J. Umm Al-Qura Univ. Eng.Archit. (2024) 15:384–397
https://doi.org/10.1007/s43995-024-00077-x

REVIEW

The green city as a driver of sustainable development

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Received: 14 February 2024 / Accepted: 15 July 2024 / Published online: 31 July 2024
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Abstract
Given the accelerating pace of urbanization and worsening environmental constraints, it has become imperative to explore innovative and integrated solutions to shape a sustainable urban future. In this context, the emergence of the "Green City" stands out as an innovative approach to addressing environmental challenges while promoting sustainable urban development. This study aims to deepen our understanding of the crucial role played by the Green City as a driver to overcome obstacles related to environmental and urban sustainability. To achieve this objective, our methodology is based on several essential steps. Firstly, we establish a solid conceptual framework by comparing the Green City to sustainable cities. This initial step allows us to precisely define the contours and specific objectives of each concept, laying the groundwork for our comparative analysis. Next, we conduct a comprehensive analysis to explore how the Green City can contribute in a targeted manner to achieving sustainable development goals. By integrating these different approaches, our goal is to substantially advance knowledge and practices in sustainable urban planning, as well as the creation of more resilient and environmentally friendly cities.

Keywords Green city · Sustainable city · Sustainable development · Urban ecology · Sustainable urban planning

1 Introduction

Rapid urbanization and the growth of urban agglomerations have highlighted the need to promote urban sustainability and preserve the environment. In this context, cities, due to their population density and intense activities, have become key players in global environmental challenges such as air pollution, biodiversity loss, and greenhouse gas emissions. As a result, sustainable urban development has emerged as a priority, seeking to reconcile urban growth with environmental protection and improving the quality of life for city dwellers [10]. In this context, the emergence of the "Green City" as an innovative approach to addressing environmental challenges while promoting sustainable urban development has become crucial. This study aims to deepen our understanding of the essential role of the Green City as a catalyst for addressing environmental and urban sustainability challenges.

To achieve this goal, our methodology relies on several key steps. First, we establish a solid conceptual framework for the green city and sustainable city. This initial step allows us to precisely define the contours and specific objectives of each concept, laying the groundwork for our comparative analysis. Next, we conduct an in-depth analysis to explore how the green city can contribute in a targeted manner to achieving sustainable development goals. Our methodological approach aims to deepen our understanding of the interactions between the green city and urban sustainability, addressing existing research gaps. Indeed, previous studies have often blurred the concepts of the green city and sustainable city without establishing a clear distinction between them. Moreover, little attention has been paid to how the concept of the green city can be a tool for sustainable development, with some works focusing solely on its environmental dimension at the expense of other crucial aspects of urban sustainability. Thus, our study seeks to address these gaps by proposing an integrated analysis of the role of the Green City as a vector for sustainable development.

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2 Méthodology

We have chosen a methodological approach that combines both in-depth theoretical analysis and comparative analysis to deepen our understanding of the concepts of the green city and sustainable city. To do this, we initially conducted a theoretical analysis by exploring existing literature on these two concepts. This exploration included consulting a variety of sources such as academic articles, government reports, reference books, and relevant case studies.

During this process, our goal was to clarify the definitions and specific objectives of the green city and sustainable city. We also sought to understand the strategic approaches generally associated with each of these urban visions. By critically analyzing different viewpoints and emerging practices in this field, we were able to establish a solid foundation for our subsequent comparative study. By combining these two approaches, our study provides a comprehensive view of the role of the green city in building the sustainable city and underscores its importance for integrated urban planning.

3 Literature review

In the literature, the concept of the green city is often discussed interchangeably with that of the sustainable city, which has sometimes led to some confusion or imprecise use of the terms. Indeed, the green city is sometimes presented as a subset of the sustainable city, or even used as a synonym, while the two concepts carry distinct nuances and encompass different aspects of urban sustainability. However, it is crucial to recognize that the concept of the green city cannot be fully understood without considering the broader vision of urban sustainability embodied by the sustainable city. Defining the green city in isolation, without reference to the broader conceptual framework of the sustainable city, risks reducing its scope and significance.

3.1 Definition of the sustainable city

Since the 1990s, the concept of the "sustainable city" has emerged and spread, closely related to the broader concept of "sustainable development." Understanding the concept of a sustainable city requires placing it within the broader context of sustainable development. Defined in the Brundtland Report in 1987, sustainable development seeks to meet present needs without compromising the ability of future generations to meet their own needs. Thus, integrating the concept of a sustainable city into this global perspective is crucial for understanding the dynamics and challenges associated with contemporary urban planning [12, 22, 27].

In this framework, the sustainable city aims to create urban environments that integrate the three dimensions of sustainable development (Fig. 1) to ensure economic prosperity, social well-being, and environmental protection according to the traditional framework of sustainable development, and sometimes it is complemented with a fourth pillar: governance [26].

The concept of the sustainable city is subject to a plurality of definitions, reflecting its inherent complexity and diverse issues it entails. Some researchers have envisioned the sustainable city as a self-sufficient entity, capable of meeting its own needs without excessively relying on external resources. This vision has been advocated notably by economists David Morris and Ignacy Sachs, who emphasize the importance of creating urban communities capable of meeting their essential needs in a balanced and sustainable manner [12, 26, 27].

Cyria Emelianoff, a geography teacher-researcher, places particular importance on the concepts of identity, quality of life, and balance when defining the sustainable city. According to her, a sustainable city is much more than just a physical place; it is a dynamic environment capable of maintaining its distinctive character over time. She also stresses the need for a sustainable city to offer optimal quality of life to all its residents, by promoting social and functional diversity in all neighborhoods. Furthermore, a sustainable city is one that allows its residents to actively engage in a political project, seeking a harmonious balance between ecological and social aspects, both at the local and global scales [20, 21].

The diversity of interpretations surrounding the notion of the sustainable city has raised deep questions about its precise definition and relevance in the current context. This diversity of interpretations partly stems from the constantly evolving challenges, issues, and concerns related to urban

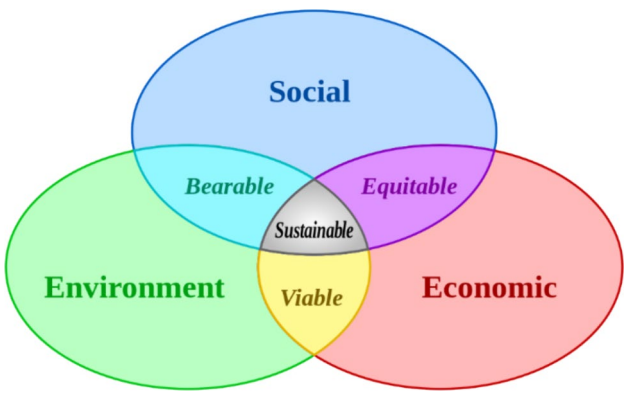


Fig. 1 The three dimensions of sustainability. Source: [3], "Sustainable development" (available at http://commons.wikimedia.org/wiki/File:Sustainable_development.svg)

development, as well as the different perspectives and priorities of actors involved in city planning and management.

The widespread use of the term "sustainable city" has gradually altered its original meaning, leading to the emergence of terms such as "green city," "resilient city," and "inclusive city." These new terms have emerged to better reflect specific aspects of urban sustainability, whether it is environmental protection, the ability to cope with shocks and stresses, or the promotion of social inclusion and equity. Thus, the diversity of terms and approaches in urban development reflects the complexity and multidimensionality of the challenges cities face. Each concept, whether it is a sustainable city, green city, resilient city, or inclusive city, brings a specific contribution to the reflection and action aiming to create more sustainable, resilient, and inclusive urban environments for all their residents.

3.2 Definition of the green city

3.2.1 Emergence of the green city

The concept of the green city is far from being a recent urban innovation; it is the result of long evolutions of the city in relation to its environment. Cities have always been subject to development strategies dependent on their environment, existing resources, and geographical advantages of the site. The city-nature relationship is considered one of the earliest approaches to the green city before the term was established. It dates back several periods in urban theory and practice, taking different forms over time.

During the nineteenth century, the question of nature was at the core of various movements and currents. The hygienist period was marked by numerous theorists and urban planners such as Haussmann, Howard, Geddes, Olmsted, and Forestier, who advocated against the unhealthy and unsanitary industrial city [17, 41]. Faced with issues of urban concentration, epidemics, and unhealthiness, nature became a necessity for public hygiene. It was considered a purification tool to maintain social peace and well-being. In Europe, particularly in Paris, extensive transformation operations were undertaken in a progressive approach aimed at ventilating the urban fabric. The urban landscape was modified by opening major roads and developing numerous parks and gardens, as well as other public facilities like schools and hospitals [17, 35, 41]. Nature became a means to make the city viable and pleasant to live in, especially to combat the epidemics that were multiplying at that time.

The late 19th and early twentieth centuries saw the development of collective transport means, giving rise to a new urban form: Ebenezer Howard's garden cities in Great Britain. Howard proposed a new approach to urban planning by seeking to create a model that would combine the advantages of the city with those of the countryside, aiming to build a new civilization where contact with nature would be an essential element of a healthy and balanced daily life [24, 36]. The city was considered a sick organism, and Howard sought to restructure it to be in harmony with nature [28].

The second phase, after World War II, the urgent need for rapid housing reconstruction, and technological progress influenced the relationship between the city and nature. Le Corbusier, the master of this era, developed the concept of the green city. For him, the city is a large park [17]. Once the buildings and road networks are in place, everything else is green space. Hygienist goals then merged with architectural forms of housing to create unique landscapes [41].

With the advent of sustainable development, the link between cities and their natural environment regained importance. This paradigm emerged from a growing awareness of the detrimental effects of human activity on the planet, as well as concerns about preserving natural resources. In 1968, UNESCO's "Man and Biosphere" program raised the question of urban growth: how to slow it down? Then the Brundtland Report published by the World Commission on Environment and Development in 1987 defined the policies needed to achieve sustainable development. This report, often seen as a turning point in understanding sustainable development, advocated for a comprehensive approach integrating economic, social, and environmental dimensions into the planning and management of human activities. It emphasized the need to preserve resources for future generations while meeting current needs, thus laying the groundwork for a long-term vision of human prosperity in harmony with nature [50].

Next came the sustainable city, which finds its roots in a specific program on the ecological city launched in 1993 to prepare for the Istanbul Habitat II summit, which translated sustainable development precepts to the city. Two events marked the beginning of this trend: in 1990, the United Nations established ICLEI (International Council for Local Environmental Initiatives), which seeks to raise awareness among cities about the environment and sustainable development, and the OECD, which initiated the first reflections on the city and urban environment, followed by a symposium on 21st-century cities. This evolution shows a growing interest in urban sustainability within the context of sustainable development [19, 20, 27, 51].

The Green Paper on Urban Environment was the first manifestation of awareness that kick-started the sustainable development policies of cities. This initiative was followed by the launch of a campaign for sustainable cities, which began at the Aalborg conference in 1994. The concept of sustainable development was integrated into cities, especially in Europe, with the implementation of Agenda 21 [12, 22, 27], where urban communities have been committed since 1993 to implementing various aspects of the program through local Agenda 21s. These were part of the

action plan adopted at the Rio conference in 1992 on environment and development. In this conference, cities were officially tasked with drafting action plans and sustainable development tailored to their urgency and scale of the situation. The aim was to raise awareness among policymakers about the risks facing cities worldwide and to rethink urban policies accordingly. Reflection on sustainable cities led to a critical reassessment of urban dynamics based on the three pillars of sustainable development (economic, social, and environmental). It seeks to explore new forms of governance, spatial management, transport, and energy, being environmentally friendly, sustainability-focused, innovative, resilient, and inclusive. Also, the green cities movement initiated during the World Environment Day in 2005 in San Francisco was a major turning point in global awareness of the need for ecological and sustainable urban planning. It was a response to the rapid growth of cities with its challenges in terms of natural resources, air quality, and climate change. World leaders, policymakers, scientists, and civil society representatives gathered at this historic event to discuss major environmental issues facing cities worldwide and to find innovative and sustainable solutions to facilitate the transition to greener and more sustainable cities [12, 22, 27].

Today, cities are increasingly criticized for their significant contribution to greenhouse gas emissions. It has become imperative to find solutions to reduce their carbon footprint and to adapt urban infrastructure to the consequences of climate change. In this context, the concept of the green city emerged to address these growing concerns about the environment and urban sustainability. The green city is an approach that aims to rethink the planning, design, and management of cities to minimize their environmental impact and promote a better quality of life for residents [6, 10, 36].

3.2.2 The green city

Given the absence of a universally accepted definition of a green city, the most relevant definitions are summarized in Table 1. A thorough analysis of these definitions highlights a great diversity in how different researchers and institutions envision a green city. These various definitions shed light on a range of approaches, from natural elements to broader concerns of urban sustainability. Originally, green city definitions often focused on nature-related elements. However, over time, they have evolved to incorporate more holistic and sustainable considerations. This transition reflects a shift in discourse, moving from a primary focus on nature preservation to a more explicit consideration of urban sustainability issues.

Some researchers have argued that the concept of a green city is closely linked to that of a sustainable city,

Table 1 Several definitions stemming from a literature review

Références	Green city définition
[6]	The Green City is a city, where all forms of nature—living organisms, biocoenosis, and their habitats—are highly significant components of green infrastructure. In a Green City, these forms of nature are preserved, maintained, and extended for the benefit of city residents. Urban nature is an ideal provider of services, and a key Concept for city development
[31]	Green cities have clean air and water and pleasant streets and parks. Green cities are resilient in the face of natural disasters, and the risk of major infectious disease outbreaks in such cities is low. Green cities also encourage green behavior, such as the use of public transit, and their ecological impact is relatively small
[42]	« La ville verte est une facette de la ville durable qui met l'accent sur les aspects environnementaux et urbanistiques de la construction de la ville»
	« la ville verte est une manière bien spécifique d'envisager la ville durable qui consiste à opérer un verdissement multiforme des territoires urbains, qu'il s'agisse de leurs espaces publics ou de leurs bâtiments»
[47]	Eight main attributes of a green city: green planning and design, implementation of green buildings, green waste, green transport system, efficiency in the use of green water and energy, green environment, and green community
[37]	"The concept of 'Green City' or 'Green Development' is not new. Previously couched within the term 'sustainable development,' it seeks to integrate environmental, social, and economic considerations within city's development processes. A Green City or Green Development is an extension of this concept but is understood within the frame of a city's actions and how these actions contribute to a city or urban area advancing as green and sustainable. Green Development considers how to improve and manage the overall quality and health of water, air, and land in urban spaces; its correlation with hinterlands and wider systems; and the resultant benefits derived by both the environment and residents"
[1]	There are at least two main factors underlying the conceptualization of a green city. First, from the consumption perspective, the concern is to reduce the demand for natural resources and services as well as waste and emission production. Second, from the production perspective, the main attention is to invest in the improvement of nature and the environment to support a better quality of life
[49]	"Une ville verte est une ville qui utilise la technologie pour créer un environnement urbain durable et résilient. Les villes vertes utilisent des solutions technologiques pour améliorer l'efficacité énergétique des bâtiments, promouvoir une mobilité durable, gérer efficacement les ressources en eau et réduire les émissions de gaz à effet de serre"

given that environmental sustainability is already inherently integrated into the very conception of a sustainable city. According to Ingrid Nappi, a professor and researcher in geography, a green city represents a specific approach to sustainable cities. In other words, the green city is considered as a facet of sustainable cities [42].

Other definitions of the term "green" exclusively refer to the environmental pillar of sustainability. The color green is often associated with nature and the environment. A green city prioritizes environmental sustainability by integrating parts of a city with natural green spaces to balance nature and the environment [6]. This symbolism conveys the idea of incorporating natural elements within urban spaces to promote a healthier and more sustainable environment. This includes creating parks, gardens, green corridors, and even green roofs, aiming to increase biodiversity, improve air quality, reduce urban heat islands, and prevent flooding [8]. However, in other research, the green in the concept of the green city goes beyond its nature-related aspect. It also embodies a commitment to adopting policies and practices that promote the use of environmentally friendly technologies. This includes integrating renewable energies, efficient waste management, and promoting sustainable transportation. Subadyo et al. [47] define eight main attributes of a green city: green planning and design, implementation of green buildings, green waste, green transport system, efficiency in the use of green water and energy, green environment, and green community. Another study (Azis et al. [2]) conceptualizes six attributes of a green city. These are green open space, green transport, green buildings, green energy, green water, and green waste.

Furthermore, other definitions emphasize that the design of a green city is based on two fundamental factors. Firstly, there is consumption reduction, which emphasizes the need to decrease the demand for natural resources as well as waste and emissions production. This requires implementing strategies to minimize resource consumption and waste production, such as promoting energy efficiency, adopting sustainable transportation systems, and advocating for recycling and composting. Secondly, there is production improvement, which involves investing in enhancing nature and the environment to foster a better quality of life for urban dwellers. This includes initiatives to improve green spaces, expand urban forests and parks, enhance air and water quality, and protect biodiversity within the city [1].

The green city goes beyond its connection with nature by integrating environmental policies and practices such as the use of renewable energies, efficient waste management, and promoting sustainable transportation [18] (Fig. 2). These two fundamental aspects of the green city, namely consumption reduction and production improvement, play a crucial role in creating more sustainable and enjoyable urban environments



Fig. 2 The main attributes of the green city

for residents while contributing to global efforts to combat climate change and preserve natural resources.

3.2.3 The characteristics of the green city

3.2.3.1 Nature in urban planning In the context of the green city as an ecological framework, the symbolism of the color green extends far beyond simply representing nature. It embodies a holistic concept encompassing the preservation, restoration, and harmonious integration of nature into the urban environment [39, 40, 44]. Thus, the color green is not limited solely to traditional green spaces like parks, gardens, and urban forests but also includes all natural elements integrated into the design of the urban environment (Fig. 3).

- **Green infrastructure**

  The integration of green infrastructure is a key feature of the green city. This involves incorporating parks, gardens, green roofs, green walls, stormwater management systems, and natural spaces into the city's structure itself, providing residents with places for relaxation, recreation, and connection with nature. The presence of nature in urban areas offers numerous benefits, such as improving air quality, reducing stress, and promoting local species diversity. Studies, such as those conducted by the European Commission, have shown that integrating nature into cities helps combat urban heat islands, improve air quality, and increase biodiversity. Therefore, it is crucial to design cities in harmony with nature, creating relaxation spaces, buffer zones to absorb pollution, ecological

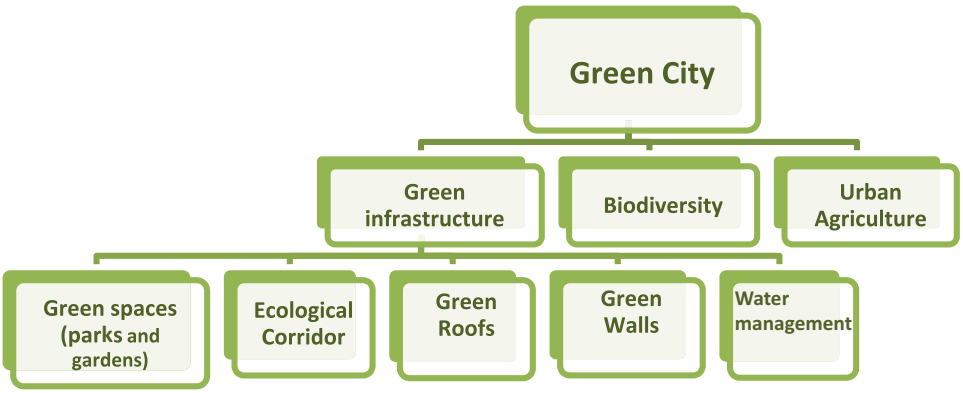


Fig. 3 The nature as a component of the green city

corridors for wildlife, and areas dedicated to urban agriculture [3, 4, 21, 24, 32, 34, 40]. Here are the components of green infrastructure that are often integrated into green city projects:

- **Parks and Green Spaces**: Urban parks, recreational areas, and public gardens provide open spaces for relaxation, leisure, and community activities. They help mitigate the adverse effects of urbanization by providing cooling areas, promoting biodiversity, and improving air quality [4, 7].
- **Ecological Corridors:** They are also used to integrate nature into cities. Green corridors promote ecological connectivity between natural spaces, allowing species to move and disperse, thereby contributing to urban biodiversity maintenance [9].
- **Green Roofs:** Green roofs maximize the use of vertical space by adding vegetation to building rooftops, offering various environmental benefits such as temperature reduction, improved air quality, and promoting biodiversity [11, 16, 29].
- **Green Walls:** Green walls are emerging components of green infrastructure. They provide benefits such as thermal insulation, stormwater retention, reduction of air pollution, and enhancement of urban aesthetics [37].

- Water management involves three essential aspects:

Water supply: This aspect aims to ensure equitable access to quality water while promoting sustainable management practices to preserve water resources [37].
Wastewater treatment and sanitation: This includes the implementation of collection, treatment, and recycling systems for wastewater to reduce water contamination risks and limit the impact on aquatic ecosystems [37].
Stormwater management and drainage: This component involves the use of facilities such as vegetated swales, plants, and special substrates to filter and absorb rainwater. These systems reduce the risk of flooding and improve water quality by enabling natural absorption and filtration of precipitation [37].

- **Urban Biodiversity**

  The conservation and promotion of urban biodiversity have become important goals in sustainable urban planning. Green spaces and natural elements in urban areas play a crucial role by providing habitats and corridors for urban fauna and flora. These spaces offer places for reproduction, food, and shelter for local species, contributing to the preservation of biodiversity [6, 23].

  Parks, gardens, and natural areas are essential components for urban biodiversity. They allow plant and animal species to coexist in an urban environment, providing opportunities for reproduction and survival. The planting of native species is particularly important, as these plants are adapted to local conditions and provide suitable habitats for local wildlife. The creation of ecological corridors is another crucial strategy to promote urban biodiversity. Ecological corridors are areas of connection between natural spaces, allowing species to move freely and colonize new habitats. These corridors can be strips of vegetation along rivers, green paths connecting parks and green spaces, or even green roofs and green walls in built-up areas.

  Preserving existing natural areas is also essential to maintain urban biodiversity. Natural spaces such as forests, wetlands, ponds, and meadows are valuable habitats for many species. They can be integrated into urban planning as nature reserves or protected areas, providing refuges for wildlife and floral [6, 25].
- **Urban Agriculture**

  Urban agriculture and community gardens play a crucial role in integrating nature into cities. They encompass various techniques of food production, ranging from individual and collective gardens to vertical farms and rooftop gardens.

Urban agriculture offers numerous economic, environmental, and social benefits. It enables local food production, raises awareness about the importance of nature, and strengthens social ties within urban communities. It contributes to food security by providing fresh and healthy food directly to city residents. Furthermore, it promotes awareness of the significance of agriculture and nature in urban settings by actively involving residents in food production [6, 7].

From an environmental perspective, urban agriculture reduces the carbon footprint of food systems by decreasing reliance on long-distance transportation and promoting sustainable farming practices. It can also contribute to biodiversity conservation by providing habitats for local species and creating ecological corridors within urban areas.

On the social front, community gardens and urban agriculture foster connections among residents, encouraging cooperation, knowledge sharing, and exchanges. They create meeting spaces where people can interact, learn from one another, and develop a sense of belonging within their community [6].

3.2.3.2 Ecological strategies to mitigate carbon emissions Reducing carbon emissions is a key element of the 'green' approach aimed at promoting environmental and urban sustainability. This involves implementing policies and practices that aim to limit the amount of carbon dioxide and other greenhouse gases emitted into the atmosphere from human activities. Cities are responsible for a significant portion of greenhouse gas emissions, mainly due to energy consumption, transportation, and industrial activities [13]. By promoting the use of renewable energy, improving the energy efficiency of buildings and infrastructure, and encouraging sustainable transportation modes (Fig. 4), cities can significantly contribute to combating climate change.

Green energy: The use of renewable energy is a key aspect of building green cities. Renewable energies such as solar, wind, and hydroelectric power offer significant benefits in terms of reducing greenhouse gas emissions, decreasing reliance on fossil fuels, and promoting a low-carbon economy. Scientific studies have shown that transitioning to renewable energy sources can significantly contribute to carbon emission reduction in urban areas [6]. Therefore, urban planning must consider the implementation of suitable infrastructure for the integration and efficient use of these alternative energy sources.

Green mobility: Promoting sustainable transportation is another key aspect of the green approach. Urban transportation is responsible for a significant portion of greenhouse gas emissions and air pollution in urban areas [11]. Scientific studies have shown that promoting public transportation, cycling, walking, and other low-emission modes of transport can help reduce greenhouse gas emissions, improve air quality, and alleviate traffic congestion [9]. Urban planning should therefore encourage the development of suitable infrastructure for these sustainable modes of transport, as well as the implementation of incentive policies to encourage their use.

Green waste management: Waste management also plays a crucial role in the green perspective. Effective waste management policies and practices, such as recycling, reuse, and waste reduction, are essential to minimize the environmental impact of cities. Scientific research has shown that efficient waste management systems can reduce air, water, and soil pollution, preserve natural resources, and promote a circular economy. Urban planning should therefore integrate suitable infrastructure and policies to promote sustainable waste management [37].

Green buildings: This refers to construction practices that utilize durable, recycled, or eco-friendly materials. Green buildings are designed to be energy-efficient, use water efficiently, reduce waste, and promote a healthy indoor environment [37, 38].

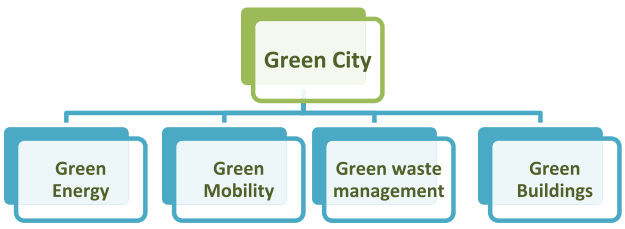


Fig. 4 Environmental sustainability in the green city

4 Similarities and differences between the green city and the sustainable city

The concepts of sustainable city and green city are two key approaches to sustainable urban development. These two notions share some similarities as they are both related to creating more environmentally friendly and sustainable cities. However, it is important to understand the nuances between these two concepts that are often used interchangeably.

The green city primarily focuses on urban environmental sustainability by implementing targeted practices and infrastructure. It aims to reduce the ecological footprint of urban areas by preserving green spaces, improving the energy efficiency of buildings, promoting environmentally friendly modes of transportation, adopting sustainable waste management, and promoting sustainable

mobility. These actions have a direct impact on quality of life by improving air quality, regulating the local climate, and creating healthier living spaces for citizens. Additionally, the green city contributes to raising awareness and mobilizing the population around environmental issues [8, 14, 25].

On the other hand, the sustainable city adopts a more holistic approach by integrating not only the environmental dimension but also the social and economic aspects of sustainable development. It encompasses a multitude of key sectors such as industry, agriculture, education, health, housing, transportation, culture, and innovation. Its goal is to create balanced and inclusive urban environments that promote economic progress, improve quality of life, and enhance social cohesion. By integrating these different dimensions, the sustainable city seeks to address the diverse needs of inhabitants and ensure balanced and sustainable urban development. The Table 2 below summarizes the similarities and differences between the green city and the sustainable city [12, 22].

Thus, the green city and the sustainable city are interdependent: the green city contributes to strengthening environmental sustainability, which in turn supports the social and economic goals of the sustainable city. By combining these two approaches, cities can aspire to be both environmentally healthy, socially just, and economically prosperous, thereby creating sustainable urban environments for current and future generations.

5 Emergence of related concepts

Cities are subject to constant changes, shaped by ever-evolving challenges and evolving urban needs. This urban dynamic has given rise to new approaches in urban planning, which view the city as a living system with a complex metabolism constantly interacting with its environment and inhabitants.

This holistic vision has led to the emergence of several complementary urban paradigms (Fig. 5), each aiming to promote urban sustainability from different angles [36]. Among these approaches are the ecological, inclusive, green, smart, and resilient city concepts. Each concept addresses specific aspects of urban development to tackle current global challenges, ranging from environmental protection to promoting social equity, and from technological innovation to the ability to cope with urban shocks and stresses. These different approaches contribute to enriching the discourse on how to design and manage cities of the future in a more sustainable and resilient manner.

Ecological City: The ecological city emerged in the 1970s and 1980s in response to growing environmental concerns, emphasizing the reduction of cities' ecological footprint. This concept promotes practices such as preserving green spaces, waste management, and promoting public transportation to reduce greenhouse gas emissions and minimize environmental impacts [12, 36].

Inclusive City: During the 1990s and 2000s, attention shifted towards social inclusion in urban development. The inclusive city emphasizes spatial equity, fair access

Table 2 Similarities and differences between the green city and the sustainable city

Green city	Sustainable city
Common objective of environmental sustainability	
Promotion of environmentally friendly practices	
Creation of more sustainable urban environments	
Integration of ecological solutions in urban planning	
The green city primarily focuses on the environmental dimension	The sustainable city takes a holistic approach by integrating the social and economic aspects of sustainable development
The green city primarily focuses on urban environmental sustainability	The sustainable city is much broader and encompasses a multitude of sectors, including industry, agriculture, education, health, housing, transportation, culture, innovation, and many others
The green city emphasizes specific solutions such as preserving green spaces, improving energy efficiency in buildings, and promoting green mobility	The sustainable city aims to achieve economic progress while promoting social equity and a better quality of life for its residents
The green city can be seen as an important step towards urban sustainability	The sustainable city aspires to create deeper and more lasting changes in how cities are designed, managed, and experienced
The green city focuses on specific initiatives, strategies, or isolated projects	The sustainable city adopts an integrated approach and involves greater collaboration among different stakeholders, including local governments, businesses, and communities, to promote long-term sustainability goals
Participatory approach: involvement of citizens	Collaborative approach: working in partnership

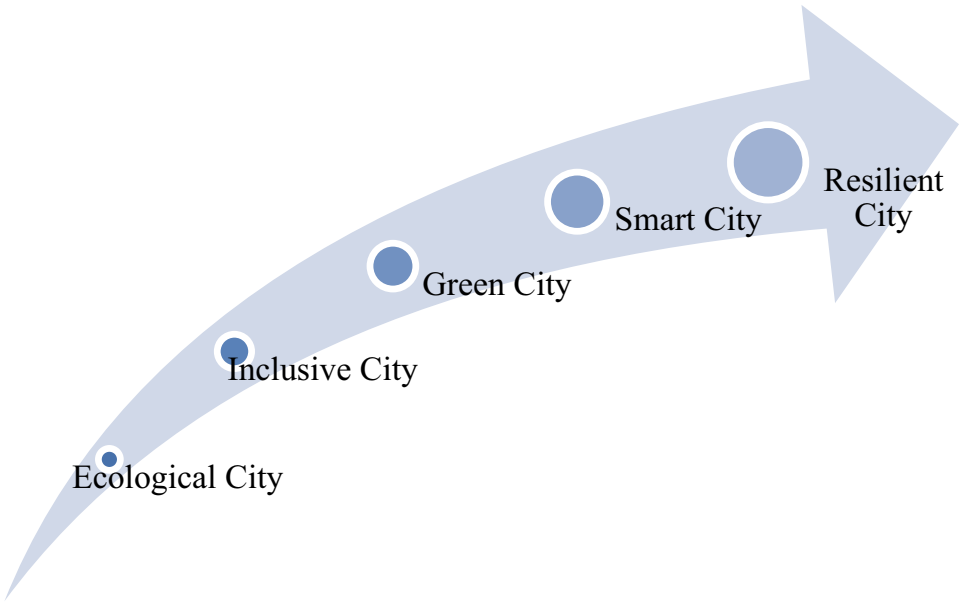


Fig. 5 The emergence of related concepts

to services and opportunities, as well as citizen participation in decision-making processes. This concept recognizes the importance of ensuring that all populations, including marginalized groups, benefit from urban development [36].

Green City: The green city emerges as an evolution of the ecological city concept, with a stronger emphasis on promoting the natural environment within urban areas. This includes creating green spaces, preserving natural ecosystems, and promoting sustainable lifestyles. The green city aims to improve residents' quality of life while reducing the environmental impact of cities.

Smart City: With the advent of information and communication technologies, the concept of the smart city emerges as a response to urban challenges in the twenty-first century. The smart city utilizes data and technologies to improve the efficiency of urban services, optimize resources, and enhance the quality of life for residents. This includes initiatives such as smart transportation systems, smart electrical grids, and connected buildings [3, 5, 15, 30, 37].

Resilient City: The concept of a resilient city emerged in response to the challenges cities face: climate change, natural disasters, population growth, social issues, and more. Urban resilience aims to reduce vulnerability and enhance a city's capacity to withstand risks. It focuses on reducing vulnerabilities and improving a city's ability to cope with risks. This can include measures such as sustainable urban planning, disaster risk management, resilient infrastructure, economic diversification, citizen participation, climate change adaptation, and social inclusion. The goal is to create cities capable of maintaining their functionality, protecting their inhabitants, and proactively adapting to future challenges [7, 13, 36].

6 The green city as a driver of sustainable development

The foundations of both the green city and sustainable development concepts are rooted in specific dimensions that define them. Initially, the concept of sustainable development, stemming from the Brundtland Commission, is based on three essential pillars: environment, social, and economic. These three dimensions are considered interdependent and complementary, aiming to strike a balance between environmental preservation, social equity, and economic prosperity. Over the years, the concept of sustainable development has been applied to various fields, from agriculture to urban planning, industry, and public policies. This has led to a growing awareness of the need to integrate these three dimensions into the planning and management of all aspects of society to ensure balanced and sustainable development [12, 22, 27, 46].

On the other hand, the concept of the green city encompasses several specific attributes that contribute to its definition. These attributes define the overall vision of a green city, where environmental, social, and economic sustainability is at the heart of all urban activities and initiatives. They include green infrastructure, green mobility, green energy, green building, waste management, biodiversity, and urban agriculture.

The green city places emphasis on environmental sustainability in its initiatives, aiming to shape cities that are more balanced, healthy, and pleasant to live in for current and future generations. Through sustainability-centered urban planning, the green city plays a crucial role in combating climate change, preserving biodiversity, and creating resilient and robust communities. As such, it becomes a powerful

driver for promoting beneficial sustainable urban development for both residents and the environmental ecosystem [2, 47, 52].

6.1 Analyzing the green city through the lens of the Sustainable Development Goals (SDG)

The indicators of SDG 11 will play a crucial role in assessing urban sustainability, which is why we have chosen to include them in our analysis of "green city" development initiatives [45].

By analyzing the green city through the lens of the SDGs, we highlight the cross-cutting components that are at the core of urban sustainability and play a crucial role in achieving sustainable development goals.

The green city thus acts as a key lever for achieving the SDGs (Fig. 6), which encompass the three essential dimensions of sustainable development: environmental, social, and economic [43, 45].

Firstly, green cities contribute to eliminating hunger (SDG 2) by promoting a more equitable urban environment and ensuring adequate access to resources for all citizens. Additionally, by improving health and well-being (SDG 3) through reducing air pollution and promoting an active lifestyle, they contribute to creating healthier and more resilient communities. By promoting the use of renewable energies in urban infrastructures and encouraging energy efficiency in buildings (SDG 7), the green city contributes to transitioning to a greener economy and reducing greenhouse gas emissions. Furthermore, by promoting decent work and economic growth (SDG 8) through creating new green jobs and developing sustainable sectors, it strengthens the economic viability of urban communities.

The promotion of sustainable cities and communities (SDG 11) is at the core of the green city vision, aiming to create urban environments where people can live, work, and thrive in a balanced and environmentally respectful manner. Additionally, by promoting sustainable production and consumption (SDG 12) through efficient resource management and waste reduction, it contributes to preserving natural resources and combating environmental degradation. Moreover, the green city plays a crucial role in the circular economy (SDG 12) and in combating climate change (SDG 13) by reducing greenhouse gas emissions and promoting adaptation to climate impacts. It also contributes to preserving biodiversity (SDG 15) by preserving green spaces and promoting harmonious coexistence between urbanization and natural ecosystems. Finally, by facilitating cooperation between local governments, businesses, and civil society organizations to implement green city initiatives and mobilize financial and technical resources (SDG 17).

The green city plays a crucial role in achieving the Sustainable Development Goals (SDGs) by offering innovative and sustainable solutions to current urban challenges. These goals encompass economic, social, and environmental prosperity, which are essential pillars for balanced and sustainable urban development.

Indeed, the green city contributes to achieving these goals by implementing practices and policies conducive to the circular economy, reducing carbon emissions, preserving urban biodiversity, improving air and water quality, and promoting sustainable mobility. These actions aim to create more resilient, inclusive, and environmentally respectful cities, while enhancing the quality of life for residents and promoting balanced urban growth.



Fig. 6 The Global Goals fro sustainable Development. Source: https://www.mobiliseyourcity.net/fr/mobilite-active

6.1.1 SDG 2: Zero Hunger

Promoting urban agriculture in green cities contributes to strengthening food security by providing local sources of healthy food.

They also support fair food distribution initiatives to reduce inequalities in access to food.

6.1.2 SDG 3: Good Health and Well-being

Green city initiatives reduce air pollution, thereby improving air quality and respiratory health for residents.

They encourage active lifestyles by promoting walking, cycling, and other healthy transportation methods, which helps reduce sedentary-related illnesses.

6.1.3 SDG 7: Affordable and Clean Energy

Green cities adopt renewable energy sources and encourage energy efficiency in buildings to reduce greenhouse gas emissions and ensure equitable access to energy for all.

They also promote sustainable mobility by investing in efficient and environmentally friendly public transportation systems.

6.1.4 SDG 8: Decent Work and Economic Growth

Green city projects provide employment opportunities in sectors such as eco-friendly construction, waste management, renewable energy, and sustainable transportation.

They foster inclusive economic growth by creating decent jobs and stimulating innovation in green industries.

6.1.5 SDG 11: Sustainable Cities and Communities

Sustainable urban planning and the creation of green spaces promote safe, inclusive, and resilient urban environments for residents.

They ensure that urban infrastructure is tailored to the needs of all residents, including disabled individuals and marginalized groups.

6.1.6 SDG 12: Responsible Consumption and Production

Green city initiatives encourage waste reduction, recycling, and responsible waste management to minimize the environmental impact of urban activities.

They also promote conscious consumption by advocating practices such as circular economy and fair trade.

6.1.7 SDG 13: Climate Action

Green city actions aim to reduce greenhouse gas emissions and enhance the resilience of urban communities to climate change impacts.

They encourage adaptation to changing climate conditions by integrating adaptation measures into urban planning.

6.1.8 SDG 15: Life on Land

Green cities preserve natural ecosystems by protecting green spaces, promoting urban biodiversity, and rehabilitating degraded areas.

They promote harmonious coexistence between urbanization and natural ecosystems, ensuring the sustainability of land resources.

6.1.9 SDG 17: Partnerships for the Goals

The green city can foster collaboration among various urban stakeholders, such as local governments, businesses, NGOs, and civil society, to implement sustainable development initiatives.

6.2 The green city and the environmental, social, and economic dimensions of sustainable development

Green cities transcend their mere environmental dimension by intrinsically integrating the Sustainable Development Goals (SDGs), allowing them to influence social and economic aspects in a concerted and interdependent manner.

Indeed, an effective green city approach goes beyond implementing environmental measures and also incorporates strategies and policies that promote social justice, economic equity, and urban resilience. This means that actions taken within a green city framework aim to address the needs of populations, reduce inequalities, promote social inclusion, and foster sustainable and equitable local economies [45].

Environmentally, green cities act to preserve ecosystems by conserving green spaces and implementing sustainable natural resource management practices. They also engage in reducing greenhouse gas emissions by promoting the use of renewable energies, improving building energy efficiency, establishing sustainable transportation modes, and ensuring efficient waste management.

On the social front, green city initiatives aim to improve residents' quality of life by creating a healthy, safe, and inclusive urban environment for all. They ensure equitable

access to essential services and green spaces, contributing to enhanced mental health and well-being among residents.

Economically, green cities support economic growth by fostering the creation of green jobs in sectors such as renewable energies, energy efficiency, urban agriculture, and waste management. They also encourage local entrepreneurship and the development of sustainable technologies, stimulating innovation and enhancing economic competitiveness. Moreover, the promotion of sustainable tourism and the circular economy strengthens the economic viability of green cities.

This synergy among the environmental, social, and economic dimensions demonstrates that the green city is much more than just a collection of ecological measures. It is part of a holistic vision of sustainable urban development, where every action taken to improve the environment also has a positive impact on citizens' well-being and the economic vitality of the city. Thus, the green city positions itself as a crucial lever for achieving the Sustainable Development Goals (SDGs) by harmoniously merging environmental, social, and economic aspirations for a resilient and prosperous sustainable city [43, 45].

6.3 Strategies for implementing green cities

Several studies have examined the most successful green cities in Europe, highlighting various exemplary practices in sustainable urban planning. These concrete examples demonstrate the effectiveness of certain specific strategies in addressing contemporary urban challenges [30]. For instance, Copenhagen in Denmark is often cited as one of the most advanced green cities [33]. The city has established an extensive network of bike lanes and promoted cycling as the primary means of transportation, thus reducing CO_2 emissions from commuting. Additionally, Copenhagen has heavily invested in green infrastructure such as urban parks and green roofs, improving air quality and providing recreational spaces for citizens [33].

Amsterdam in the Netherlands is another notable example of a successful green city [9, 25]. The city has adopted an integrated approach to stormwater management by combining natural solutions like rain gardens and urban wetlands with technical infrastructure. This approach not only reduces flood risks but also contributes to urban biodiversity and the creation of attractive green spaces. However, the successful transition to sustainability and the creation of a green city rely on several key elements to effectively integrate these sustainable practices into urban development. Best practices in sustainable urban planning in green cities are diverse and adaptable based on the specific challenges each city faces. Nonetheless, the transition to sustainability and the establishment of a green city rely on several key elements that are crucial for achieving this transformation [9, 25].

Evaluation of challenges and resources: A city must conduct a thorough assessment of the environmental, social, and economic challenges it faces, as well as its available resources. This may include analyzing energy consumption, waste management, water usage, air quality, urban mobility, etc.

Defining a vision and objectives: The city must develop a clear vision of what it aims to achieve in terms of urban sustainability. This vision should be supported by specific, measurable, achievable, relevant, and time-bound objectives. For example, reducing carbon emissions by 50% by 2030, increasing the share of renewable energy to 50% of total energy consumption, etc.

Political commitment and stakeholder mobilization: Strong political commitment is essential to successfully transition to a green city. Municipal leaders must actively promote sustainability and mobilize key stakeholders, such as citizens, businesses, community organizations, and universities, to support urban sustainability efforts.

Planning and cross-cutting integration: Integrated urban planning is necessary to incorporate sustainability principles into all aspects of urban development, including land use, transportation, water management, energy efficiency, etc. It is important to adopt a cross-cutting approach, involving multiple sectors and stakeholders for effective coordination.

Use of policies and regulatory tools: Green cities adopt policies and regulations supportive of sustainability, such as eco-friendly building standards, tax incentives for renewable energy, incentives for sustainable mobility, waste management regulations, etc. These policies must be supported by appropriate regulatory tools and effective implementation.

Use of technologies and innovations: Green cities integrate advanced technologies and innovations to optimize resource use, improve energy efficiency, manage waste, treat water, etc. This may include the use of smart systems, sensors, energy distribution networks, energy-efficient solutions in buildings, etc.

Awareness and citizen participation: Green cities actively involve citizens in the transition to sustainability. This can be achieved through awareness campaigns, education, public participation programs, consultations, and collaborations with local communities. It is essential to create opportunities for citizens to contribute to decision-making and be involved in the implementation of sustainable projects.

Monitoring, evaluation, and adjustments: Once sustainability measures are in place, it is important to regularly monitor and evaluate their effectiveness. This helps measure progress against set objectives, identify areas requiring adjustments, and make necessary changes to continuously improve sustainability practices.

7 Conclusion

In conclusion, the concept of the "green city" has evolved beyond mere aspiration to become an urgent necessity and an essential tool in building sustainable and equitable cities, thereby ensuring a viable and prosperous future for current and future generations. A review of the literature highlights the multidimensionality of the "green city" concept, addressing a diverse range of complex and interdependent environmental challenges such as climate change, biodiversity loss, pollution, and resource degradation. These challenges demand decisive action at the urban level. It is crucial to adopt an innovative and comprehensive approach that integrates the social, environmental, and economic dimensions of urban development.

This comprehensive approach is essential to position the city as a green and sustainable entity. By emphasizing the need for an integrated and innovative approach, this article underscores the critical role that the green city can play in creating fair, sustainable, and resilient cities. It highlights the importance of rethinking our urban development models to effectively and sustainably address contemporary urban challenges. By adopting an inclusive and forward-looking approach, we can build cities that benefit all their inhabitants while preserving natural resources and ensuring balanced long-term development.

Author contributions The contributions of the authors to this research are as follows.

Funding Not applicable.

Data availability Not applicable.

Declarations

Conflict of interest We declare that we have no conflict of interest.

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