Int. j. adv. multidisc. res. stud. 2026; 6(1):1595-1604

Received: 10-12-2025
Accepted: 20-01-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Assessing the Impact of Urban Sprawl on Agricultural Land Use in Rangpur Sadar Using GIS and Remote Sensing

[1] Mst. Nushrat Jahan, [2] Md. Rabbi Hasan, [3] Md. Likujjaman Like, [4] Md. Nasir Uddin, [5] Ratu Rumana Chowdhury Snaha

[1, 3, 4, 5] Department of Geography and Environmental Science, Begum Rokeya University, Rangpur, Bangladesh
[2] Department of Mass Communication and Journalism, Begum Rokeya University, Rangpur, Bangladesh

Corresponding Author: **Md. Nasir Uddin**

Abstract

This research investigates the rapid changes in land use patterns in Rangpur Sadar over the period from 2008 to 2024. With the region experiencing substantial urban growth, this study aims to analyze the spatial extent, directional trends, and consequences of urban sprawl on the district's agricultural landscape. Utilizing high-resolution satellite imagery and GIS-based spatial analysis, the research mapped land use changes, identified sprawl patterns, and quantified the impact on agricultural areas. The results show a striking increase in built-up areas, expanding from 2,837.1 hectares (9%) in 2008 to 12,625 hectares (36%) in 2024, primarily concentrated in the east (E, ENE, ESE) and northwest (NW, WNW) directions, indicating a clear trend driven by population growth and infrastructure development. Conversely, agricultural land has significantly declined, dropping from 12,946.7 hectares to 3,053.53 hectares within the same period. The most rapid decline occurred between 2008 and 2016 when agricultural land decreased by over 62% due to the conversion of fertile fields into urban infrastructure. The study also highlights how urban sprawl has led to the fragmentation of farmlands, reducing their productivity and efficiency while introducing environmental pressures like soil degradation and pollution. The research found that areas within a 5-kilometer radius of the Central Business District (CBD) are particularly affected by high-density urbanization. Based on these findings, the study concludes that unchecked urban sprawl poses a serious threat to the food security and agricultural sustainability of Rangpur Sadar and recommends zoning regulations, urban growth boundaries, and sustainable urban planning supported by GIS and remote sensing.

Keywords: Urban Sprawl, GIS and Remote Sensing Based Analysis, Land Use Change, Agricultural Sustainability

1. Introduction

Urban sprawl is a kind of urban development that is defined by the unplanned, uncontrolled growth of metropolitan areas into nearby rural or undeveloped terrain. This phenomenon is characterized by the fragmentation of natural landscapes brought about by the outward expansion of low-density residential, commercial, and industrial activities. A lack of precise zone and land-use planning, the conversion of natural or agricultural land into urbanized regions, and transportation systems.

Bangladesh is a populous South Asian country that is facing rapid urban sprawl, especially in its larger cities. Due to this phenomenon, the agricultural landscape is changing in metropolitan areas as well as the residential, commercial, and industrial spaces are increasing. The boundaries between urban and rural areas are fading due to the growth of metropolitan centers, and uncontrolled urban sprawl is creating more demand for agricultural land.

If the increase is faster than normal, the city will have additional significant issues. (Habibi & Asadi, 2011) [10] Bangladesh is a small and developing nation and it has a wide and rapidly expanding population. Due to greater work possibilities and lifestyles, there is an excessive urban expansion and that leads to an agricultural land use shift.

Planners and policymakers have developed a special interest in urban sprawl throughout the last 20 years. The many purported negative effects of sprawl, which are opposed worldwide, include diminished public services in the suburbs and weakened central cities' economies due to a lack of scale economies; increased energy consumption from promoting the use of private vehicles, which results in traffic jams and air pollution; and irreversible harm to ecosystems from dispersed and fragmented

urban development in open spaces. dispersed urbanization in open spaces. (Ewing, 1997) [7]; (Brueckner, 2000) [4]; (Downs, 1998) [5]; (Johnson, 2001) [15]; (Frenkel & Ashkenazi, 2008) [8].

Urban sprawl on agricultural land has spread around the world and is now a problem for the affluent and poor alike. Most countries on the globe, especially developing ones, have faced difficulties as a result of this phenomenon due to rapid population growth and the resulting depletion of resources, particularly agricultural fields surrounding urban areas. (Al Tarawneh, 2014) [1].

The purpose of this research is to critically investigate the causes that work behind the urban sprawl and agricultural land use change in Rangpur city. This study aims to examine urban sprawl and land use through different analyses using various approaches. To understand the shift of agricultural land in Bangladesh and other countries, a systematic literature review was conducted. The study also identified gaps in previous research and included new material in the latest edition to fill those gaps.

The transformation of agricultural landscapes due to urban sprawl reflects not only physical changes but also intricate shifts in societal dynamics. Agriculture, once predominantly rural, is now increasingly influenced by urbanization, altering traditional farming practices and the very fabric of rural communities.

In many regions, the encroachment of urban areas into agricultural land has led to the fragmentation and isolation of once-contiguous farmlands. This spatial reconfiguration poses challenges to the efficiency of agricultural operations, impacting economies of scale and altering the traditional patterns of land use.

Moreover, the impact of urban sprawl on agricultural ecosystems extends beyond land conversion. It involves the alteration of hydrological patterns, changes in soil composition, and potential disruptions to biodiversity. The delicate balance between urban development and environmental preservation becomes a critical consideration as cities expand into areas historically dedicated to food production.

Understanding the historical context of this transformation provides insights into the evolution of land use policies and planning practices. Previous approaches to urban development may have inadvertently accelerated the encroachment on agricultural land, necessitating a reevaluation of planning strategies to achieve a harmonious balance.

While there is a growing body of literature on urban sprawl and its consequences, a specific research gap exists in understanding the nuanced impact on agricultural land.

Previous studies have often focused on broader environmental and social aspects, neglecting the intricate dynamics within agricultural landscapes. This research seeks to address this gap by zooming in on the specific challenges, opportunities, and adaptations required within the realm of agriculture as urban sprawl advances.

As urbanization continues to shape our landscapes, an in-depth exploration of the interplay between urban sprawl and agriculture is crucial. By identifying and analyzing the gaps in current knowledge, this study aims to contribute to the development of more targeted and effective strategies for sustainable land use planning, ensuring the coexistence of urban and agricultural spaces.

In summary, the background of this study emphasizes the historical evolution of the connection between urban sprawl and cultivatable land, the societal and environmental implications, and the existing research gap that motivates the need for a focused and comprehensive investigation.

Due to unchecked migration from the neighboring areas and natural expansion, the population of Larkana is growing quickly. This has caused the built-up area to haphazardly expand over the productive agricultural land. Urban sprawl can occur in a variety of ways, such as on agricultural land, on highways, on archeological sites, on water supplies, on sources of biodiversity, and residential buildings, industrial facilities, infrastructure, etc. One problem that still affects the world's agricultural resources is urban sprawl on agricultural land.

Bangladesh is an agricultural country, and its economy mostly depends on agriculture. 80% of it depends on agriculture. Some important terms such as food security, economic development, and sustainable development depend on the evaluation and protection of agricultural lands.

Agricultural productivity is impacted by both the severity of agricultural land use and urban sprawl on arable land. (Long & Zou, 2010) [18] (Jiang *et al*., 2012). To create policies that will balance the pressures of urban growth, reduce the uses of cultivatable land, and protect, it is essential to comprehend the relationship between agricultural land use severity and urban sprawl. (Jiang *et al*., 2013) [14].

Urban planners and policymakers will benefit greatly from the study's findings, which offer vital insights into the pace of urbanization and the direction of sprawl. To balance urban growth and conserve essential agricultural resources, sustainable urban planning requires an understanding of the pattern of urban sprawl.

Urban sprawl is a problem in Bangladesh as well as Dhaka because of unplanned medium-scale manufacturing industry setups, population increase, haphazard housing developments, unplanned urban migration, warehousing, and lower-class housing. (Wang & Sarker, 2020a)

Based only on indicators of land-use change About 2.5 hectares of arable land were lost every day in the Dhaka district between 2000 and 2010 as a result of haphazard housing projects, expanded industrial buildings, unplanned brick kiln setups, and the construction of roads and other infrastructure. Over 16,997 hectares of land makeup Keraniganj, however, because of haphazard real estate construction, its agricultural land has shrunk from 11,380 hectares to 9,688 hectares. (Wang & Sarker, 2020a)

Since Bangladesh's urban economy accounts for over 60% of GDP, rural residents migrate to the city in search of better living conditions and means of subsistence. The city provides office jobs, business jobs, and manufacturing industry jobs, accounting for 43.6% of all formal employment in the nation. (Mowla, 2015) [21]. This migration creates extra pressure on agricultural land.

The excessive expansion of built-up regions and informal urbanization in Dhaka have resulted in the suffocation of sensitive and agricultural lands. Thus, "big urban agglomerations are growing and becoming denser at a speedy rate with very little and irregular planning control." (Baumgart & Kreibich, 2011) [3].

To accomplish the task, the study has specified two objectives- a) To analyze the pattern of urban sprawl in

Rangpur Sadar; b) To quantify the change in agricultural land use. The research questions of this research are, how has urban sprawl influenced the agricultural land use patterns in the Rangpur Sadar over the last 16 years? What are the environmental consequences of urban sprawl on agricultural land? What kind of urban sprawl pattern may be found in this region, and how does it evolve?

Urban sprawl can occur on agricultural land, on highways, on archaeological sites, on water sources, on sources of biodiversity, and in many other ways. Examples of its various forms include residential buildings, industrial facilities, infrastructure, and so forth. The world's agricultural resources continue to face the problem of urban sprawl on agricultural land. Not only does this development degrade the quality of life for suburbanites, but it also raises alarms globally. Fair housing proponents, environmentalists, land use planners, and even many suburban employers who struggle to find work acknowledge that the costs of this development extend far beyond aesthetics. (Squires, 2002) [30] Some literature review on the research topic explained below:

(Rai *et al*., 2017) [27] describe the changing circumstances, patterns, and compositions of land use and land cover in the area. The data demonstrates that metropolitan areas, primarily around Dhaka, have risen fast, turning agricultural and woodland territory into urban districts. The existing study does not give appropriate data at both national and sub-national sizes. The article underlines the importance of greater study on Bangladeshi land use changes.

(Hosen *et al*., 2021) [12] using remote sensing and GIS tools, the research assesses the influence of industrial expansion on the area's land use patterns. The results reveal major shifts in land use and land cover, especially the expansion of built-up regions and a decrease in water bodies, barren plains, and vegetation. However, a key research gap indicated in the report is the absence of comprehensive consideration of the socio- economic effects of these land use and land cover changes on the local people living around the industrial core.

(Wang & Sarker, 2020b) explores the effect of urban sprawl on sustainable development in Dhaka, Bangladesh, focusing on the period from 1990 to 2017. The study incorporates primary and secondary data, including Landsat photographs. The result shows a research gap in the absence of detailed geomorphological and land use mapping in the examined area despite prior regional-scale studies in Bangladesh.

(M. N. Rahman, 2019) [25] designs to map out the Land Use and Land Cover (LULC) status of the region to identify land consumption rates and changes that have transpired throughout the supplied time. The paper stresses the quick increase in built-up districts, including residential, commercial, industrial, and transportation zones, resulting in congestion in the city. The results suggest a huge loss of agricultural land and bare soil, with a notable growth in water sources. However, the study gap lies in the need for further inquiry into the unique drivers of urban growth, the socio-economic repercussions of land use changes, and potential mitigation measures to meet the difficulties encountered by fast urbanization in the region.

(Hassan & Southworth, 2017) [11] focus on monitoring land use and land cover change, urban growth dynamics, and landscape pattern analysis in five rapidly urbanizing cities in Bangladesh, with a specific emphasis on Dhaka. The study utilizes remote sensing data and the Random Forest approach to estimate land cover changes from 1972 to 2015. Key findings include a considerable decrease in agricultural land cover, mainly in the Dhaka City Corporation zone, and larger urban growth rates in nearby cities like Gazipur and Savar.

(Mamun *et al*., 2022) [19] Geospatial techniques were applied to study urbanization tendencies in Jamalpur, Bangladesh, from 1991 to 2021. The evaluation suggested a 748.92% gain in built-up areas and the loss of natural resources such as bare soil, water, and agricultural land. Remote sensing technologies were recognized as efficient for monitoring urbanization patterns. The study did not address prediction modeling or the implications of urbanization on biodiversity and land-surface temperature, providing a research void for future urban sustainability studies.

(Zhou *et al*., 2015) [35] evaluate the impact of urban sprawl on net primary production (NPP) in Nanjing, China, using the BEPS model from 2001 to 2010. It implies major land-cover changes are attributable to urbanization, with urbanized regions growing and green areas declining. The research illustrates that modeling NPP with a process- based model at a sufficiently fine resolution can yield more accurate evaluations of the consequences of urbanization on NPP, especially in regions undergoing quick urban expansion like Nanjing.

(Al Tarawneh, 2014) [1] studies urban growth on agricultural land, underlining its effect on national economies, the environment, and food security. It defines urban sprawl, explores its origins and impacts, and tackles its relationship with land use planning. Drawing on experiences from Egypt and Ontario, it offers strategies to limit urban sprawl. The report provides a local case study in northern Karak city, Jordan, analyzing the effect on agricultural fields using the DPSIR approach. However, a research vacuum exists in the lack of extensive investigation of the particular difficulties confronted by Jordan in handling urban growth on agricultural land.

(Nuissl & Siedentop, 2021) [22] addresses the issues of urban land use transformation, including its environmental, social, and economic ramifications. It underlines the continuous conversation regarding the implications of urbanization and the difficulty in regulating urban development appropriately. It underscores the importance of a coordinated political approach at different levels to address urban land use successfully. Additionally, the research stresses the role of social learning and long-term agenda- setting mechanisms in preventing urban growth.

(G. Rahman *et al*., 2023) [24] focus on the impact of urban expansion on agricultural land and the thermal environment in Larkana, Pakistan. The research leverages the Random Forest algorithm on the Google Earth Engine platform to investigate land use/land cover patterns from 1990 to 2020. The results reveal a considerable growth in built-up areas at the expense of agricultural land and open spaces, adding to environmental issues.

(Mosammam *et al*., 2017) [20] investigated land use change and urban sprawl in Qom City, Iran, from 1987 to 2013, employing satellite pictures and Shannon's entropy analysis. It underlines the enormous development in built-up regions and the impact on agriculture, gardens, and wasteland. The analysis forecasts further urban sprawl in the future. However, the study gap lies in the requirement for more

specific rules and regulations to address the prevalent style of linear expansion and its implications on land use patterns in Qom City.

(Subramani & Vishnumanoj, 2014) [31] present a comprehensive analysis of land use and land cover changes in the Panamarathupatti Lake region of Salem. The research applies remote sensing techniques to investigate the geographical land use changes that occurred from 1973 to 2009. The research underscores the huge development in urban built-up areas, a loss in forest areas, and an increase in grasslands, leading to a rise in impervious surface areas and related environmental vulnerabilities. Additionally, the research on urban sprawl using the Shannon entropy index reveals that while sprawling did not considerably increase during the study period, some sections of the city had high amounts of sprawling.

(M. T. Rahman, 2016) [26] studies the land use and land cover changes in Al-Khobar, Saudi Arabia using remote sensing data from 1990, 2001, and 2013. The research stresses large increases in urban built-up areas and vegetation, suggesting a high pace of urban expansion in the city. However, a study shortage exists in understanding the nature of land use and land cover changes that transpired as a result of the population rise in Al-Khobar.

(Jiang *et al*., 2013) [14] analyze the influence of urban expansion and socioeconomic characteristics on agricultural land use intensity in China. Using panel econometric models, the study demonstrates that urban expansion is related to a decline in agricultural land use intensity. The research shows that ongoing urbanization-driven labor transfer will likely lead to changes in spatial patterns of agricultural land use, with a tendency towards more intensive cropping in inland provinces. The research underlines the prospect of continued agricultural land growth in reaction to urban expansion, suggesting continuing strain on China's natural land resources.

(Embaby, 2021) [6] focuses on assessing urban sprawl in the Greater Cairo Region from 2000 to 2016 via remote sensing and GIS approaches. The investigation found tremendous expansion in built-up regions and huge losses of agricultural land. The research stressed the need for improved government assessment procedures to prevent urban expansion and highlighted the significance of trustworthy data and the use of GIS and remote sensing technology in land management policies. However, the paper did not address the likely social and environmental effects of urban expansion.

(Zhang *et al*., 2007) [34] explore the effect of urban growth on soil resources in Nanjing City by employing satellite pictures and digital databases. It measures the quantity of urban expansion and its repercussions on soil resources by measuring changes in land use over time. The research stresses the quick expansion of urbanization in Nanjing city, with substantial tracts of rural land being transformed to urban usage.

Shalaby (2012) [29] reveals a considerable rise in metropolitan areas at the price of exceptionally fertile soils, with Class I and moderately competent soils incurring notable losses. The findings underscore the urgent need for sustainable land use planning to address the detrimental effects of urbanization on agricultural production and environmental sustainability in the region.

Torrens & Alberti (2000) [32] study the challenging problem of suburban sprawl, underlining the insufficient knowledge of its drivers and aspects. To solve the aforementioned gap, the research proposes several methodologies for measuring sprawl aspects, including surfaces, gradients, fractal measures, and accessibility estimations. By bridging the gap between theoretical talks and real measurement methodologies, the study seeks to establish a better-informed basis for minimizing urban sprawl and directing policy decisions.

S. Khan (2019) [17] indicates a gradual loss of agricultural land in the Aligarh district, owing to urban expansion. Using remote sensing and GIS analysis, Population, and economic factors were acknowledged as key drivers in developing urban centers, but weaker incentives and weather fluctuations led to the loss of agricultural land. The research stresses the need to harmonize present land use needs with future population demands and encourages the preservation of agricultural land in expanding metropolitan peripheries. The study underscores the necessity of using current technologies like remote sensing and GIS for effective urban sprawl monitoring and land use planning.

(Omasire *et al*., 2020) [23] centered on the impacts of urban development on agricultural land was done in Wote Town, Makueni County, Kenya. The study identified low economic returns from agricultural activities as the principal driver of urban development in the area, leading to the conversion of agricultural land for other purposes. The ramifications of urban expansion included unauthorized development, proliferation of unplanned housing, increased population pressure, and harm to the natural environment.

(Furberg, 2014) [9] studies satellite monitoring of urban expansion in Stockholm, GTA, and Shanghai, focusing on urban growth patterns and environmental repercussions. It studies the use of categorization algorithms and landscape measurements to study changes in land use throughout time. The research underlines the need for a deeper inquiry into the comparability of urban growth patterns in different nations and the difficulties of sustainable urban development particular to each terrain. One issue that needs to be emphasized is the limited analysis of how urbanizing landscapes affect ecosystem services and the absence of specialized indicators for regions undergoing mild urban expansion.

2. Materials and Method

Description of the Study Area

Rangpur Sadar is a significant administrative and commercial center located in the Rangpur District of Bangladesh. Rangpur Sadar is situated in the northern part of Bangladesh, specifically within the Rangpur Division. Geographically, it lies at the coordinates approximately 25.7460° N latitude and 89.2517° E longitude. The area is characterized by flat terrain, part of the larger Gangetic Plain, with fertile agricultural land surrounding the urban center. The area is characterized by low-lying landforms with gentle slopes, making it suitable for agriculture. The land is primarily composed of fertile alluvial soil deposited by the nearby rivers, contributing to the region's agricultural productivity.

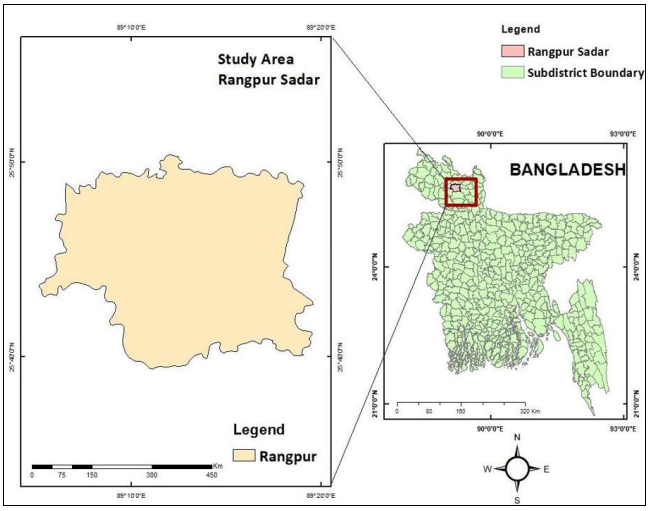

Fig 1: Study Area Map

For the study I selected Rangpur Sadar as it is a central urban area within the district, it attracts people from neighbouring rural areas seeking employment opportunities, education, and access to services.

Methods of Study

Data

Remote sensing is a source of information and data for indicating the change of bar dynamics of an area and identifying the long-term changes. To understand various bar dynamics changes that took place in the study area, the images were collected from Landsat 4-5 and Landsat-8 TM. For image processing and enhancement, supervised image classification is done to classify these images. According to the classification, five land cover classes are determined. These are 1) Water 2) Built areas 3) Agriculture 4) Vegetation 5) Others. Among them, built-up areas and agricultural classes are used for this study.

Table 1: Data Used in this Research

Sensors	Date	Resolution	USGS	Band Combination
Landsat 8-9 OLIS	January,2024	30 m	USGS Earth Explorer	Band 1, Band 2, Band 3, Band 4, Band 5, Band 6,Band 7
Landsat 8-9 OLIS	December2020	30 m	USGS Earth Explorer	Band 1, Band 2, Band 3, Band 4, Band 5, Band 6,Band 7
Landsat 8-9 OLIS	November 2016	30 m	USGS Earth Explorer	Band 1, Band 2, Band 3, Band 4, Band 5, Band 6,Band 7
Landsat 7ETM	July 2012	30 m	USGS Earth Explorer	Band 1, Band 2, Band 3, Band 4, Band 5, Band 6,Band 7
Landsat 4-5TM	August 2008	30 m	USGS Earth Explorer	Band 1, Band 2, Band 3, Band 4, Band 5, Band 6,Band 7

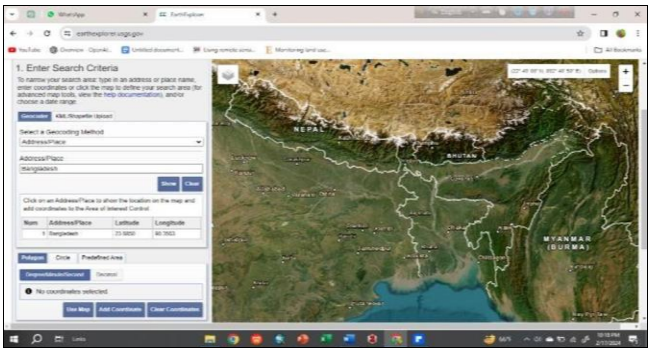

Fig 2: Data source (US Geological Survey Website)

Software and Material

Moreover, image processing and GIS software (Table 2) should be used to create databases, simple statistical analysis, and image processing.

Table 2: Software and Material

Image processing and analysis Software	Statistical analysis	Word Processing report writing
Arc GIS 10.8	Arc GIS 10.8, MS Excel 2016	MS Word 2016

Data Types

There are two kinds of data in GIS, that is.

1. Spatial data
2. Attribute data

Spatial Data

Spatial data are the data that deal with the spatial projection of an area. It may be a map or an image. This projection is worked through some layers, each layer represents some objects, and the combination of this layer projects a final map.

Attribute Data

Attribute data may be information on the features or the layers. It is the data table that contains information on different layers in a data table. We can edit data or add and remove data that can change the projection or the field that we want to show.

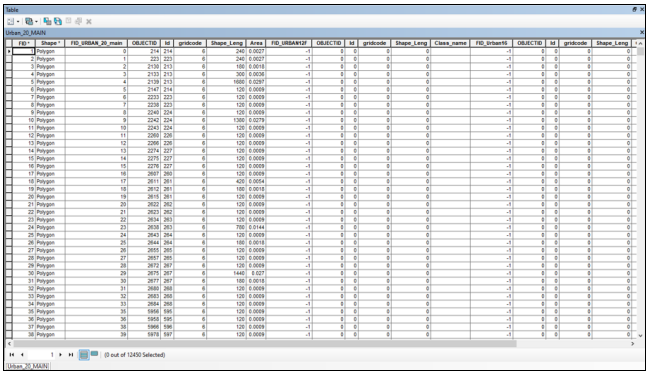

Fig 3: Attribute Table and Data

Data Processing

Data processing in ArcGIS and QGIS is an essential component of research, especially in fields like geography, environmental science, and urban planning. These platforms provide robust capabilities for spatial data analysis, with each offering unique features suited to different user needs.

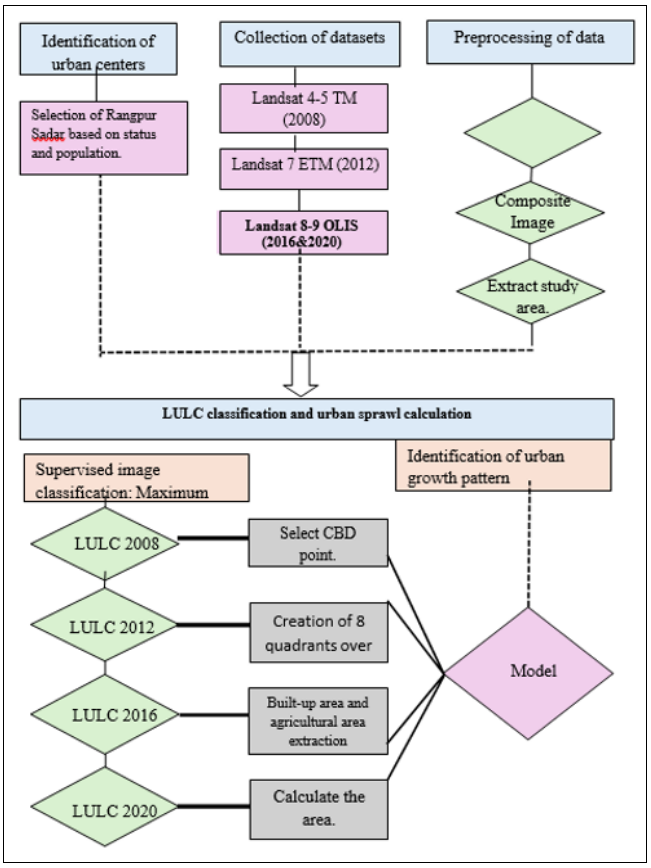

Fig 4: Identification of Urban Center & Generation of Dataset work

Image Classification Techniques

Image classification refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. Depending on the interaction between the analyst and the computer during classification, there are two types of classification: a) Supervised classification, b) Unsupervised classification.

Supervised Classification:

This classification uses the spectral signatures obtained from training samples to classify an image. With the assistance of the Image Classification toolbar, you can easily create training samples to represent the classes you want to extract. You can also easily create a signature file from the training samples, which is then used by multivariate classification tools to classify the image.

Unsupervised Classification:

This classification finds spectral classes (or clusters) in a multiband image without the analyst's intervention. The Image Classification toolbar aids in unsupervised classification by providing access to the tools to create the clusters, the capability to analyze the quality of the clusters and access to classification tools.

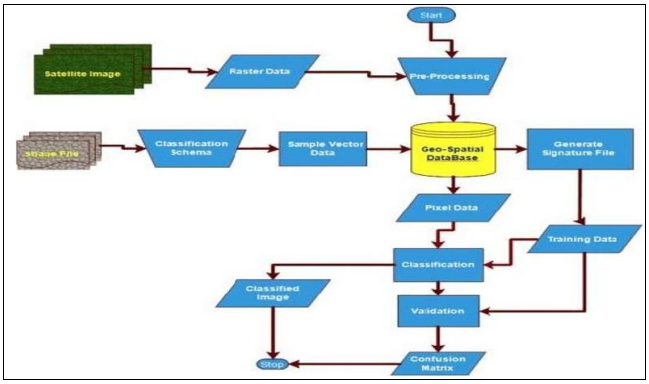

Fig 5: Supervised Image Classification

3. Results & Discussion

Results and Analysis

The results of the Bar dynamics classification of Rangpur Sadar LULC for the years 2008,2012, 2016, 2020, and 2024, are documented graphically in Figure 4.1. Quantitative details about the land cover in the respective years are presented in Table and represented in the Bar diagram (Figure 4.1).

Table 3: Land Distribution of Rangpur Sadar

Year	2008	2012	2016	2020	2024
Built up area	2837.1	4472.65	7356	10400.5	12625
	9%	12%	17%	29%	36%
Agriculture	12946.70	8840.11	5981.1	4372.04	3053.53
	37%	25%	22%	12%	9%

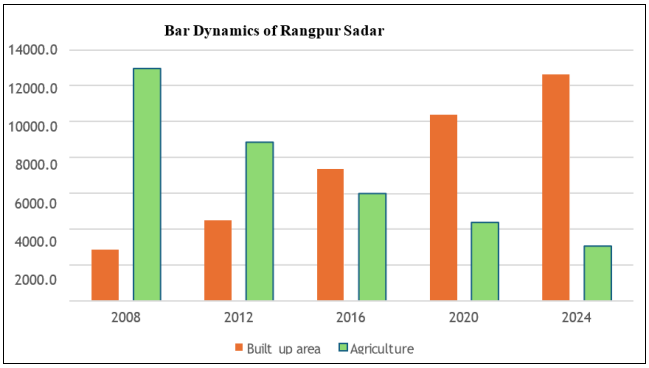

Fig 6: Bar Dynamics of Land Classification

Image Interpretation

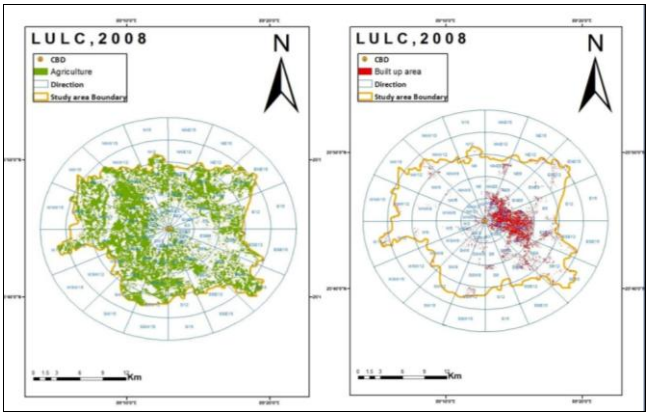

Fig 7: Agricultural and Built-up Area 2008

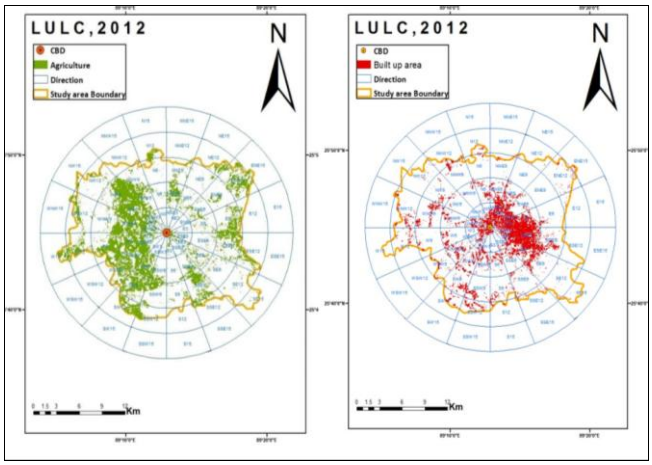

Fig 8: Agricultural and Built-up Area 2012

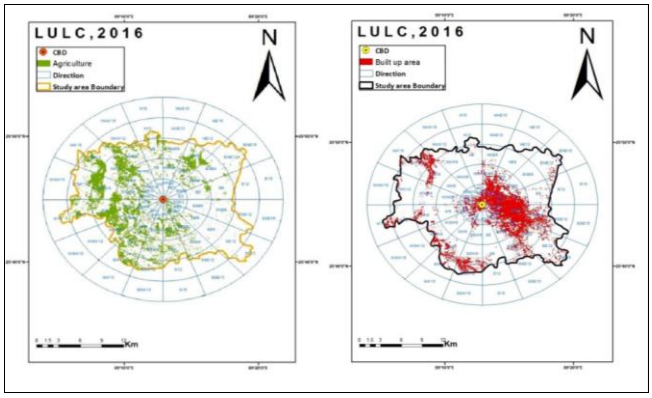

Fig 9: Agricultural and built-up area 2016 and 2020

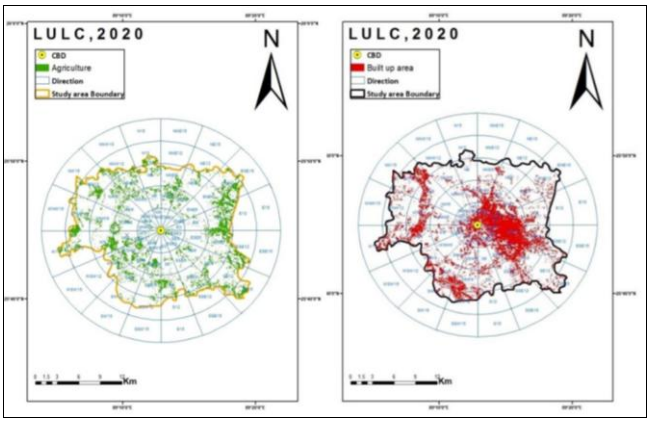

Fig 10: Agricultural and built-up area 2016 and 2020

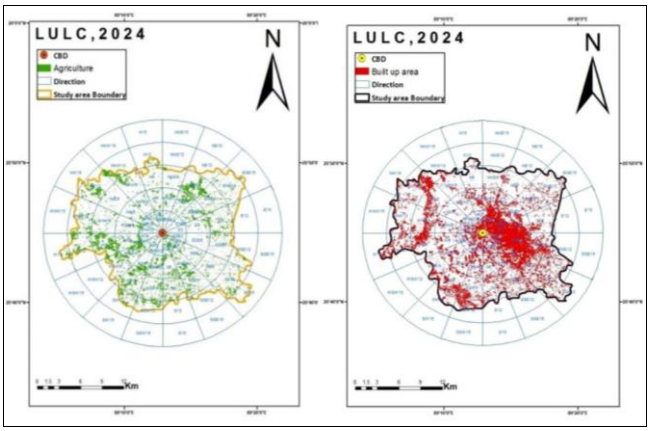

Fig 11: Agricultural and built-up area 2024

From the categorized map of 2008, 2012, 2016, 2020, and 2024 (Figure 4.2, 4.3, 4.4, 4.5, 4.6), it is obvious that the region is predominantly controlled by an agricultural area. During this era built-up area underwent a significant development, beginning from 2837.1 hectares (9%) in 2008 and finishing at 12625 hectares (36%) in 2024. This growth was especially evident in the latter two seasons, with a 29% rise from 2016 to 2020 and a 36% jump from 2020 to 2024. The acceleration of urbanization and infrastructure development is obvious from these statistics, reflecting a rising population and a trend towards more urban lifestyles such as employment and job, financial position, education, and social and cultural activities. This trend implies a large increase of urban and residential areas, possibly owing to population growth, urbanization, and infrastructural development. The rise in built-up areas has quickened, significantly signifying urbanization and development in recent years. The area under agriculture has reduced from 12946.7 hectares in 2008 to 3053.53 hectares in 2024. The rate of drop has been especially noticeable in the first two years, with a 37% decrease from 2008 to 2012 and a 25% decrease from 2012 to 2016. This shows a considerable decline of agricultural land, which might be attributable to reasons such as urbanization, conversion of agricultural land for other purposes, or changes in farming techniques.

The pace of loss in agricultural land has slowed in the previous two periods, indicating stability or a slower rate of conversion of agricultural land. The data demonstrates a clear pattern of urbanization and growth, with a large rise in built-up areas and a commensurate decline in agricultural land throughout the years. The significant growth in built-up areas from 2016 to 2024 predicts a time of strong urban development and expansion. The decline in agricultural acreage, particularly in earlier eras, might raise worries about food security and the sustainability of agricultural operations. The slowing down of the pace of reduction in agricultural land in the previous two periods may suggest attempts to balance urban expansion with the preservation of agricultural land or a trend towards more sustainable land use practices.

Urban Sprawl Direction

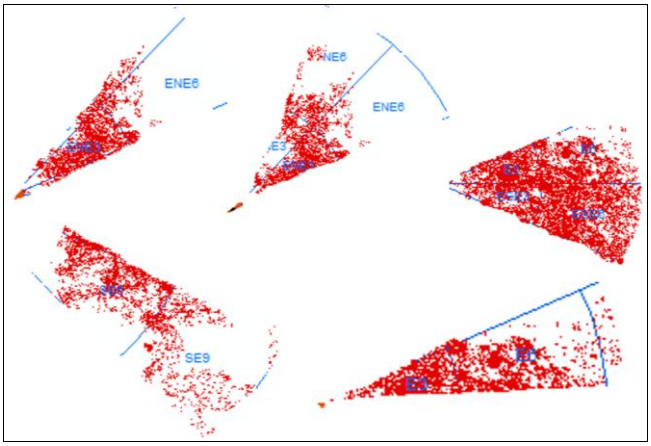

Fig 12: Sprawl direction image of 2008

Table 4: Sprawl direction data of 2008

Direction	Area	Direction	Area
E	10.1	S	0.5
ENE	7.5	SE	0.3
ESE	5.6	SSE	0.1
N	1.1	SSW	0.1
NE	0.7	SW	0.1
NNE	0.7	W	0.1
NNW	0.7	WNW	0.1
NW	0.6	WSW	0.1

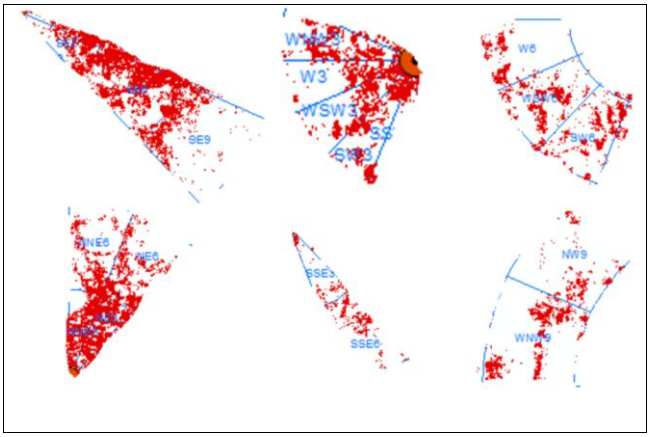

Fig 13: Sprawl direction image of 2012

Table 5: Sprawl direction data of 2012

Direction	Area	Direction	Area
E	15.1	S	0.6
ENE	9.5	NNE	0.9
ESE	8.6	SSE	0.3
N	2.1	SSW	0.2
NE	1.7	SW	0.1
SE	3.5	W	0.1
NNW	0.9	WNW	0.1
NW	0.7	WSW	0.1

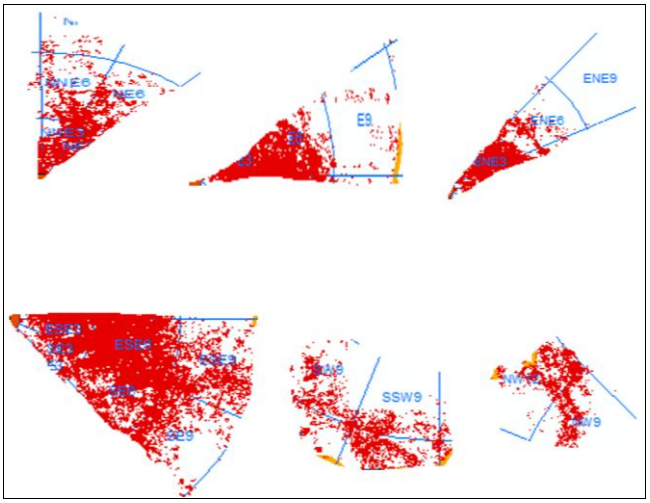

Fig 14: Sprawl direction image and data for 2016

Table 6: Sprawl direction data for 2016

Direction	Area	Direction	Area
E	20.5	S	1.7
ENE	10.4	SE	4.5
ESE	9.6	SSE	1.2
N	3.5	SSW	2.7
NE	5.6	SW	2.1
NNE	3.5	W	0.5
NNW	1.4	WNW	0.2
NW	3.5	WSW	0.2

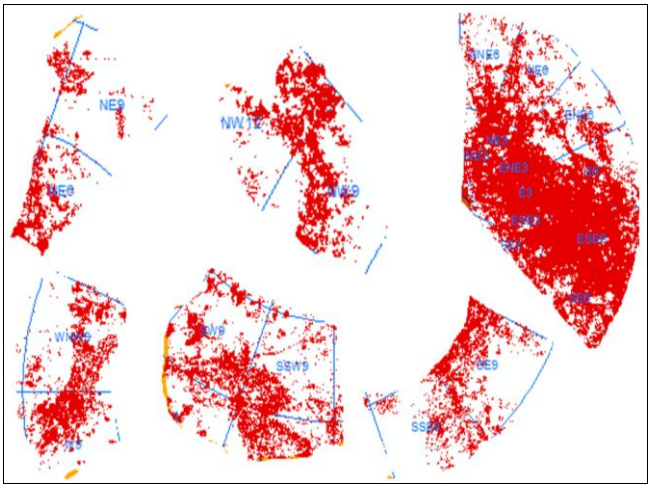

Fig 15: Sprawl direction image and data for 202

Table 7: Sprawl direction data for 2020

Direction	Area	Direction	Area
E	23.5	S	2.1
ENE	12.3	SE	5.3
ESE	14.5	SSE	1.9
N	3.8	SSW	3.5
NE	5.4	SW	1.2
NNE	6.2	W	3.4
NNW	2.5	WNW	3.3
NW	7.5	WSW	0.5

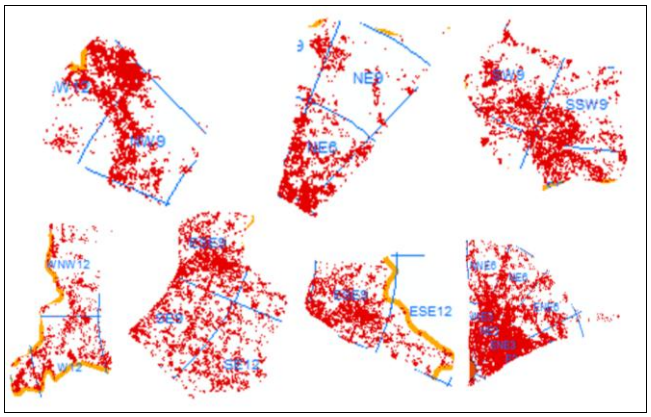

Fig 16: Sprawl direction image of 2024

Table 8: Sprawl direction data of 2024

Direction	Area	Direction	Area
E	1605.3	S	758.5
ENE	1266.1	SE	751.7
ESE	1198.3	SSE	684.2
N	1078.1	SSW	606.6
NE	1034.8	SW	557.5
NNE	982.7	W	546.2
NNW	970.6	WNW	351.5
NW	877.8	WSW	190.7

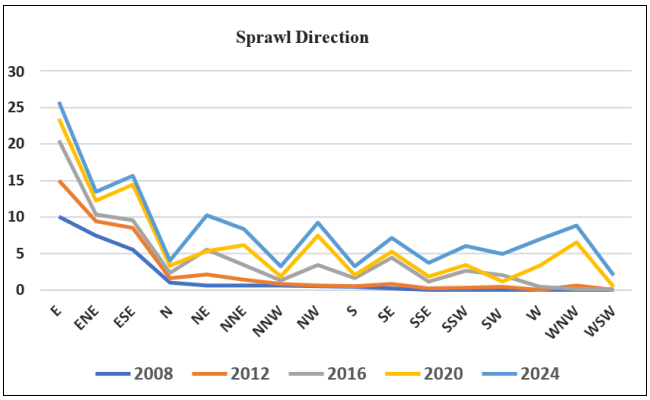

Fig 17: Sprawl direction of Rangpur Sadar

The information shown in this table pertains to the urban sprawl growth in various directions of Rangpur Sadar. Each line in the chart represents a specific year between the years 2008 and 2024. In every line, the direction of departure is from east to west- southwest. The trend pattern that occurs during sprawl may be broken down into three distinct patterns, and this urban sprawl follows that trend pattern.

A Strong Eastward Trend (E, ENE, ESE):
Over time, there has been a discernible shift in the direction of urban sprawl toward the east. There are locations in urban sprawl that are next to the central business district (CBD) that have been seen to have amazing and inconceivable extents.

Strong Northwest and Western Trend (NW, WNW):
Even though the neighborhood of 9 and 12 kilometers in the NW and WNW is located a considerable distance from the central business district, there has been a significant amount of urban sprawl and urban expansion at the same time.

Variability in other directions:
Every year, discontinuous urban sprawl can be observed and observed in other directions. The area that is next to the central business district (CBD) is experiencing a significant amount of urbanization virtually every year. In 2008 and 2012 urban sprawl is reasonable but it evolves into an alarming rate after 2012. The year 2016 marks the beginning of major urban sprawl in all directions, particularly in the northwest, west-northwest, and northeast. In the year 2024, it transforms into an immense metropolitan sprawl.

Discussion and Findings
The examination of the impact of the urban spread in agricultural land in Rangpur Sadar underlines the diverse character of urbanization's impacts on rural landscapes. Rangpur Sadar's agricultural land is being encroached upon as a result of the growth of urban areas, which are defined by the building of infrastructure, dwellings and businesses, and related utilities. The region's complete agricultural sector's sustainability as well as the food security of the local inhabitants are all substantially impacted by this loss of fertile land. Urban sprawl often causes agricultural land parcels to become fragmented, which diminishes farm sizes and increases inefficiencies in land usage. Furthermore, the quality and productivity of the remaining agricultural lands may be considerably impacted by pollution, soil degradation, and other environmental stress brought on by the proximity of urban activity. From this research, it is discovered that the pattern and gradient of urban sprawl over years and how agricultural land is influenced by it. It is also obvious that agricultural land in this region is shrinking rapidly.

4. Conclusion
The study provides a comprehensive analysis of the spatial and temporal transformations in land use patterns from 2008 to 2024. Utilizing high-resolution satellite imagery and GIS tools, the research reveals a dramatic increase in built-up areas from 2,837.1 hectares (9%) in 2008 to 12,625 hectares (36%) by 2024 a fourfold rise within 16 years. This urban expansion has primarily been concentrated in the eastern (E, ENE, ESE) and northwestern (NW, WNW) directions, with areas up to 9- 12 kilometers from the Central Business District (CBD) witnessing intense urban growth, particularly after 2016. Concurrently, agricultural land has suffered a significant decline, shrinking by nearly 76%, from 12,946.7 hectares in 2008 to just 3,053.53 hectares in 2024. The most alarming reduction occurred between 2008 and 2016, where agricultural areas decreased by 62% in just eight years, driven largely by the conversion of fertile farmlands into residential, commercial, and infrastructural zones. This rapid urbanization has not only led to the fragmentation of farmlands, reducing the average farm size, but also intensified environmental pressures such as soil degradation, water runoff, and pollution due to the proximity of urban settlements. Geographically, areas within a 5-kilometer radius of the CBD experienced the highest density of urban sprawl, with expansion tapering off in outer zones. The strong directional growth towards the east and northwest is attributed to the availability of land and infrastructure development projects, which have facilitated easier access for businesses and housing projects. The shift from an agrarian landscape to a predominantly urban environment raises pressing concerns about food security, especially given that Rangpur Sadar was once a major agricultural hub in the region, supporting both local consumption and broader economic stability.

5. Recommendation
To address these challenges, the study recommends enforcing zoning laws to protect remaining agricultural land, establishing urban growth boundaries to control unchecked sprawl, and promoting sustainable urban planning practices that include green spaces and urban farming. Additionally, leveraging GIS and remote sensing for real-time monitoring can provide critical data for policymakers to make informed decisions, ensuring that future urban growth is balanced with the preservation of agricultural resources. Without such measures, Rangpur Sadar risks losing its agricultural heritage, potentially impacting the livelihoods of its residents and the region's long-term sustainability.

6. References
1. Al Tarawneh WM. Urban Sprawl on Agricultural Land (Literature Survey of Causes, Effects, Relationship with Land Use Planning and Environment): A Case Study from Jordan (Shihan Municipality Areas). Journal of Environment and Earth Science. 2014; 4(20):97-124.
2. Arifeen HM, Phoungthong K, Mostafaeipour A, Yuangyai N, Yuangyai C, Techato K, *et al*. Determine the land-use land-cover changes, urban expansion and

their driving factors for sustainable development in Gazipur Bangladesh. Atmosphere. 2021; 12(10):1353.
3. Baumgart S, Kreibich V. Informal urbanization-Historical and geographical perspectives. disP-The Planning Review. 2011; 47(187):12-23.
4. Brueckner J. Urban sprawl: Diagnosis and remedies, international regional science review. SAGE Publications, 2000.
5. Downs A. How America's cities are growing: The big picture. Brookings Review. 1998; 16(4):8-12.
6. Embaby ME-S. Assessing urban sprawl by remote sensing and GIS techniques. Global Journal of Engineering and Technology Advances. 2021; 7(3):144-156.
7. Ewing R. Is Los Angeles-style sprawl desirable? Journal of the American Planning Association. 1997; 63(1):107-126.
8. Frenkel A, Ashkenazi M. Measuring urban sprawl: How can we deal with it? Environment and Planning B: Planning and Design. 2008; 35(1):56-79.
9. Furberg D. Satellite Monitoring of Urban Growth and Indicator-based Assessment of Environmental Impact. KTH Royal Institute of Technology, 2014.
10. Habibi S, Asadi N. Causes, results, and methods of controlling urban sprawl. Procedia Engineering. 2011; 21:133-141.
11. Hassan MM, Southworth J. Analyzing land cover change and urban growth trajectories of the mega-urban region of Dhaka using remotely sensed data and an ensemble classifier. Sustainability. 2017; 10(1):10.
12. Hosen MS, Islam S, Paul A, Bhuiyan MMH. Geospatial evaluation of land use and land cover changes in Ashulia Industrial Hub in Dhaka, Bangladesh. Grassroots Journal of Natural Resources. 2021; 4(4):27-41.
13. Islam MS, Islam A, Rahman F, Ahmed F, Haque MN. Geomorphology and land use mapping of northern part of Rangpur District, Bangladesh. Journal of Geosciences and Geomatics. 2014; 2(4):145-150.
14. Jiang L, Deng X, Seto KC. The impact of urban expansion on agricultural land use intensity in China. Land Use Policy. 2013; 35:33-39.
15. Johnson MP. Environmental impacts of urban sprawl: A survey of the literature and proposed research agenda. Environment and Planning A. 2001; 33(4):717-735.
16. Khan NI. Temporal mapping and spatial analysis of land transformation due to urbanization and its impact on surface water system: A case from Dhaka metropolitan area, Bangladesh. Int. Arch. Photogramm. Remote Sens. 2000; 33:598-605.
17. Khan S. The impact of urban expansion on agricultural land use changes in Aligarh, Uttar Pradesh, India. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. 2019; 42:381-384.
18. Long H, Zou J. Grain production driven by variations in farmland use in China: An analysis of security patterns. Journal of Resources and Ecology. 2010; 1(1):60-67.
19. Mamun SAA, Islam MM, Okely AD, Hossain MS. Rapid and unplanned urbanization in the least developed districts of Bangladesh: A case study from Jamalpur using geospatial techniques. Discover Sustainability. 2022; 3(1):42.
20. Mosammam HM, Nia JT, Khani H, Teymouri A, Kazemi M. Monitoring land use change and measuring urban sprawl based on its spatial forms: The case of Qom city. The Egyptian Journal of Remote Sensing and Space Science. 2017; 20(1):103-116.
21. Mowla QA. Review of Dhaka structure plan 2016-2035. Official Report Submitted to RAJUK, 2015.
22. Nuissl H, Siedentop S. Urbanisation and land use change. Sustainable Land Management in a European Context: A Co-Design Approach, 2021, 75-99.
23. Omasire AK, Kimondiu JM, Kariuki P. Urban sprawl causes and impacts on agricultural land in Wote town area of Makueni county, Kenya. Int. J. Environ. Agric. Biotechnol. 2020; 5:631-635.
24. Rahman G, Chandio NH, Moazzam MFU, Al Ansari N. Urban expansion impacts on agricultural land and thermal environment in Larkana, Pakistan. Frontiers in Environmental Science. 2023; 11:1115553.
25. Rahman MN. Urban expansion analysis and land use changes in Rangpur city corporation area, Bangladesh, using remote sensing (RS) and geographic information system (GIS) techniques. Int. J. Adv. Study Res. Work. 2019; 2(10):22-30.
26. Rahman MT. Detection of land use/land cover changes and urban sprawl in Al-Khobar, Saudi Arabia: An analysis of multi-temporal remote sensing data. ISPRS International Journal of Geo-Information. 2016; 5(2):15.
27. Rai R, Zhang Y, Paudel B, Li S, Khanal NR. A synthesis of studies on land use and land cover dynamics during 1930-2015 in Bangladesh. Sustainability. 2017; 9(10):1866.
28. Sayed MB, Haruyama S. Urbanization impact on agricultural land of Manikganj Pourashova, Bangladesh. International Journal of Sciences: Basic and Applied Research (IJSBAR). 2016; 28:243-253.
29. Shalaby A. Assessment of urban sprawl impact on the agricultural land in the Nile Delta of Egypt using remote sensing and digital soil map. International Journal of Environment and Sciences. 2012; 1(4):253-262.
30. Squires GD. Urban sprawl: Causes, consequences, & policy responses. The Urban Insitute, 2002.
31. Subramani T, Vishnumanoj V. Land use and land cover change detection and urban sprawl analysis of Panamarathupatti Lake, Salem. Int J Eng Res Appl. 2014; 2(6):217-227.
32. Torrens PM, Alberti M. Measuring sprawl, 2000.
33. Wang L, Sarker P. Analyzing urban sprawl and sustainable development in Dhaka, Bangladesh. Journal of Economics and Sustainable Development. 2020; 11(6):9-20.
34. Zhang X, Chen J, Tan M, Sun Y. Assessing the impact of urban sprawl on soil resources of Nanjing city using satellite images and digital soil databases. Catena. 2007; 69(1):16-30.
35. Zhou Y, Xing B, Ju W. Assessing the impact of urban sprawl on net primary productivity of terrestrial ecosystems using a process-based model A case study in Nanjing, China. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2015; 8(5):2318-2331.