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Review

A Systematic Review of Morphological Transformation of Urban Open Spaces: Drivers, Trends, and Methods

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Abstract: Ongoing urbanization has led to the continuous expansion of built-up areas; as a result, open space is under great threat. Despite the wealth of studies conducted on open spaces, there is still a further need to further investigate the morphology of open space, particularly in an effort to understand the trends and drivers of open space morphological transformation that remain under-researched. Besides, although the previous literature has highlighted several factors influencing urban space morphology, it remains unclear how those key drivers interact. In this article, the PRISMA methodology was used to conduct a systematic literature review, screening and selecting articles from three primary databases (Web of Science, Elsevier, and Scopus). In total, 47 journal articles covering the years 2000 to 2022 were selected for the final review to identify key factors that influence open space morphology, including natural geographical factors, socioeconomic factors, and government policy factors. The results indicate that, as cities developed, the size of green spaces decreased, their structure fragmented, and their distribution became progressively less connected. Meanwhile, socioeconomic determinants played a greater role in influencing changes in green spaces than natural geographical factors and policy management factors. In addition, carrying out the present study confirmed that Landsat remote-sensing data with landscape metrics is a powerful research method for studying green space change. A research framework is offered in this paper to illustrate an understanding of which factors influence the dynamics of green spaces, identify the interaction mechanisms, and provide an optimization strategy of urban open space for urban planners or policymakers.

Keywords: urban open space; morphology; systematic literature review; drivers; trends; methods

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1. Introduction

Open space is a widely studied topic; as such, it is no surprise that a number of academics have put forward various definitions and classifications in relation to this subject. Tang and Wong adopt a broad definition that encompasses parks and recreational spaces, outdoor public gathering places, unroofed and undeveloped natural landscapes on urban land, adjacent spaces between villages and buildings and urban spaces, and areas open to the public and commerce (including cafes, retail markets, theme parks, sports, streets, and sidewalks) [1]. It should also be noted that open space is a form of space that continually changes in line with urban development. Mark Francis claims that in addition to the traditional public spaces of city parks, squares, neighborhood parks, and playgrounds, the significance of the value of public space gave rise to community open spaces and gardens near to nature, linear parks, waterfronts, and greenways accessible to pedestrians, so as to provide a diverse and resourceful environment for learning, manipulation, and enjoyment [2]. It should also be noted that, in urban studies research, open spaces and green spaces interact to a considerable degree.

As an aspect of urban planning, green spaces are an increasingly important factor influencing urban residents' quality of life. Due to its significant environmental, social, and economic value, urban green space (UGS) is widely regarded as one of the most important indicators of sustainable development. Specifically, in addition to changing the physical dimensions of the city, enhancing its aesthetics, and boosting property values, UGS also provides space for recreational activities, promotes health and social well-being, fosters relations with nature, and creates beautiful landscapes [3]. Moreover, the health benefits derived from UGS are important for improving urban environments [4]. In the past two years, the perception and use of UGS have assumed a renewed importance against the backdrop of the COVID-19 pandemic, largely due to its capacity to improve mental health and physical activity levels [5]. On this basis, the importance of urban nature and open spaces as a means to prepare for pandemics cannot be understated. Although green spaces offer a multitude of benefits for urban residents, increasing UGS may trigger gentrification in neighboring areas, driving up housing prices and encouraging the development of more high-end facilities, which steadily pushes out existing residents so that more affluent individuals can move in [6].

Today, the majority of the global population live in urban areas. In 2045, there will be 6 billion urban residents, 1.5 times the 2020 urban population [7]. This shift will lead to an inevitable extension and/or increase in the density of urbanized areas and the transformation of green spaces, thereby opening up urban open spaces to dynamic change. In cities, the growth of residential and commercial areas and infrastructure has precipitated and expedited the decline of green spaces, as can be seen in the cases of Kuala Lumpur [8] and Hong Kong [9]. Elsewhere, other studies have observed that UGS are rapidly disappearing in cities located in Asian countries, such as Karachi, Pakistan [10] and Hanoi, Vietnam [11]. Anguluri and Narayanan claim that urbanization that does not also create green spaces has exerted many negative physical and social impacts on city residents. As such, there is value in studying the factors that influence the changes in urban open space [12].

However, the best way to research the formation and transformation process of open space in terms of size, shape, and function is based on urban morphology. This is because urban morphology relates to temporal conditions, and urban forms are affected by historical/periodical changes [13]. For this reason, urban morphology researchers attach importance to retrospective studies in order to understand the current situation and present conditions. In this way, the physical structure of the city can be analyzed and the evolution of the city explained by referring to both historical and contemporary research. The "morphology" of urban green space can be understood by referring to the basic levels of "form", "distribution", and "pattern", as well as the correlations between the three. More importantly, there is insufficient literature available to study and understand the factors pertaining to urban green space morphology as integral research, and a focus on the interactions of individual characteristics and how they influence urban open space evolution.

This paper reviewed the latest literature by adopting a morphological perspective to identify and update the potential factors that bring about changes in open spaces, including natural geographical factors, socioeconomic factors, and government policy factors. Particular attention is paid to how these factors affect urban open-green spaces morphology exhibiting tendencies towards fragmentation, miniaturization, and discretization at the city scale. Modern research methodologies, including data collection and analysis, have been widely deployed to investigate the spatio-temporal dynamics of urban expansion and UGS change. This article attends to the gaps in the existing body of research (as an academic contribution) on how urban open space morphology influences multiple factors and their interactions. In addition, urban planners and policymakers may benefit from achieving a better understanding of the dynamics of those drivers influencing green spaces (as a practical value).

It is worth noting that there are various definitions suited to different research needs. The multitude of rich meanings attached to open space makes it an idiosyncratic component of the cityscape. This article posits that the meaning of urban open space can reflect the natural positive features symbolized by 'green' itself. Moreover, the studies mentioned are synonymous with urban backgrounds, such as "urban green space", "urban open space", and "public open space".

2. Methods

To answer the research questions, a systematic literature review was conducted and the protocol of the "Preferred Reporting Items for Systematic Review Recommendations" (PRISMA) method (Figure 1) was adopted to carefully and systematically select any relevant research from the existing body of literature. Significantly, this method has been widely applied in studies including the evaluation of ecological restoration approaches [14], environmental sustainability policy implementation failures [15], factors shaping urban green space provision [16], spatial and non-spatial factors influencing willingness to pay for urban green spaces [17], and the impacts of trail infrastructure on vegetation and soils [18].

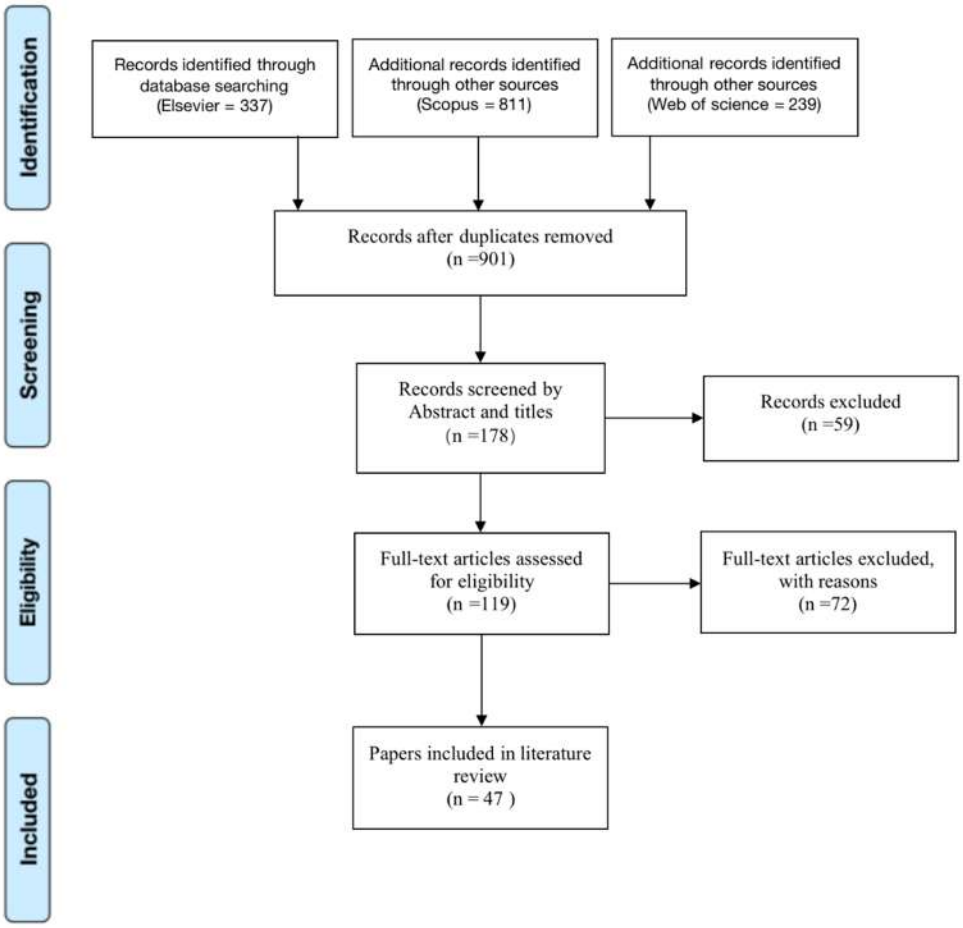


Figure 1. PRISMA methodology flowchart. Source: UNC Health Science Library. (2020). Creating a PRISMA flow diagram. Retrieved from https://guides.lib.unc.edu/prisma (accessed on 19 May 2022).

The methodology is a four-stage process: identification, screening, eligibility, and inclusion (Figure 1). A search of peer-reviewed English-language journals and review articles was carried out on three online databases: Web of Science, Elsevier (Science Direct), and Scopus. A Boolean operator 'AND', 'OR' computerized search ("open space" OR "green space") AND ("morphology" OR "change" OR "distribution" OR "evolution"), was conducted between 2000 and 2022 to identify articles. The coverage of this time period is relatively long because "urban open space" and "morphology" articles are rare. In addition, the period was selected to intentionally highlight more of the comprehensive factors and trends pertaining to urban open space morphology research.

From the Elsevier database, 337 articles were identified, whilst 811 and 239 were identified from Scopus and Web of Science, respectively. In total, 1387 papers were derived from these three databases. Next, to avoid reviewing the same articles, any duplicates were removed, leaving 901 papers. These 901 papers were screened by title and abstract to explore their applicability and relevance. After screening, 178 papers remained. More specifically, a set of indicators was used to assess the suitability and relevance of the articles. This includes focusing on what factors influence open space quantities or proportions, and how they are changing. Following the screening, 59 papers were excluded, resulting in 119 papers being taken through to the next phase.

Then, for the third stage, the articles were further evaluated based on their full texts and contents to determine their eligibility. The program determines the actual eligibility of articles based on criteria and needs such as geography/background, vocabulary description, etc., which further reduced the total number of reports to 47. Ultimately, based on the inclusion phase (2000–2022), only 47 (papers) were used for the review.

After analyzing 47 studies, several main keywords can be highlighted as primary terms: "natural geographical", "policy", and "socioeconomic", respectively. Under which the following sub-themes are located: "location", "topography", "population increases", "economic growth", "real estate development", "urbanization", "political policy", and "economic policy". Therefore, the authors utilize these terms throughout the study. In terms of the trend themes, keywords, such as "scattered", "fragmented", "dense", and "concentrated", were identified.

3. Results and Discussion

3.1. Drivers Influencing Urban Open Space Morphology

The drivers or factors that are described here are variables or determinants of open space morphology as a whole. Previous research on this topic has tended to explore the impacts of factors, including the policy, management, intrapersonal, and structural factors affecting urban green space visitation [19]; environmental factors influencing adults' participation in physical activity [20]; and physical and non-physical factors influencing perceived green space accessibility [21]. Notably, these are the outcomes relating to the influence of diverse factors. Additionally, although a variety of factors have been said to affect urban open space morphology, few studies have examined these factors and outcomes in great detail. This is a significant knowledge gap, as these factors influence the changes that occur in urban open spaces.

More specifically, based on the wide-ranging definitions of open space, it is important to understand changes in open spaces in terms of quantity and space. However, morphological theory reveals the historical process of development in the city form and its spatial consequences. The study of the drivers influencing urban green spaces from a morphological perspective has both theoretical and practical significance for the comprehensive understanding of city spaces, along with its application in urban planning and construction. Moreover, a comprehensive perspective helps to identify what is already known, the gaps in the existing knowledge, and directions for further research. Thus, useful guidelines can be provided for urban planners and landscape architects.

Based on the literature (Table 1), several factors were identified in the relevant research on urban open spaces based on morphology theory, including natural geographical factors, government policy factors and socioeconomic factors. (1) Natural geographical factors: the location and topographic gradients of elevation and slope; (2) Government policy factors: the policy of green spaces and urban development; (3) Socioeconomic factors: population increases and economic growth. The research framework was established by authors for exploring the relationship between the three factors, urban open space, and the morphology of public open space changes outcomes.

Table 1. Previous studies from 2000–2022.

Year	Types of Settings	Authors	Scale	Research Concerns and Objectives	Identified Drivers of Space Morphology	Methods (Data Collection and Data Analysis)
2022	Urban green spaces	[22]	City	Investigating the distribution patterns and drivers of UGS.	Wealth and land use	Using a combination of remote sensing data and fieldwork. Calculating the proportion of UGS in different urban functional units.
2022	Green spaces	[23]	District	Exploring the local spatial evolution and analyzing the influence factors of its transformation.	Social and economic development.	The remote sensing image data was used as the basic data. Extracting the green space area conversion analysis information.
2022	Green spaces	[24]	City	Investigating the changing pattern of green spaces and how the topographic gradients of elevation and slope influence changes.	Topographic gradients of elevation and slope.	Applied for land use/land cover classification using GIS. Using overlay analysis.
2022	Parks and green spaces	[25]	City	Analyzing the correlation between urban development and parks and green spaces policy.	Green spaces policy.	Literature review, including theses, academic journal papers, research reports, and newspaper materials.
2022	Green spaces	[26]	City	Analyzing the green spaces of Dhaka over a 30-year period using GIS and remote sensing.	High population density and accelerated infrastructure development.	Using GIS and Remote Sensing to collect images. Using normalized difference vegetation index (NDVI) to calculate the total changes.
2022	Urban green spaces	[27]	Downtown	Comparing the changes of greening policies for UGS evolution in the two cities.	Several urban greening policies.	Using GIS and Remote Sensing to collect images. Statistical Yearbooks and document planning. Using the area change index, spatial morphological dimension, and spatial aggregation dimension.
2021	Urban green spaces	[28]	City	Exploring the spatial-temporal dynamics of UGS and its influences on urban eco-environments in developing cities.	Rapid urbanization and population growth.	Landsat images and MODIS products; maps; statistical data. Landscape pattern analysis.
2021	Green spaces	[29]	Not available	Identifying the relevant issues to address the challenges facing China's Green spaces planning system.	Policy regulations.	Literature review and policy analysis.
2021	Green spaces	[30]	City	Evaluating the impact of changes on the structure of green spaces, and exploring the impact of different types of urban expansion and planning policies on changes to green space structure.	Rapid urban expansion.	Land use land cover (LULC) maps of the cities were developed based on satellite images. Landscape metrics and statistical analysis.
2021	Urban green spaces	[31]	City	Assessing the magnitude, directions of urban expansion and UGS change, as well as spatial variations.	The spatio-temporal pattern of urban expansion.	RS and GIS and Landscape Expansion Index (LEI) were used to extract Land Use Land Cover (LULC) data. Measuring urban expansion and UGS change and analyze urban growth patterns.

Table 1. *Cont.*

Year	Types of Settings	Authors	Scale	Research Concerns and Objectives	Identified Drivers of Space Morphology	Methods (Data Collection and Data Analysis)
2021	Green spaces	[32]	Regional	Revealing the spatial-temporal change and driving factors of green spaces.	Anthropogenic activities and geographical environmental factors.	Remote sensing imageries. Landscape pattern index.
2021	Urban green spaces	[33]	Cities	Exploring the effect of different levels of urbanization on changes in green spaces.	Economic development.	Using a time-series of remote sensing data. Indexes analysis.
2021	Urban green spaces	[34]	City	Employing integrated approaches to characterize the changing patterns and intensities of green spaces.	Rapid urbanization and greening policies.	Landsat images to interprete land use datasets. Landscape metrics.
2020	Urban green spaces	[35]	City	Assessing the present status of green cover and evaluating the spatio-temporal changes in the land use/land cover composition.	Rapid and unplanned urbanization.	Field visits, the Office of the Asansol Municipal Corporation. Calculation of NDVI.
2020	Urban green spaces	[36]	District	Analyzing the dynamic changes in landscape patterns, quantitatively evaluating the eco-service value of urban green spaces, and discussing how they mutually influence each other.	The rapid development of urban-rural integration and human factors.	Remote sensing image. Landscape pattern index.
2020	Urban green spaces	[37]	City	How political circumstances of municipal governance and the pursuit of development can precipitate losses.	The political circumstances of an urban area.	Using a time series of satellite images. Using the area calculation function in ArcMap 10.5.
2020	Green spaces	[38]	City	Analyzing and assessing the changing scale and spatial layout of the urban green spaces.	The expansion of urban and built-up areas, and the influx of migrants.	Using the landsat thematic mapper (TM) and OLI/TIRS remote sensing image data. Assessment using various indices.
2019	Urban green spaces	[39]	Town	Analyzing urban green space changes and their drivers.	Physical expansion of the built-up area, population growth, high land value, and laxity in the enforcement of planning regulations.	Using series Landsat images, land inventory, interview, focus group discussion, and field observation for data collection, and a combination of techniques, including pixel based image classification, qualitative descriptive and GIS-based processing for data analyses.
2019	Green spaces	[40]	City	An analysis of fragmented green spaces has been conducted.	Urbanization.	High-resolution satellite images. Using ENVI software computing.
2019	Urban green spaces	[41]	City	Analyzing temporal and spatial changes in urban green spaces and exploring the driving forces underlying the observed changes.	Different districts' geographical locations.	The Earth System Science Data Sharing Platform. Remote sensing images. Calculating landscape indices.

Table 1. *Cont.*

Year	Types of Settings	Authors	Scale	Research Concerns and Objectives	Identified Drivers of Space Morphology	Methods (Data Collection and Data Analysis)
2019	Urban open-green spaces	[42]	City	Investigating the changes that have occurred in urban open-green spaces in Nevsehir.	Urbanization.	Analyses consist of satellite image classification, plant index production, and GIS-based analyses methods.
2019	Green spaces	[43]	City	Understanding the factors that determine an increase or decrease of urban green spaces in a post-socialist city.	Different regimes.	Historical maps and aerial images. Temporal analysis, proximity analysis.
2019	Urban green spaces	[44]	City	Focusing on urban GS at a neighborhood scale to analyze GS in more granular detail.	Compact urbanization.	Urban GS was extracted using the normalized difference vegetation index based on GF-1 remote sensing images. Overlay.
2019	Urban green spaces	[45]	City center	Developing an understanding of how urbanization influences the fragmentation of urban green spaces, and offers insights into the planning of urban green spaces from the perspective of promoting sustainability.	Rapid urbanization and planning policies.	Landsat images. Landscape metrics.
2018	Urban green spaces	[46]	Cities	Determining the appropriate proportion of public greenery to built-up areas in cities.	Urbanization.	The Local Data Bank. Surveys.
2018	Green spaces	[47]	Regional	Investigating green space types of the Beijing–Tianjin–Hebei region based on the elevation data and land use/cover for those years.	Urbanization and greening policies.	Landsat images. Using ENVI software computing.
2018	Urban public spaces	[48]	City	Identifying the major environmental challenges associated with the continued destruction of public urban space.	Rapid population increase.	Literature review.
2017	Urban green spaces	[49]	Regional	Developing a systematic approach to monitoring changes in the urban landscape and assessing the conditions of UGS in the Klang Valley.	Urbanization.	Remote sensing processing techniques were used to extract meaningful data from mid-resolution Landsat satellite images. Analyse using landscape metrics.
2017	Urban green spaces	[50]	City	Studying the distribution of various types of urban green space in Shanghai.	Rapid urbanization.	High satellite image data. Landscape pattern index and gradient analysis.
2017	Public open spaces	[51]	City	Discerning the influence of factors on open space planning and development in Hong Kong.	Government planning and development strategies.	Government's latest planning and development strategies.
2017	Urban green spaces	[52]	Cities	Identifying general patterns relating to the quantity and structure of urban green space, and the demographic and economic characteristics of the cities in the study.	Population density and economic level.	Using remote sensing analysis of Landsat 7 data. Calculating landscape indices.

Table 1. *Cont.*

Year	Types of Settings	Authors	Scale	Research Concerns and Objectives	Identified Drivers of Space Morphology	Methods (Data Collection and Data Analysis)
2016	Green spaces	[53]	City	Exploring the change of green space in Suzhou and revealing the spatial characteristics, ecological benefits, and its impact mechanism.	Different districts' geographical locations.	Landsat remote-sensing image data. Analyse using landscape metrics.
2015	Green spaces	[54]	City	Assessment of changes in green spaces of Nanjing in terms of scale and structure.	Population density.	Landsat Satellite Data. Analyse using landscape metrics.
2015	Urban green-spaces	[55]	Cities	Identifying problems, challenges and strategies of urban green space planning during the densification processes.	Urban densification.	Literature review.
2013	Urban green spaces	[56]	City	Investigating land use/land cover changes in Dehradun city and associated changes in urban green cover between 2004 and 2009.	Urbanization.	Remote Sensing to obtain detailed. Using Image Derived Parameters.
2013	Green spaces	[57]	Cities	Investigating the temporal trend in green space coverage and its relationship with urbanization.	Urbanization.	The Statistics Yearbook, green space coverage of cities were calculated through least square linear regressions.
2013	Urban green spaces	[58]	City	Analyzing the environmental quality based on green spaces to provide appropriate recommendations to elevate the environmental quality to international standards.	Population density.	Green space areas were extracted from Thailand Earth Observation System (THEOS) satellite imagery using Normalized Difference Vegetation Index (NDVI). Extracted green space areas were further analysed quantitatively with air quality indicators and population density utilizing deductive indexing method.
2011	Green spaces	[59]	City	To develop a comprehensive plan of green spaces development both at the municipal and regional levels.	Geography.	Using GIS and FRAGSTATS 3.3. Overlaying the two green space distribution maps and calculating the changing area, and the variation values of each green space type were obtained from the data of the land use change survey.
2011	Green spaces	[60]	City	Using landscape metrics to assess green spaces fragmentation.	Different districts' geographical locations.	The original orthophoto maps and land use digital maps with 0.5 m resolution used in this study were purchased from the Hong Kong government. Green spaces and different land uses were extracted from the maps and transferred to raster maps, assisted by "3S" techniques. Calculating different landscape metrics.

Table 1. *Cont.*

Year	Types of Settings	Authors	Scale	Research Concerns and Objectives	Identified Drivers of Space Morphology	Methods (Data Collection and Data Analysis)
2011	Urban green spaces	[61]	City	Using landscape pattern metrics to characterize shifting green space patterns.	Rapid urbanization and greening policies.	Remote-sensing image data. Landscape metrics analysis.
2009	Urban green spaces	[62]	City	To detect changes in the extent and pattern of green areas of Mashad and analyze the results of landscape ecology principles and functioning of the green spaces.	Open lands for housing development.	Combination of remote sensing image classification, landscape metrics assessment and vegetation indices.
2008	Open spaces	[1]	City	Evaluating the land-use zoning and development of open spaces.	Different districts' geographical locations.	The land-use planning and statutory zoning for open space.
2007	Urban green spaces	[11]	Downtown	Identifying green space changes and their drivers.	Economic growth, population increases, urbanization, and weaknesses in the planning and management of urban development.	Graph theory, landscape metrics, GIS and FRAGSTATS 3.3.
2007	Greenbelt	[63]	City	Documenting the spatial and temporal changes of greenbelts over the past decade by analyzing satellite images.	Urban containment policy.	Remote Sensing, analysis of archived documents.
2006	Urban green spaces	[64]	City	Presenting a new method for quantifying and capturing changes in green space patterns.	Government policy.	GIS and remote sensing. Landscape metrics.
2006	Urban open spaces	[65]	City	Exploring the revitalization of existing traditional open spaces.	City Planning Act.	Case study.
2003	Green spaces	[66]	City	Examining the issues, obstacles, and processes involved in remediating potentially contaminated urban brownfield sites.	Urban planning policy.	Case studies and personal interviews.

3.1.1. Natural Geographical Factors

In Hong Kong, fringe rural and urban areas with higher green coverage and greater sustainable green space tend to be less fragmented. To be precise, Kowloon and Hong Kong Island have the highest green dispersion rate in built-up areas, whilst the New Territories have the lowest [60]. Hong Kong is a high-density, congested city with high-rises and multiple land-use intensification concepts, such that it is closely aligned with the characteristics of a compact city [67]. There is no denying that there are very few UGS in Hong Kong's built-up areas, which is a serious problem. Tang and Wong also explore how the geographical distribution of the "Open Space" zone is different across Hong Kong's five sub-regions, concluding that the different locations within the city feature different trends in terms of open space [1].

Shanghai, China, is one of the world's largest coastal mega cities. Its city center, suburbs, and islands differ in their spatial and temporal trends concerning green space [41]. In the city center and suburbs, the limited urban green space was developed to serve transportation and construction purposes. Meanwhile, because of urban sprawl and urban expansion, natural or semi-natural vegetation has been reduced around city centers and suburbs [68]. While the islands of Shanghai have the highest urban green spaces values within the city, this is due to the Shanghai government's proposal to develop Chongming

Island as a global eco-island, featuring wetland protection as a key component of its natural ecosystem conservation efforts [69].

Interestingly, in Chattogram, Bangladesh, most of the decrease in green spaces can be attributed to the expansion of built-up areas. The changes in the city have mainly occurred at low to moderate elevations (0–26 m) and on gentle to moderate slopes (0–15%). Contrastingly, the decreasing trend of forest cover was relatively low in high to very high elevations (26–88 m) and steep to very steep slope (15–66%) gradients [24].

Moreover, plant degradation due to human activities and natural disasters (i.e., sandstorms, mudslides, and landslides) can lead to the destruction of green spaces, especially in mountainous areas. A large area of greenery has been lost in the southwest of Beijing's Fangshan district, China, which is located in an area that suffers from soil erosion and blown sand. Large-scale grazing pastures have been abandoned, gradually forming desert areas with sparse vegetation and uncultivated areas [59].

Xu and Cui conducted their research in Suzhou, China, finding that the different districts show different changes in urban green spaces due to their geographical location [53]. For instance, as Kunshan district is the most economically developed administrative area and its east side is close to Shanghai, the green spaces decrease rate was the highest. Moreover, the form of green space was strongly disturbed by urbanization and exhibited a clear fragmentation pattern. The decline rate of UGS is the largest, and its spatial form is seriously disturbed by urbanization, showing an obvious scattered type in Kunshan district. Elsewhere in Suzhou, Gusu is a district with a long history. The terrain here is flat, the roads are well developed, and the building density is high. The green area and green coverage in the Gusu district are the lowest amongst all regions in Suzhou city, as the greening in the area is dominated by residential quarters, experiencing the highest density and the lowest degree of connectivity.

Weng et al. observe that the spatial variation of green space is mainly concentrated along the coastal and southern regions of China [32]. Notably, such variation may be affected by topography. Within the study area, the mountainous area is dominated by the central and western regions, whilst the east is made up of plains. As a result, the core of the city is in the east. The rapid urbanization of the city is centered on the city center, meaning that the impact of human activities on urban green spaces is mainly confined to the east coast. In the terms of latitude, the topography in the north area is more undulated than that in the south area, resulting in difficulties in developing land in the north. Therefore, the southern region experienced a greater change in green space than the northern region. In other words, the spatial change of green space has been influenced by geographical environment differences, including topography and average altitude.

3.1.2. Government Policy Factors

The allocation of urban land to green spaces as a class of land use is a major policy issue in most cities. Against the backdrop of urbanization, many cities are discussing the comprehensive management and planning of urban greening. Urban greening is driven by greening policy [70]. Greening policies use quantitative indicators to limit the construction of UGS and guide the spatial layout of UGS. Several urban greening policies have been proposed by the Shanghai government since the 1980s. Wu et al. studied the national policy and that published by the Shanghai Municipal government to devise a set of policies aimed at increasing urban greening coverage to achieve Shanghai's slogan of "*a city in the forest, a forest in the city*" [41]. Despite the dense population in the city center, the government has made green spaces development a top priority. Therefore, the number of parks and the areas dedicated to them have been increasing in Shanghai since 1980. Shanghai's top-down greening policy was also investigated by Liu et al. [27].

In Bucharest, scholars have noted that socialist policy-driven actions are effective in ensuring urban areas have open spaces. The number and surface of green spaces increased significantly under the social government before decreasing as a result of a weak legislative framework, land restitution, and urbanization. Hence, it can be concluded that the socialist regime brought about important changes to urban green spaces [43]. Furthermore, De Sousa looked into the redevelopment of brownfield sites into green spaces in Toronto under the influence of political support (Toronto Planning, 2000) [66]. As a result, soil quality improved, habitats were created, recreational opportunities were enhanced, and neighborhoods were economically revitalized. Brownfields can be defined as "idled, abandoned, commercial sites or underused industrial areas that have real or perceived environmental contamination that makes its expansion or redevelopment a challenge" [71].

Nirarta Samadhi and Tantayanusorn mentioned that there are currently regulations within the city plan that control the use of open space in Chiang Mai, which are enforced by the City Planning Division of the Interior Ministry [65]. According to the popular aspiration, religious land (Kuang wat) has been changed into urban open space by the local government. Many of Beijing's planning policies since the 1990s have been aimed at preserving and creating green spaces. In particular, the successful holding of the 2008 Summer Olympic Games in Beijing strengthened the greening work in the North Olympic District. However, although the first and second green zones are accorded importance in the official policies, these areas are scattered and few and far between [45].

Nevertheless, there are many loopholes in Hong Kong's policy regarding open space. Tang and Wong found that the current lack of public open space stems from the inefficient division of government responsibilities, revenue-maximizing land sale policy, and a pro-growth planning ideology [1]. In effect, there has been discrimination against open spaces in land planning and allocation. The main reason for this is that public open spaces cannot generate revenue for the government, meaning that the government is unwilling to provide and maintain them. The policy demonstrates that the government has always looked to optimize every available plot of land, and as such, public open space is often replaced by residential areas. Furthermore, Tang reveals a wider range of political forces to facilitate the division and distribution of Hong Kong's open spaces [51]. Moreover, urban planning policy contributes to inequitable open space distribution across residential and commercial development. For example, Hong Kong's 'Open Space' zones are mainly near upmarket, low-density residential areas, and mixed commercial-business zones, as opposed to high-density mass housing areas. Munyati and Drummond also demonstrated that the government permitted the green spaces to be used for commercial purposes and social amenities, such as schools and housing, thus decreasing the quantity and quality of green spaces [37].

Interestingly, some government agencies have implemented economic policies to promote green space. For instance, farmers previously could receive a one-time subsidy of $9375 per hectare and an annual payment of $225 per hectare if they converted their farmland into green space [72]. Although the green space scale did not improve much under this policy, the practice at least helped to maintain some green spaces in the city [63]. In short, green policies are an important force in promoting the restoration of urban green space systems, and strategic greening strategies can dramatically increase the amount of green space in cities. The study results suggest policy and management factors can exert both positive and negative influences on the provision of urban green spaces. Based on the literature review, policy factors can be divided into two aspects: spatial planning and economic policy causing urban open space morphologic change. From this, it can be gathered that urban planners and governments have a significant impact on land-use patterns.

3.1.3. Socioeconomic Factors

Uy and Nakagoshi identified that economic factors influence UGS changes [11]. In 1995, Vietnam's economy reached an important turning point when it experienced its first wave of foreign investment at that time. Consequently, Hanoi's economy grew at a rate of more than 10% per year. Simultaneously, the city's industrial, service, and agricultural economic mechanisms shifted from 38, 58.2, and 3.8 percent in 1996 to 41.5, 55.5, and 3 percent in 2005. To meet the requirements of urbanization, in the construction of urban construction areas, roads, commercial areas, and other infrastructure areas, agricultural land-based construction land was also transformed into built-up areas.

Elsewhere, in Chattogram, one of Bangladesh's largest cities, the growing service sector requires more people [73]. Chattogram has a unique potential for economic growth compared to other cities in Bangladesh. Chattogram is the country's major seaport of the country, handling more than 80% of all imports and exports [74]. Among the 700 economic zones around the world, Chattogram Export Processing Zone ranked fourth in terms of "Best Economic Potential" [75]. Although Chattogram is an economically thriving city, it is paying a price for this newfound growth. Economic development has brought a large number of migrant workers to the city, resulting in the random development of the city and the exhaustion of green spaces.

In Zhengdong New District, Zhengzhou, China, the increases and decreases in green spaces have been driven by social and economic development. With the development of the social economy, the government is increasingly paying attention to greening, bolstering investment in gardens, and promoting the demand for leisure and entertainment [23]. Likewise, Shenzhen experienced rapid economic development and urban expansion between 1978 and 2018. In these 40 years, it is evident that the destruction of UGS areas and landscapes has been determined by anthropogenic activities [28].

From their investigation of 107 Chinese cities, Wu et al. concluded that in the long-term built-up area, the trend of greening is more significant in economically developed cities [33]. Moreover, they observed that these economically more powerful cities exhibit stronger greening trends than less economically developed cities. For example, long-term built-up areas with a developed city economy have a higher level of green space optimization. This may reflect the effective implementation of greening policies, such as environmental policies, to promote ecological restoration and green city construction.

In Haikou, a tropical coastal city in China, the expansion in the scale and number of urban green spaces were limited by land prices, as they require different levels of economic and management investment. It should be noted that urban green spaces are influenced by maintenance frequency and housing prices, which are proxies for the luxury effect [22].

On the other hand, Nawar et al. noted that Dhaka's high population density and rapid infrastructure development are major factors contributing to the destruction of green spaces [26]. Using GIS and RS technology analysis they identified a gradual change in green spaces through time, which charted a decreasing trend. As of 2020, most of the green spaces in Dhaka, Bangladesh, are fragmented and there has been a pronounced loss of healthy green spaces. The reason for this is that urban areas are expanding to accommodate housing, businesses, and other amenities, which is causing green spaces to decrease. Similarly, the green area per capita decreased rapidly as the population increased in Shanghai [41]. Meanwhile, Girma et al. determined that a large amount of green space was converted into built-up areas in Sebeta, Ethiopia, during the study period [39]. Several factors are directly responsible for this problem, including population growth, the increasing size of the built-up area, and high land values. A result of urban sprawl is that it becomes more compact in terms of population density, whilst urbanization alters the spatial pattern of green spaces. Mumbai, India has witnessed similar changes for the same reasons [38]. In brief, growing urban populations place a strain on the available resources, leading to the fragmentation of green spaces. Malaysia is one of the most urbanized countries in East Asia, with a rapidly increasing urban population. In Kuala Lumpur, urban green spaces are smaller and fragmented where there are more built-up areas due to population increase, which results in the disorder, scattering and remoteness of green spaces, thus producing green space areas with less connectivity and shape complication [40]. A similar trend was described by Michał et al. [46] in cities in western Poland and by Aklibasinda and Ozdarici Ok [42] in Nevsehir.

Due to the pressure for additional housing and business in towns and urban areas, existing urban green spaces are altered to an even greater extent in the course of development. Urbanization leads to changes in land-use patterns, which result in the occupation of green spaces [64] and the transformation of green spaces into construction land. There is very little evidence to suggest that as a result of extensive construction and the development of transportation infrastructure in both the city center and suburban districts, green spaces in Beijing decreased by 47.05 percent annually from 1992 to 2004. Moreover, there is a growing body of evidence to suggest that urban green space is disappearing due to densification, particularly in Asian and Australian cities, and also North American and European cities to a lesser extent [55].

Wan and Zhao stated with the rapid development of urban-rural integration urban green spaces are threatened and destroyed by human factors, which leads to fragmentation of landscape patterns and area of reduction to a certain extent [36]. Farmland has been seriously decreasing whilst construction has increased, whilst patches at the landscape level showed fragmentation. There was a noticeable loss of green spaces in Beijing and Shijiazhuang, especially in the surrounding areas of built-up areas. Additionally, the grassland and forest in the plain were also transformed into built-up land. However, the magnitude of such transformations were comparatively small, and the positions were comparatively scattered [47].

Green space changes are linked to urbanization processes. It has been reported that rapid urbanization produces many environmental impacts associated with the reduction of green spaces [61]. Urbanization is characterized by the urbanization of land, intensive land use changes, economic development, and rapid population growth [76]. When the area of green spaces decreases and/or fragments because of the rapid development of urbanization, this is related to increased population pressure on resources and a concomitant increase in buildings and infrastructure. In the context of urbanization, many cities are exploring the development and implementation of comprehensive policies and strategies for urban green spaces. As urbanization continues, green spaces are being occupied, resulting in the fragmentation of urban green spaces. This in turn produces a number of socioeconomic and environmental problems. Urbanization has been attributed to an upward trend in people flocking to cities by the United Nations [77]. McDonald et al. also state the amount of open space lost is closely related to changes in population, with cities with increasing populations losing more open space [78]. There is no denying that an increasing population usually means increased urbanization, including the conversion of forests, farms, and other lands for housing, transportation, and commercial purposes.

The growing urban population has resulted in conflicts between land use for urban construction and land use for green spaces. Urban development consumes green spaces, which may only be incorporated into gaps within the constructed land, resulting in the fragmentation of these areas or their disappearance altogether. It can be gathered from the existing research that government engagement is essential in optimizing green space patterns and preventing encroachment on any remaining green spaces [64].

Rafiee et al. reported that urbanization has had a significant impact on the urban environment in Mashad, Iran, with green spaces being converted into built-up areas, causing a corresponding loss of function in the green areas [62]. With the rapid change of urban areas in Mashad in recent decades, there has been a significant increase in the built-up areas in the city. Accordingly, the rapid growth in construction in the city has destroyed many green spaces. A significant reduction in the number of green spaces in urban areas was followed by their fragmentation, leading to the downgrading and destruction of their functions and services. However, city officials have implemented timely measures to reverse the trend of these changes. In Kunming, China, the landscape analysis and metrics used in this study demonstrated that rapid urbanization has resulted in the loss of green spaces [61]. Elsewhere, Li et al. reported that, starting from the 1980s, Chinese cities experienced demographic change and economic growth, both of which are closely linked with the urbanization process: the urbanization process significantly influenced the green spaces and urbanization drove the fragmentation process of green spaces [45]. Chan and Vu found that the fragmentation of UGS increased by approximately 100% in two decades, with fragmentation mainly occurring in areas with higher density built-up [49]. In fact, in the early stages of urban expansion, green spaces have increased with urbanization, which is a positive indication that there is a growing number of urban green spaces in the city. However, as the city becomes denser, urban green spaces are becoming more fragmented. According to the directional analysis, urban green spaces are generally more fragmented in areas with greater built-up areas.

Rapid economic development is the primary cause of rapid urbanization, as economic opportunities in the city fuel massive migration from rural areas to urban areas. As a result of rapid growth in the city, the city landscapes have been radically altered, with the simultaneous expansion of built-up and economic spaces and an alarming rate of decay of green areas [35].

3.1.4. The Interaction Mechanisms of Three Factors on Urban Green Space Changes

Thus far, very few studies have attempted to combine research on three types of influencing factors—natural geographical factors, socioeconomic factors, and government policy factors—to explore how they interact and their influence on urban green space morphology. The present research was developed to highlight the range of possible causal factors impacting urban open space changes and the various interactions between attributes (Figure 2). Topography can influence issues such as runoff and flooding hazards as well as the availability of land for development, all of which limit real estate development. It is readily apparent that the decrease in green spaces was mainly due to the expansion of built-up areas. To be more precise, as flat terrain can accommodate larger populations, built-up areas will account for the majority of any land development. What is more, the geographic distribution of the populations gives rise to varying population densities in different areas. Taking Shanghai as an example of urban green space, the urban green spaces in the city center, suburbs and the islands of Shanghai feature different population densities. One reason for this is that the availability of jobs and economic activities within a region leads to an increase in population density. Meanwhile, additional housing and business demands in towns and urban areas alter existing urban green spaces. Urbanization changes land-use patterns, resulting in the occupation of green spaces and its transformation into construction land. As this rapid urbanization is causing congestion and pollution in cities, many cities have formulated sustainable urban development policies to ensure their urbanization activities meet the requirements of green spaces. From the above analysis, it can be seen that the three factors have an interaction effect, which makes urban open spaces present different morphological changes.

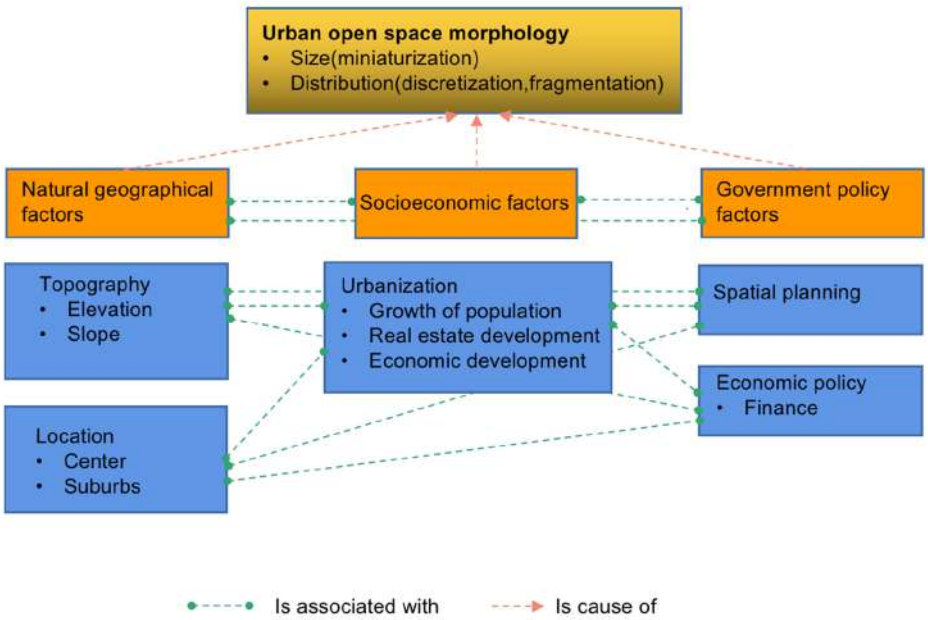


Figure 2. The interaction mechanisms of three factors relating to urban green space changes.

Interestingly, three influencing factors may affect the morphology of green spaces in different city areas, such as the center and suburbs. The area of green spaces in suburban areas was obviously larger than that in the center areas [31,41]. This is because center areas have extensive construction and transportation infrastructure. In other words, this phenomenon is related to the level of economic development. The more developed a place is, the more the green spaces will decrease size. Green spaces are consumed during urban development or may only be contained into suitable gaps within the built-up areas, which results in their fragmentation. The green space patches in the city center were shown to be less in quantity, poor in connectivity, and maximum in disperse distance. However, the government policies also have an influence on city center green spaces to some extent, considering the improvement of the urban environment, enhancing urban health and so on. For example, Shanghai has proposed a "Central City Public Green Spaces Plan" in order to transform it into a 'city in the forest'. Therefore, green spaces in the Shanghai city center decreased in 2005 but then showed an obvious upward trend in 2015. In terms of the suburbs, it may be affected by topography, as the construction build-up is limited by terrain. Meanwhile the suburbs retained a large volume of cultivated land, water and woodland. Even though there was development by construction and transportation, there was no distinct difference in quantity, which tended to be large, concentrated, and stable in pattern.

Our study provides a new perspective for identifying the drivers of urban green spaces transformation. Moreover, it identifies how the factors affect the morphology of green spaces in different city areas. Thus, it provides comprehensive theoretical support for the construction and ecological management of green spaces in an urban perspective.

3.2. Trends of Urban Open Space Morphology

As shown in Table 1, approximately 80% of studies have analyzed the urban open space spatial transformation at the city scale. Based on the studies mentioned above, most cities exhibit a trend in which their overall green space is declining and shrinking (Figure 3). However, green space patches are not distributed evenly across all districts. Green space in the central urban area shows a lower distribution pattern than the suburbs. There is a layer decrease gradually in the amount of green spaces in the surrounding areas of central city districts, suburban districts, and rural counties. This is because the urban core is most commonly associated with economic activity: it is a place where people live, work, and engage in widely. Due to urbanization and improved living standards, ever-increasing housing demands has led to tensions between land use for urban construction and green spaces. Therefore, urban development typically takes precedence over green spaces. Alternatively, green spaces are merely incorporated into gaps within the constructed land, resulting in the fragmentation of the green space, poor connectivity, size miniaturization and discrete distances. In Sebeta, Ethiopia, there was a drastic loss of 1410.7 ha of urban green space when it was transformed into constructed land over a period of 13 years from 2003 to 2016. Green spaces in urban centers may only be incorporated into suitable gaps within the built-up land, resulting in the aforementioned fragmentation. In light of the need to promote environmental protection and sustainable development, as governments become more interested in greening, they are encouraging investment in greening and boosting the demand for leisure and recreation to meet the needs of the growing population. This phenomenon is common in Chinese cities. In the period after the reform and opening-up, widespread real estate development and economic development needs have led the amount of open spaces to chart a declining trend. However, in the context of urbanization, many cities such as Beijing, Shanghai, and Shenzhen are exploring a broader range of comprehensive policies and strategies for urban green spaces. Greening policies and strategies are major drivers of green space recovery in cities, which can lead to a dramatic rise in green spaces. There is a good example in Shanghai, China, where the number and area of parks increased between 1980 and 2015. This was part of the local government's goal of building a world-class city by developing its urban green spaces.

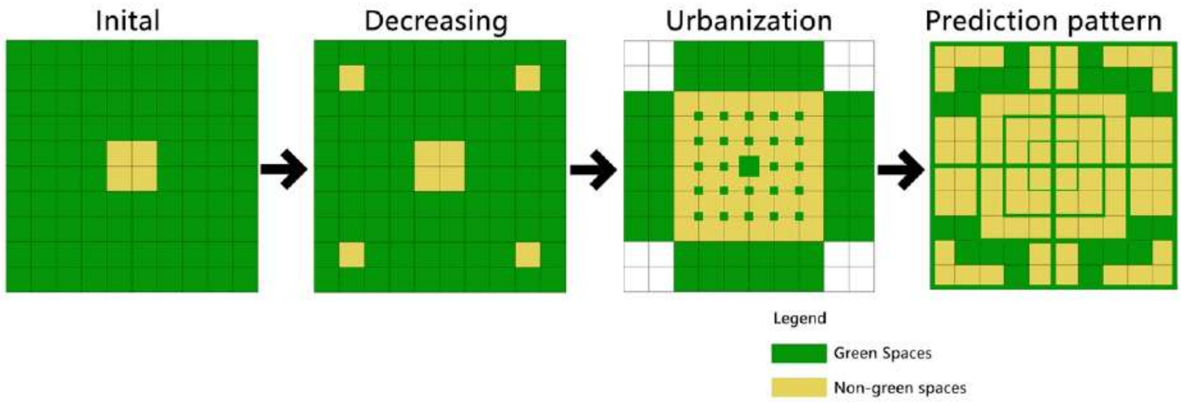


Figure 3. The spatial formation process of urban green spaces (city scale).

3.3. Methods Applied in Studying on Open Space Morphology

The methodology can be categorized into two parts: data collection and data analysis. Drawing on a sample of 47 articles, the traditional morphological data collection uses historical maps and documents, archaeological investigations, ethnographic research descriptions, and archival documents. Although it can offer precise information on UGSs, they are costly and time consuming and can be subjective. In the 1980s, new research methods emerged with the help of computer software; since then, geographical information system (GIS) and remote sensing (RS) techniques have widely been used to investigate the spatio-temporal dynamics of urban expansion and UGS change. According to recent advances such as high spatial resolution imagery and free data access policies, remote sensing provides a valuable set of tools that are able to minimize the need for field survey. Green space distribution maps were extracted from different times with land use maps by GIS. Remote sensing technologies have accounted for an important place in the study of urban green spaces, because they can generate repeated and complete coverage at different spatial scales [23]. Therefore, it is easy to collect data compared to traditional methods. However, a limitation is that remote sensing technologies lacks the high-resolution satellite images in the early stage, so it is hard to research obtained green space information by visual interpretation [27]. The primarily qualitative existing analysis focused on experience, direct perception, and visuality in a specific place or formal element. It was subsequently gradually supplemented or replaced by quantitative, statistically-based measurements.

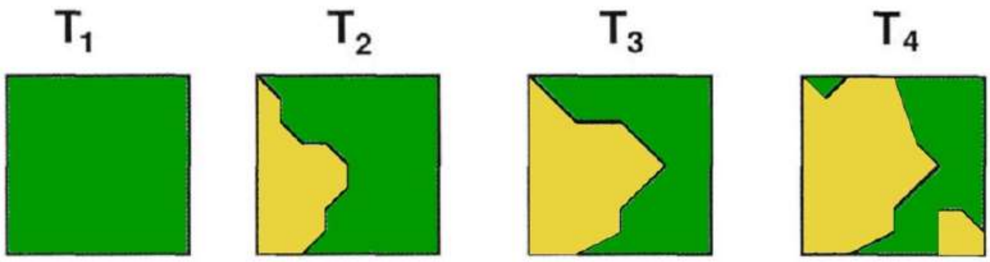
To date, urban open space variables have been measured using a variety of parameters. Landscape metrics are an important analysis method in the study of urban green space patterns and urban landscape patterns to provide evaluation criteria, which can then be combined with remote sensing data to analyze the green spaces. Many previous studies have utilized Landsat remote-sensing data combined with landscape metrics to analyze the changing green space morphology. For example, Xu used remote sensing data and green landscape metrics to study the green space morphology in Nanjing [54]. To be specific, extracting a distribution map of the patches of green spaces in city using Landsat remote-sensing image data in a period, analyzing and assessing the changes in scale and spatial layout of the green spaces using various landscape metrics. As can be seen from Table 2, some landscape metrics can be quantitatively measured. After calculating the landscape metrics of green patches in different years, the research team compared and analyzed these metrics to evaluate the evolution of green spaces. It is worth emphasizing that landscape metrics constitute one of the most important analytical methodologies in the study of the change and morphological characteristics of green spaces, which represents powerful tools for quantifying landscape structure. Landscape metrics based on the number, size, and is valuable information on a landscape pattern. However, there are numerous landscape metrics that may lead to a lack of comparability between individual studies.

Table 2. Landscape metrics used to analyze patterns of change (Modified from [54]).

Metrics	Purpose
Percent of land (PLAND)	PLAND refers to the greening rate. A larger PLAND value indicates a higher greening rate.
Mean patch size (MPS)	MPS refers to the average area of green space patches. A larger MPS value indicates a greater average area of green space patches.
Largest patch index (LPI)	LPI refers to the ratio of the floor area of the largest green space patch. A larger MPS value indicates a higher concentration degree of green space.
Patch number (NP)	NP refers to the degree of fragmentation. A larger NP value means that more green spaces are fragmented.
Patch density (PD)	PD refers to the degree of fragmentation. A larger PD value means that more green spaces are fragmented.
Total edge (TE)	TE refers to the shape complexity of a green space patch. A larger TE value indicates a higher degree of shape complexity and more severe disturbance of the patch.
Edge density (ED)	ED refers to the shape complexity of a green space patch. A larger ED value indicates a higher degree of shape complexity and more severe disturbance of the patch.
Mean proximity index (MPI)	MPI refers to the connectivity of green space patches, which increases with a higher MPI value.
Landscape shape index (LSI)	LSI refers to the shape complexity of a green space patch. A higher LSI value indicates greater shape complexity and more severe patch disturbance.

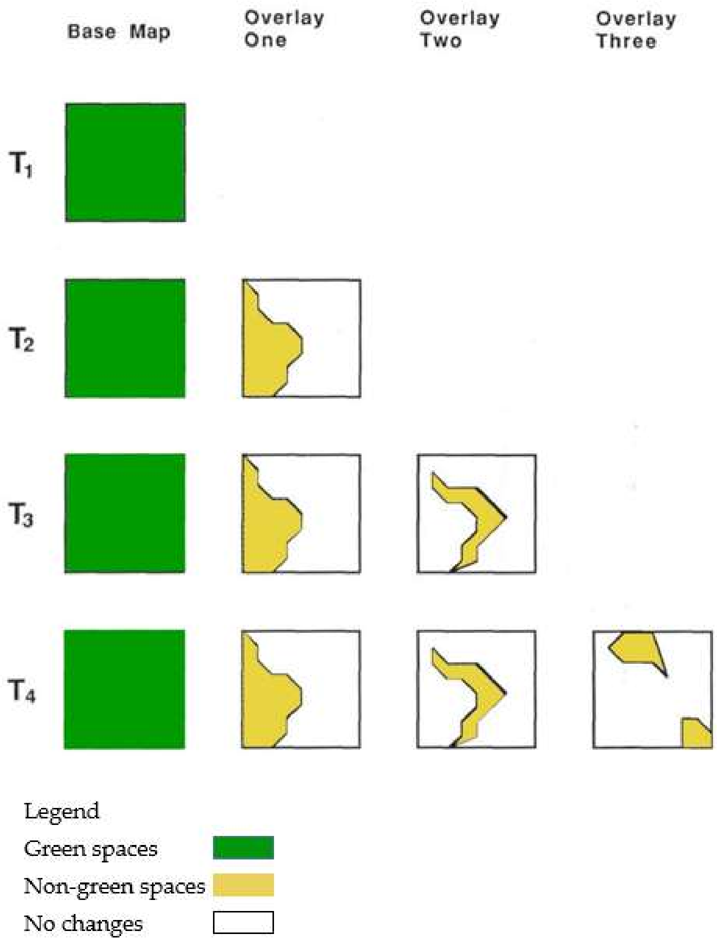
Moreover, planning documents, government statistics, and historical maps need to be integrated and analyzed in the study. Using a large number of historical maps as the base data, the GIS map correction function is used to standardize these historical maps at different scales and projections, thus allowing for a comparison of the evolution of open spaces in cities over time. The description of the site change is the basis for morphological analysis. Broadly, there are two ways of describing the increase or decrease in the area during a site change: time-slice snapshots and base maps with overlays. Figure 4a,b can be used to visualize and understand the two methods from an open space morphology perspective using the authors' drawing. The time-slice snapshots record conditions at a specific point in time. As each layer is built independently, no temporal topology is formed between the layers (Figure 4a). The base map with overlays is based on the base map at the time of the change, and specifically records the parcel of land where the change occurred (Figure 4b). It is beneficial to understand the relationship between the open space and the surrounding land.

With the continuous development of remote sensing and geographical information system technology, manual measurement uncertainty has been effectively alleviated. GIS can currently not only record the spatial characteristics of habitats, but also combine spatial properties and quantitative data.



(**a**)

Figure 4. *Cont.*



(**b**)

Figure 4. (**a**). Time-slice snapshots (Modified from [79]). (**b**) Base map with overlays (Modified from [79]). Notes: T means time or year.

4. Conclusions and Recommendations

Based on the contributing factors of urban open space morphology, and in consideration of the UGS issue and its future development, using PRISMA to review 47 articles, this research explores the causes of public open space changes. This includes natural geographical factors, government policy factors, and socioeconomic factors. These drivers constitute the interaction mechanisms for urban green space evolution, tending towards fragmentation, miniaturization, and discretization. The changing of the urban green spaces system is significantly more affected by social and economic development than by natural and administrative factors.

This study introduced new research approaches in terms of urban open space changes from the perspective of morphology, most of which are case-based empirical studies. The "classical" morphological studies are mainly based on qualitative data, such as hand-made, historical maps. Recently, "modern" research methods have emerged with the help of computer software, which represents a quantitative approach. Nowadays, the work of urban morphology researchers is supported by geographical information system (GIS) and remote sensing (RS) techniques, which have been widely used to investigate the spatio-temporal dynamics of urban expansion and UGS change. Notably, traditional statistical data has defects such as missing data and distortion. This makes it difficult to attend to the needs of large-scale, long-term research. The interpretation of remote sensing images can provide an understanding of the changing pattern and process of urban green spaces. The landscape metrics were used to analyze the change and morphological characteristics of green spaces. There is no denying that quantitative measures can enrich the landscape pattern information and exhibit aspects of its structure and spatial development.

Moreover, the majority of the world's population is migrating to cities, thus increasing the process of urbanization, particularly in developing countries. Siddique and Uddin show that rapid urbanization in developing countries like Bangladesh increases the pressure on green spaces [24]. Rapid population growth and construction activities are responsible for reducing the scale and number of green spaces, especially in mega cities such as Mumbai and Shanghai. On the basis of the above analysis, developing countries and Asian cities are more prone to this tendency. This is because developing countries today face greater challenges than developed countries, such as a lack of management, inadequate or improper implementation of environmental policies, and unplanned rural-urban migration. Additionally, the research indicates that urban green spaces are more dispersed where there are more built-up areas. China scholars has made more contributions to the study of urban green space morphology in terms of research.

However, China's rapid economic growth has improved living standards, and urban residents have gradually become more aware of their impact on the environment. As a result, the focus of city governments has moved away from exclusively focusing on GDP to one in which quality of life is a major factor in the planning and construction of new green areas [64]. Therefore, it is noteworthy that urbanization influences the changing patterns of urban green spaces in developing countries.

This study provides policymakers (local governments) with several points to consider when building urban green areas. The three mentioned factors should be taken into account as they influence spatial development, which consequently affects urban green spaces' morphological changes, especially in developing countries. They will also be appropriately useful in the future planning of urban green spaces to increase connectivity, form green networks, and realize sustainability in compact cities. Although compact cities' urban structures are considered densely concentrated, they require optimization of land use and greening elements. The UN Human Settlements Programme mentions how open green spaces make important contributions to the city environment, urban residents, and ecosystems [80]. Therefore, due to the limited availability of land resources, green spaces can be introduced into compact cities in a creative manner by adding vertical gardens, roof gardens, and other green surfaces amidst artificial structures. A high-quality green city should not only take into account the planning and management of the city, but also the health of the environment.

Finally, this study has several limitations. Firstly, as there are a limited number of studies that have discussed the open spaces changing from the morphological theory in the pool of literature, this paper may not be deeply reviewed. Even so, it does offer a certain degree of guidance for readers. Secondly, as the majority of the articles screened consisted of research at the city scale, this review paid more attention to the city-scale urban open space tendency. We also suggest more studies should be conducted on different scales or sizes, such as communities, districts and so on. Thirdly, in future, more factors can be identified to further enrich the comprehensive framework needed to support research on urban green space morphology. Moreover, to further validate and substantiate the factors, the study suggests that more empirical quantitative research should be conducted.

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References

1. Tang, B.-S.; Wong, S.-W. A Longitudinal Study of Open Space Zoning and Development in Hong Kong. *Landsc. Urban Plan.* **2008**, *87*, 258–268.
2. Zube, E.; Moore, G. *Advance in Environment, Behavior, and Design*; Springer: Berlin/Heidelberg, Germany, 1989. [CrossRef]
3. Haq, S.M.A. Urban Green Spaces and an Integrative Approach to Sustainable Environment. *J. Environ. Prot.* **2011**, *2*, 601–608.
4. Zhang, L.; Tan, P.Y.; Richards, D. Relative Importance of Quantitative and Qualitative Aspects of Urban Green Spaces in Promoting Health. *Landsc. Urban Plan.* **2021**, *213*, 104131.
5. Venter, Z.S.; Barton, D.N.; Gundersen, V.; Figari, H.; Nowell, M.S. Back to Nature: Norwegians Sustain Increased Recreational Use of Urban Green Space Months after the COVID-19 Outbreak. *Landsc. Urban Plan.* **2021**, *214*, 104175.
6. Wu, L.; Rowe, P.G. Green Space Progress or Paradox: Identifying Green Space Associated Gentrification in Beijing. *Landsc. Urban Plan.* **2022**, *219*, 104321.
7. Urban Development. Available online: https://www.worldbank.org/en/topic/urbandevelopment/overview (accessed on 18 June 2022).
8. Nor Akmar, A.A.; Konijnendijk, C.C.; Sreetheran, M.; Nilsson, K. Greenspace Planning and Management in Klang Valley, Peninsular Malaysia. *Arboric. Urban For.* **2011**, *37*, 99–107. [CrossRef]
9. Jim, C.Y. Monitoring the Performance and Decline of Heritage Trees in Urban Hong Kong. *J. Environ. Manag.* **2005**, *74*, 161–172.
10. Qureshi, S.; Hasan Kazmi, S.J.; Breuste, J.H. Ecological Disturbances due to High Cutback in the Green Infrastructure of Karachi: Analyses of Public Perception about Associated Health Problems. *Urban For. Urban Green.* **2010**, *9*, 187–198.
11. Uy, P.D.; Nakagoshi, N. Analyzing Urban Green Space Pattern and Eco-Network in Hanoi, Vietnam. *Landsc. Ecol. Eng.* **2007**, *3*, 143–157.
12. Anguluri, R.; Narayanan, P. Role of Green Space in Urban Planning: Outlook towards Smart Cities. *Urban For. Urban Greening.* **2017**, *25*, 58–65. [CrossRef]
13. Mıhçıoğlu Bilgi, E. *The Physical Evolution of the Historic City of Ankara between 1839 and 1944: A Morphological Analysis*; Middle East Technical University: Ankara, Turkey, 2010.
14. Wortley, L.; Hero, J.-M.; Howes, M. Evaluating Ecological Restoration Success: A Review of the Literature. *Restor. Ecol.* **2013**, *21*, 537–543.
15. Howes, M.; Wortley, L.; Potts, R.; Dedekorkut-Howes, A.; Serrao-Neumann, S.; Davidson, J.; Smith, T.; Nunn, P. Environmental Sustainability: A Case of Policy Implementation Failure? *Sustain. Sci. Pract. Policy* **2017**, *9*, 165. [CrossRef]
16. Boulton, C.; Dedekorkut-Howes, A.; Byrne, J. Factors Shaping Urban Greenspace Provision: A Systematic Review of the Literature. *Landsc. Urban Plan.* **2018**, *178*, 82–101.
17. Nordin, A.N.; Ling, G.H.T.; Tan, M.L.; Ho, C.S.; Ali, H.M. Spatial and Non-Spatial Factors Influencing Willingness to Pay (WTP) for Urban Green Spaces (UGS): A Review. *J. Sustain. Dev. Afr.* **2020**, *13*, 130.
18. Ballantyne, M.; Pickering, C.M. The Impacts of Trail Infrastructure on Vegetation and Soils: Current Literature and Future Directions. *J. Environ. Manag.* **2015**, *164*, 53–64.
19. Liu, H.; Li, F.; Xu, L.; Han, B. The Impact of Socio-Demographic, Environmental, and Individual Factors on Urban Park Visitation in Beijing, China. *J. Clean. Prod.* **2017**, *163*, S181–S188. [CrossRef]
20. Humpel, N.; Owen, N.; Leslie, E. Environmental Factors Associated with Adults' Participation in Physical Activity: A Review. *Am. J. Prev. Med.* **2002**, *22*, 188–199. [CrossRef]
21. Wang, D.; Brown, G.; Liu, Y. The Physical and Non-Physical Factors That Influence Perceived Access to Urban Parks. *Landsc. Urban Plan.* **2015**, *133*, 53–66. [CrossRef]
22. Zhang, H.-L.; Padullés Cubino, J.; Nizamani, M.M.; Harris, A.J.; Cheng, X.-L.; Da, L.; Sun, Z.; Wang, H.-F. Wealth and Land Use Drive the Distribution of Urban Green Space in the Tropical Coastal City of Haikou, China. *Urban For. Urban Green.* **2022**, *71*, 127554.
23. Xiao, Z.; Tian, Y.; Hao, L. Evolution of Green Space Based on Remote Sensing Images in Zhengdong New District. *Proc. Int. Wirel. Commun. Mob. Comput. Conf.* **2022**, *2022*, 3599045. [CrossRef]
24. Siddique, S.; Uddin, M.M. Green Space Dynamics in Response to Rapid Urbanization: Patterns, Transformations and Topographic Influence in Chattogram City, Bangladesh. *Land Use Policy* **2022**, *114*, 105974. [CrossRef]
25. Choi, J.; Kim, G. History of Seoul's Parks and Green Space Policies: Focusing on Policy Changes in Urban Development. *Land* **2022**, *11*, 474. [CrossRef]
26. Nawar, N.; Sorker, R.; Chowdhury, F.J.; Rahman, M. Present Status and Historical Changes of Urban Green Space in Dhaka City, Bangladesh: A Remote Sensing Driven Approach. *Environ. Chall.* **2022**, *6*, 100425. [CrossRef]
27. Liu, J.; Zhang, L.; Zhang, Q.; Li, C.; Zhang, G.; Wang, Y. Spatiotemporal Evolution Differences of Urban Green Space: A Comparative Case Study of Shanghai and Xuchang in China. *Land Use Policy* **2022**, *112*, 105824. [CrossRef]
28. Liu, Y.; Li, H.; Li, C.; Zhong, C.; Chen, X. An Investigation on Shenzhen Urban Green Space Changes and Their Effect on Local Eco-Environment in Recent Decades. *Sustain. Sci. Pract. Policy* **2021**, *13*, 12549. [CrossRef]
29. Zhou, Q.; Konijnendijk van den Bosch, C.C.; Chen, Z.; Wang, X.; Zhu, L.; Chen, J.; Lin, Y.; Dong, J. China's Green Space System Planning: Development, Experiences, and Characteristics. *Urban For. Urban Green.* **2021**, *60*, 127017. [CrossRef]

30. Muhamad Nor, A.N.; Abdul Aziz, H.; Nawawi, S.A.; Muhammad Jamil, R.; Abas, M.A.; Hambali, K.A.; Yusoff, A.H.; Ibrahim, N.; Rafaai, N.H.; Corstanje, R.; et al. Evolution of Green Space under Rapid Urban Expansion in Southeast Asian Cities. *Sustain. Sci. Pract. Policy* **2021**, *13*, 12024. [CrossRef]
31. Woldesemayat, E.M.; Genovese, P.V. Monitoring Urban Expansion and Urban Green Spaces Change in Addis Ababa: Directional and Zonal Analysis Integrated with Landscape Expansion Index. *For. Trees Livelihoods* **2021**, *12*, 389. [CrossRef]
32. Weng, H.; Gao, Y.; Su, X.; Yang, X.; Cheng, F.; Ma, R.; Liu, Y.; Zhang, W.; Zheng, L. Spatial-Temporal Changes and Driving Force Analysis of Green Space in Coastal Cities of Southeast China over the Past 20 Years. *Land* **2021**, *10*, 537. [CrossRef]
33. Wu, W.-B.; Ma, J.; Meadows, M.E.; Banzhaf, E.; Huang, T.-Y.; Liu, Y.-F.; Zhao, B. Spatio-Temporal Changes in Urban Green Space in 107 Chinese Cities (1990–2019): The Role of Economic Drivers and Policy. *Int. J. Appl. Earth Obs. Geoinf.* **2021**, *103*, 102525. [CrossRef]
34. Liu, S.; Zhang, X.; Feng, Y.; Xie, H.; Jiang, L.; Lei, Z. Spatiotemporal Dynamics of Urban Green Space Influenced by Rapid Urbanization and Land Use Policies in Shanghai. *For. Trees Livelihoods* **2021**, *12*, 476. [CrossRef]
35. Siddique, G.; Roy, A.; Mandal, M.H.; Ghosh, S.; Basak, A.; Singh, M.; Mukherjee, N. An Assessment on the Changing Status of Urban Green Space in Asansol City, West Bengal. *GeoJournal* **2022**, *87*, 1299–1321. [CrossRef]
36. Wan, J.; Zhao, Z. Analysis of landscape pattern change and ecosystem service value of urban green space—Taking Beidaihe district as an example. *Fresenius Environ. Bull.* **2020**, *29*, 5382–5389.
37. Munyati, C.; Drummond, J.H. Loss of Urban Green Spaces in Mafikeng, South Africa. *World Dev. Perspect.* **2020**, *19*, 100226. [CrossRef]
38. Rahaman, S.; Jahangir, S.; Haque, M.S.; Chen, R.; Kumar, P. Spatio-Temporal Changes of Green Spaces and Their Impact on Urban Environment of Mumbai, India. *Environ. Dev. Sustain. A Multidiscip. Approach Theory Pract. Sustain. Dev.* **2021**, *23*, 6481–6501. [CrossRef]
39. Girma, Y.; Terefe, H.; Pauleit, S.; Kindu, M. Urban Green Spaces Supply in Rapidly Urbanizing Countries: The Case of Sebeta Town, Ethiopia. *Remote Sens. Appl. Soc. Environ.* **2019**, *13*, 138–149. [CrossRef]
40. Rasli, F.N.; Kanniah, K.D.; Ho, C.S. Analysis of Fragmented Green Spaces in Kuala Lumpur, Malaysia. *Chem. Eng. Trans.* **2019**, *72*, 457–462.
41. Wu, Z.; Chen, R.; Meadows, M.E.; Sengupta, D.; Xu, D. Changing Urban Green Spaces in Shanghai: Trends, Drivers and Policy Implications. *Land Use Policy* **2019**, *87*, 104080. [CrossRef]
42. Aklibasinda, M.; Ozdarici Ok, A. Determination of the Urbanization and Changes in Open-Green Spaces in Nevsehir City through Remote Sensing. *Environ. Monit. Assess.* **2019**, *191*, 756. [CrossRef]
43. Badiu, D.L.; Onose, D.A.; Niță, M.R.; Lafortezza, R. From "red" to Green? A Look into the Evolution of Green Spaces in a Post-Socialist City. *Landsc. Urban Plan.* **2019**, *187*, 156–164. [CrossRef]
44. Sun, C.; Lin, T.; Zhao, Q.; Li, X.; Ye, H.; Zhang, G.; Liu, X.; Zhao, Y. Spatial Pattern of Urban Green Spaces in a Long-Term Compact Urbanization process—A Case Study in China. *Ecol. Indic.* **2019**, *96*, 111–119. [CrossRef]
45. Li, F.; Zheng, W.; Wang, Y.; Liang, J.; Xie, S. Urban Green Space Fragmentation and Urbanization: A Spatiotemporal Perspective. *Forests* **2019**, *10*, 333. [CrossRef]
46. Krzyżaniak, M.; Świerk, D.; Szczepańska, M.; Urbański, P. Changes in the Area of Urban Green Space in Cities of Western Poland. *Bull. Geogr. Socio-Econ. Ser.* **2018**, *39*, 65–77. [CrossRef]
47. Tang, H.; Liu, W.; Yun, W. Spatiotemporal Dynamics of Green Spaces in the Beijing–Tianjin–Hebei Region in the Past 20 Years. *Sustain. Sci. Pract. Policy* **2018**, *10*, 2949. [CrossRef]
48. Azare, I.M.; Dantata, I.J.; Musa, I.D.; Duala, T. Urban Public Spaces and Associated Environmental Challenges in Nigeria: A Review. *Int. J. Innov. Res. Dev.* **2018**, *7*, 18026. [CrossRef]
49. Chan, K.M.; Vu, T.T. A Landscape Ecological Perspective of the Impacts of Urbanization on Urban Green Spaces in the Klang Valley. *Appl. Geogr.* **2017**, *85*, 89–100. [CrossRef]
50. Wang, Z.B.; Zhang, L.J.; Zhao, X.L.; Du, H.Y.; Yang, D.Y.; Cai, Y.L. Analysis on landscape pattern of urban green space in Shanghai. *J. Environ. Prot. Ecol.* **2017**, *18*, 788–801.
51. Tang, B.-S. Is the Distribution of Public Open Space in Hong Kong Equitable, Why Not? *Landsc. Urban Plan.* **2017**, *161*, 80–89. [CrossRef]
52. Richards, D.R.; Passy, P.; Oh, R.R.Y. Impacts of Population Density and Wealth on the Quantity and Structure of Urban Green Space in Tropical Southeast Asia. *Landsc. Urban Plan.* **2017**, *157*, 553–560. [CrossRef]
53. Xu, H.; Cui, J. Assessing changes in green space of Suzhou city using remote-sensing images and landscape metrics. *Int. J. Simul. Syst. Sci. Technol.* **2016**, *17*, 31.1–31.8.
54. Xu, H. Assessment of Changes in Green Space of Nanjing City Using 1998 and 2007 Landsat Satellite Data. *Open House Int.* **2015**, *40*, 63–70. [CrossRef]
55. Haaland, C.; van den Bosch, C.K. Challenges and Strategies for Urban Green-Space Planning in Cities Undergoing Densification: A Review. *Urban For. Urban Green.* **2015**, *14*, 760–771.
56. Sharma, K.; Jalan, S. Change assessment of urban green spaces of Dehradun city using image derived parameters. *Trans. Inst. Indian Geogr.* **2013**, *35*, 63–74.
57. Zhao, J.; Chen, S.; Jiang, B.; Ren, Y.; Wang, H.; Vause, J.; Yu, H. Temporal Trend of Green Space Coverage in China and Its Relationship with Urbanization over the Last Two Decades. *Sci. Total Environ.* **2013**, *442*, 455–465. [PubMed]

58. Senanayake, I.P.; Welivitiya, W.D.D.P.; Nadeeka, P.M. Urban Green Spaces Analysis for Development Planning in Colombo, Sri Lanka, Utilizing THEOS Satellite Imagery—A Remote Sensing and GIS Approach. *Urban For. Urban Green.* **2013**, *12*, 307–314. [CrossRef]
59. Xu, X.; Duan, X.; Sun, H.; Sun, Q. Green Space Changes and Planning in the Capital Region of China. *Environ. Manag.* **2011**, *47*, 456–467.
60. Tian, Y.; Jim, C.Y.; Tao, Y.; Shi, T. Landscape Ecological Assessment of Green Space Fragmentation in Hong Kong. *Urban For. Urban Green.* **2011**, *10*, 79–86.
61. Zhou, X.; Wang, Y.-C. Spatial–temporal Dynamics of Urban Green Space in Response to Rapid Urbanization and Greening Policies. *Landsc. Urban Plan.* **2011**, *100*, 268–277.
62. Rafiee, R.; Salman Mahiny, A.; Khorasani, N. Assessment of Changes in Urban Green Spaces of Mashad City Using Satellite Data. *Int. J. Appl. Earth Obs. Geoinf.* **2009**, *11*, 431–438. [CrossRef]
63. Yang, J.; Jinxing, Z. The Failure and Success of Greenbelt Program in Beijing. *Urban For. Urban Green.* **2007**, *6*, 287–296.
64. Kong, F.; Nakagoshi, N. Spatial-Temporal Gradient Analysis of Urban Green Spaces in Jinan, China. *Landsc. Urban Plan.* **2006**, *78*, 147–164. [CrossRef]
65. Nirarta Samadhi, T.; Tantayanusorn, N. Reinventing Religious Land as Urban Open Space: The Case of Kuang in Chiang Mai (Thailand). *Habitat Int.* **2006**, *4*, 886–901. [CrossRef]
66. De Sousa, C.A. Turning Brownfields into Green Space in the City of Toronto. *Landsc. Urban Plan.* **2003**, *62*, 181–198. [CrossRef]
67. Zhang, X.Q. High-Rise and High-Density Compact Urban Form: The Development of Hong Kong. In *Compact Cities*; Routledge: Abingdon-on-Thames, UK, 2002; pp. 257–266. ISBN 9780203478622.
68. Johnson, M.P. Environmental Impacts of Urban Sprawl: A Survey of the Literature and Proposed Research Agenda. *Environ. Plan. A* **2001**, *33*, 717–735. [CrossRef]
69. Huang, B.; Ouyang, Z.; Zheng, H.; Zhang, H.; Wang, X. Construction of an Eco-Island: A Case Study of Chongming Island, China. *Ocean Coast. Manag.* **2008**, *51*, 575–588. [CrossRef]
70. Fan, P.; Xu, L.; Yue, W.; Chen, J. Accessibility of Public Urban Green Space in an Urban Periphery: The Case of Shanghai. *Landsc. Urban Plan.* **2017**, *165*, 177–192. [CrossRef]
71. United States Environmental Protection Agency. *Overview of EPA's Brownfields Program*; US EPA: Washington, DC, USA, 2014.
72. Beijing Municipal Bureau of Parks. *Yearbook of Beijing Landscape and Gardening*; Beijing Municipal Bureau of Parks: Beijing, China, 1995. (In Chinese)
73. Ara, S.; Islam, M.A.; Showkat, S. Effect of Land-Use Intensity on Surface Temperature: A Study on Chittagong City Corporation Area. In Proceedings of the 2016 5th International Conference on Informatics, Electronics and Vision (ICIEV), Dhaka, Bangladesh, 13–14 May 2016; pp. 72–77.
74. Ethirajan, A. Bangladesh Pins Hope on Chittagong Port. *BBC*, 4 September 2012.
75. Bss. Dhaka Ctg EPZ 4th in Global Ranking. Available online: https://www.thedailystar.net/news-detail-156797 (accessed on 19 June 2022).
76. Antrop, M. Changing Patterns in the Urbanized Countryside of Western Europe. *Landsc. Ecol.* **2000**, *15*, 257–270. [CrossRef]
77. Ghosh, I. The Dramatic Global Rise of Urbanization. Available online: https://www.weforum.org/agenda/2019/09/mapped-the-dramatic-global-rise-of-urbanization-1950-2020/ (accessed on 19 June 2022).
78. McDonald, R.I.; Forman, R.T.T.; Kareiva, P. Open Space Loss and Land Inequality in United States' Cities, 1990–2000. *PLoS ONE* **2010**, *5*, e9509. [CrossRef]
79. Langran, G.; Chrisman, N.R. A Framework for Temporal Geographic Information. *Cartogr. Int. J. Geogr. Inf. Geovis.* **1988**, *25*, 1–14. [CrossRef]
80. UN-Habitat. Adequate Open Public Space in Cities: A Human Settlements Indicator for Monitoring the Post-2015 Sustainable Development Agenda. In *Human Settlements Indicator*; UN Human Settlements Programme (UN Habitat): Nairobi, Kenya, 2015.