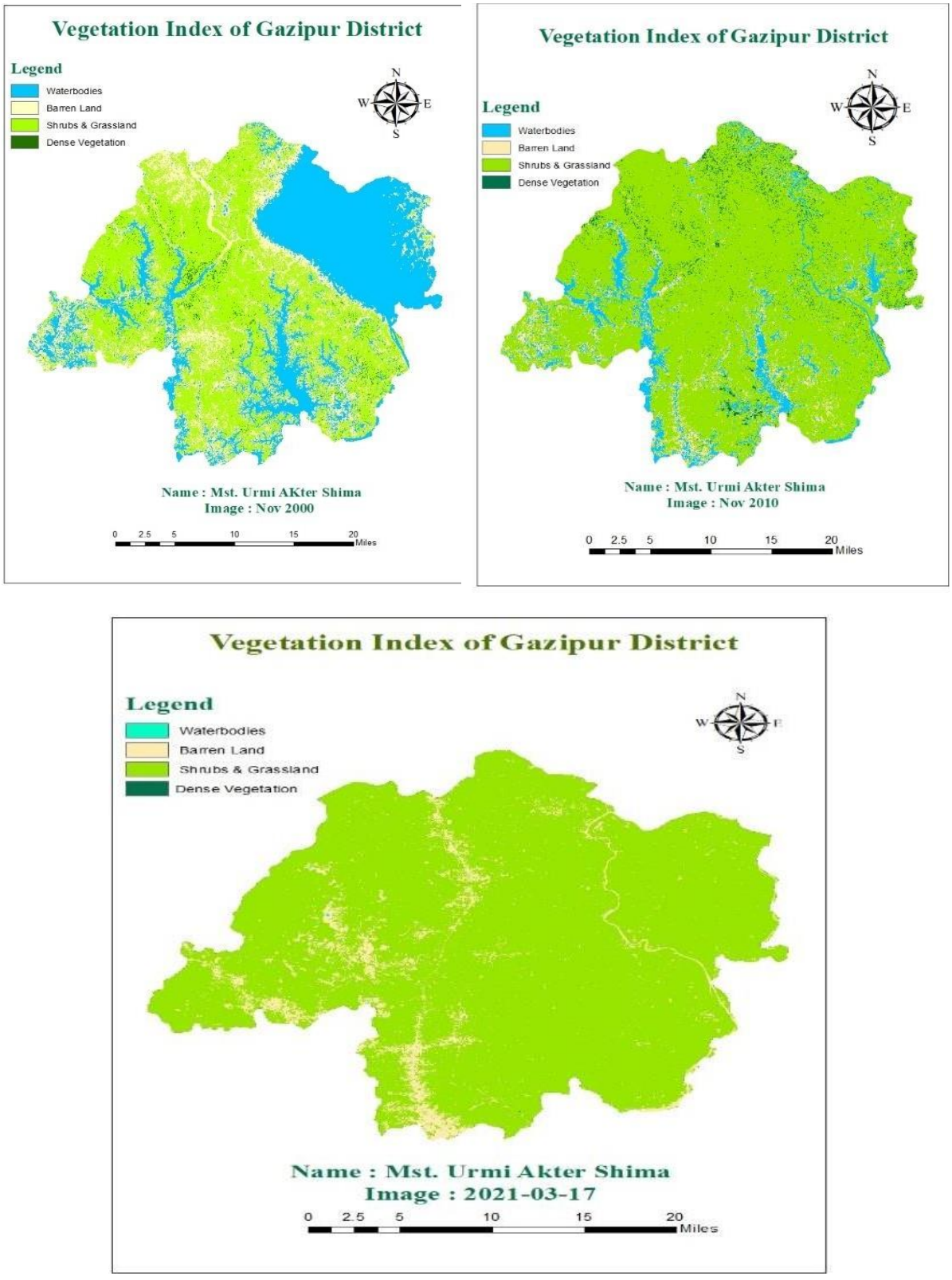

Figure 5: Vegetation coverage from Satellite imageries

Changes of Land Surface Temperature

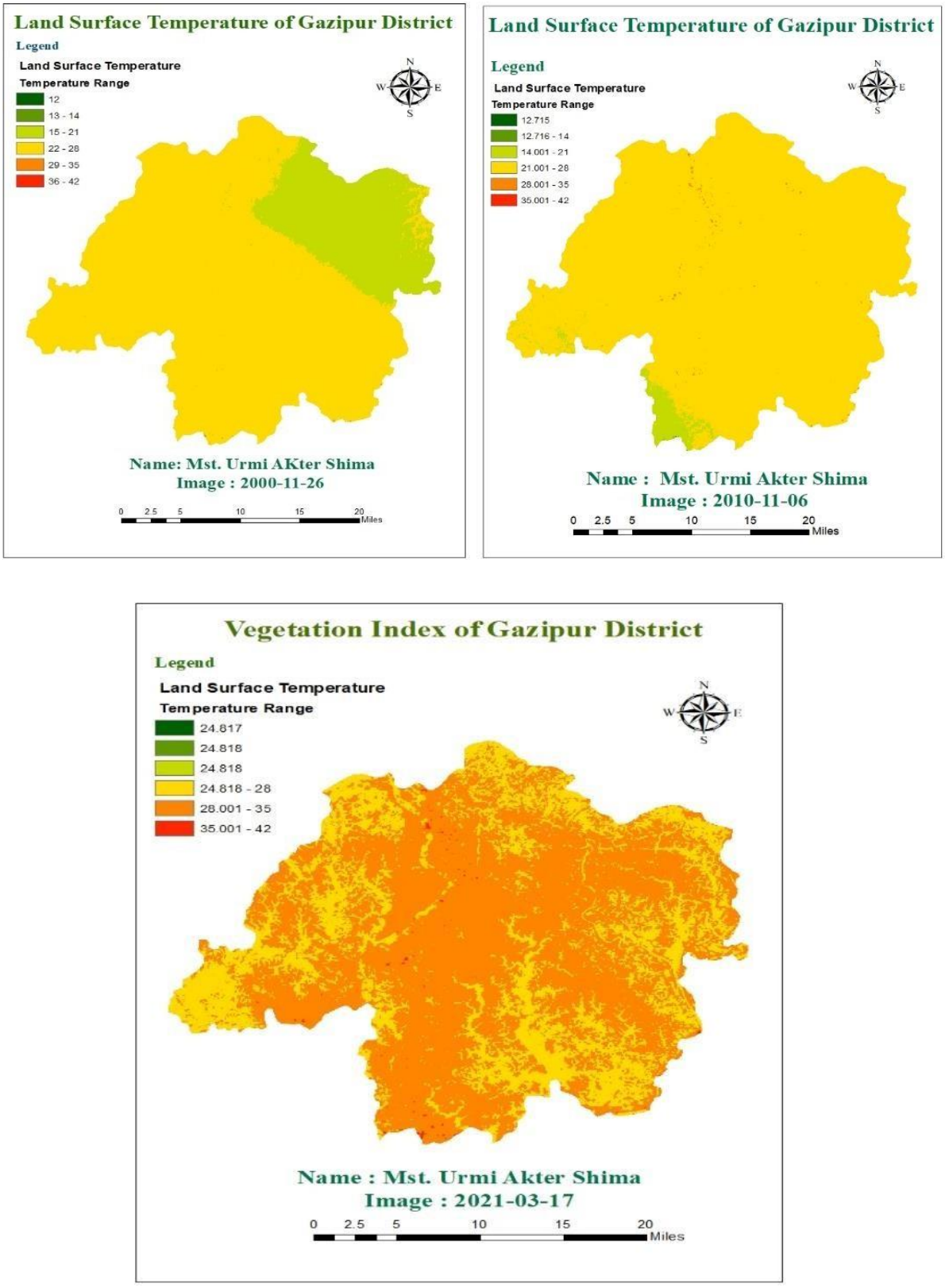

Figure 6: Changes of Land Surface Temperature in Satellite Imageries

The 2021 reclassification land use map of Gazipur clearly indicates that the predominant land use in Gazipur during that period was vegetation. Another prevalent land use category during that period was open space. The land with the lowest use in that particular year consisted of water bodies and barren terrain, occupying a relatively small proportion of the total area. The land surface map of Gazipur in 2021 reveals that the prevailing temperature in most locations ranged from 28°C to 35°C. These temperatures were considered severe and were mostly seen in regions with little vegetation and predominantly urban development. The minimum temperature ranged from 21°C to 28°C, characteristic of regions abundant in flora and waterbodies. In 2021, The maximum temperature recorded in the land area during that period varied between 35°C and 42°C, including both open spaces and developed areas. Based on the land surface map of Gazipur in 2010, it can be concluded that the areas with water bodies and vegetation had the lowest land surface temperature compared to other areas. The prevailing temperature during that year ranged from 15°C to 28°C and was classified as low to moderate. The maximum land temperature during that period ranged from 21°C to 28°C, including the developed and open areas. The lower temperatures in areas with vegetation and water bodies could be attributed to the evapotranspiration process, where water is released into the atmosphere through plant leaves, resulting in a decrease in temperature. Additionally, the lower land surface temperatures in these areas may be due to the cooling effects of water bodies and the shade that trees provide. Overall, these findings highlight the importance of preserving and maintaining green spaces and water bodies in order to mitigate the effects of rising temperatures in urban areas.

Discussion

The observed changes in land use and vegetation cover in Gazipur District align with broader trends discussed in the literature on land transformation. In the year 2000, the prevalence of barren land, water bodies, and shrubs and grassland in Gazipur reflected a landscape where water bodies covered a substantial area (33.23%), and dense vegetation accounted for a minimal percentage (0.81%). This initial composition resonates with the literature highlighting the impact of human activities, such as urbanization and industrial development, on land cover, with water bodies and barren land being significant components (Yang et al., 2018; Su et al., 2022). The decline in dense vegetation from 2000 to 2010, attributed to factors like deforestation and urbanization, is consistent with global concerns about biodiversity loss due to land transformation (Buriti & Barbosa, 2022). The subsequent rise in thick vegetation by 2010, potentially influenced by conservation efforts and reforestation, aligns with the literature emphasizing the positive impact of such initiatives on ecosystem health (Zhou et al., 2022).

The continuous decrease in water bodies from 2000 to 2021 corresponds with literature discussing the negative consequences of urbanization and land use changes on aquatic habitats and water resources (Trenberth, 2004). The large increase in shrubs and grassland, which will reach 92.6% by 2021, shows a big change in how land is used. This could be because of farming or urbanization, which is in line with other research that stresses how ecosystems change over time and the need for long-term land management (Iovanna & Vance, 2007). The observed align in vegetation density and water bodies aligns with the literature's discussions on the adverse effects of human activities on natural vegetation and the interconnectedness of land cover changes with surface temperature variations (He et al., 2007; Lo and Quattrochi, 2003). The changes in land surface temperature from 2000 to 2021 shown on the maps show how these land use changes have affected local temperatures. This is in line

with what we know about Urban Heat Islands (UHI) and the link between land cover types and land surface temperature (Ahmed et al., 2013). These findings suggest that human-induced land use changes, such as deforestation and urbanization, have played a significant role in altering surface temperatures in the study area. The increase in impervious surfaces, such as concrete and asphalt, associated with urban development has led to the formation of UHI, where urban areas experience higher temperatures compared to surrounding rural areas. Conversely, the decrease in vegetation cover, particularly in forested regions, has reduced the cooling effect of evapotranspiration, resulting in elevated land surface temperatures. These findings highlight the need for sustainable land management practices to mitigate the adverse effects of land use changes on local climate and to promote the conservation of natural vegetation.

The implications of these changes on biodiversity, soil erosion, and water resources are consistent with broader discussions in the literature regarding the ecological consequences of land transformation (Rahman, 2009). The identified patterns in land use alteration, particularly the conversion of water bodies into open space and the dominance of shrubs and grassland, emphasize the need for effective conservation and sustainable land management strategies, aligning with the literature's emphasis on the importance of preserving green spaces (Levien et al., 1999). These changes in land use can have significant implications for biodiversity. The conversion of water bodies into open spaces may lead to the loss of aquatic habitats and the decline of species that depend on them. Additionally, the dominance of shrubs and grassland can lead to a decrease in plant diversity and the loss of habitat for many animal species. This poses risk to livelihood development of the people in the area specifically those who are living on agricultural activities. Seasonality in agriculture is disrupted due to land use change and implications for marginalization of the households for food security (Hasan, 2014, Hasan, 2015).

Moreover, the alteration of land use can also exacerbate soil erosion. The removal of natural vegetation, especially in hilly or sloping areas, can increase the vulnerability of the soil to erosion by wind and water. This can result in the loss of valuable topsoil, nutrient depletion, and decreased agricultural productivity. Furthermore, the conversion of land for urban development can also contribute to the fragmentation of natural habitats. As more land is cleared for infrastructure and housing, the remaining patches of natural habitat become isolated, making it difficult for species to move and disperse. This can lead to genetic isolation and a decrease in biodiversity. Additionally, the increased impervious surfaces in urban areas can lead to water runoff and flooding, further impacting the surrounding ecosystems. Furthermore, changes in land use can impact water resources. The conversion of natural land cover to urban or agricultural areas can disrupt the natural water cycle, leading to increased runoff, reduced infiltration, and decreased groundwater recharge. This can result in water scarcity, especially in regions that rely on groundwater as a primary source of freshwater.

To address these ecological consequences, effective conservation and sustainable land management strategies are crucial. Preserving green spaces, such as wetlands, forests, and parks, can help maintain biodiversity, mitigate soil erosion, and protect water resources. Implementing practices like afforestation, reforestation, and sustainable farming techniques can also contribute to the preservation and restoration of ecosystems. By aligning with these strategies, we can strive towards a more sustainable and resilient future for our planet.

The observed changes underscore the need for proactive conservation measures and sustainable land management practices to mitigate the adverse ecological and environmental consequences of

urbanization and land use changes. These measures should include the preservation and restoration of green spaces, such as parks and gardens, which are crucial for maintaining biodiversity and providing various ecosystem services. Additionally, implementing strategies that promote sustainable land management, such as reforestation and soil conservation practices, can help mitigate soil erosion and degradation caused by urbanization. By adopting these measures, we can ensure the long-term sustainability and resilience of our urban environments, benefiting both human and ecological communities.

Conclusion

The comprehensive analysis of land transformation in Gazipur District spanning from 2000 to 2021 provides valuable insights into the dynamic interplay between human activities, land use changes, and their environmental consequences. The results reveal a significant evolution in the district's landscape, with notable shifts in land cover types and vegetation patterns. In the initial years of the study, Gazipur exhibited a landscape dominated by water bodies, barren land, and shrubs and grassland. However, by 2010, there was a noticeable increase in shrubs and grassland and a decline in dense vegetation and water bodies. This change is a result of factors like deforestation, urbanization, and possibly climate change. This shift aligns with broader global trends discussed in the literature on the impact of human activities on land cover and biodiversity.

The subsequent years, particularly from 2010 to 2021, witnessed a substantial decrease in barren land, coinciding with a rise in shrubs and grassland. However, the complete eradication of dense vegetation raises concerns about biodiversity loss and habitat degradation. These findings resonate with literature emphasizing the adverse effects of urbanization on natural vegetation and the importance of conservation efforts to maintain ecosystem health. The temperature maps provide a tangible link between land use changes and surface temperatures. The rise in land surface temperature correlates with the decrease in water bodies and dense vegetation, aligning with the literature on urban heat islands and the influence of land cover types on temperature variations. The observed temperature variations underscore the environmental repercussions of land transformation, emphasizing the need for sustainable land management strategies.

The overall contribution lies in its localized examination of Gazipur District, shedding light on the nuanced challenges posed by rapid urbanization and land use changes. The results underscore the urgency of implementing conservation measures to preserve green spaces, mitigate temperature increases, and safeguard biodiversity. As Gazipur continues to grapple with the repercussions of industrialization and urban development, informed policy decisions and sustainable land management strategies become imperative for ensuring a balance between economic growth and environmental preservation. The findings from Gazipur District not only contribute valuable data to the understanding of local land transformation but also resonate with broader principles discussed in the literature. The observed trends emphasize the interconnectedness of human activities, land cover changes, and environmental impacts, underscoring the importance of proactive measures to foster sustainable development and ecological resilience in the face of evolving landscapes.

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