



URBAN HORTICULTURE

Introduction to Urban horticulture Volume 1



UNIVERSITY
OF AGRONOMIC SCIENCES
AND VETERINARY MEDICINE
OF BUCHAREST



ЛЕСОТЕХНИЧЕСКИ
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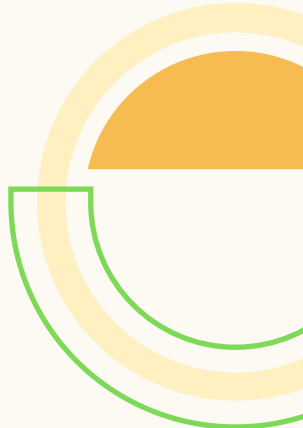
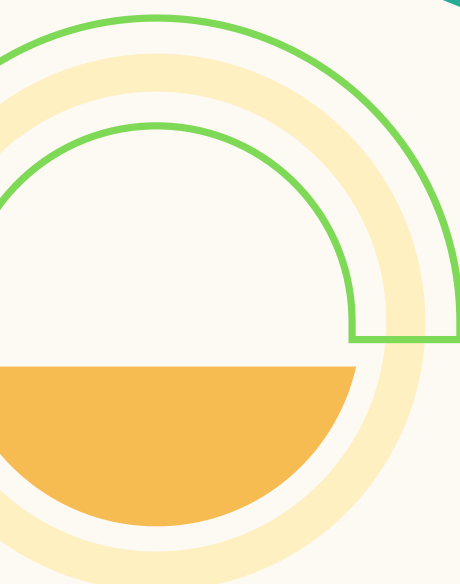
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"Enhancing practical skills of horticulture specialists to better address the demands of the European Green Deal"

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Volume 1

Introduction to Urban horticulture

Oana Venat
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Introduction



Urban horticulture is an intricate field that involves the cultivation, processing, and distribution of both food crops and ornamental plants within urban and the surrounding peri-urban areas. This discipline is diverse in its scope, ranging from small-scale practices like maintaining home and community gardens to more extensive operations such as managing urban farms and greenhouses. A key characteristic of urban horticulture is its innovative approach to optimizing the use of limited urban space and resources. Techniques like vertical farming, hydroponics, and rooftop gardening are frequently employed to maximize yield in constrained environments. Furthermore, urban horticulture plays a vital role in fostering community engagement, advancing educational goals, and enhancing social well-being. It contributes significantly to urban biodiversity, bolsters food security, and improves the aesthetic and ecological aspects of urban landscapes. This discipline brings together horticulture, urban planning, and environmental science in order to respond to the concrete constraints and development possibilities characteristic of densely built urban areas.

According to the Biodiversity Information System for Europe (BISE), Europe is notably urbanized, with projections indicating that 80% of its population will reside in cities by 2050. Urban areas, though they constitute only about 4% of Europe's surface area, exert profound influences on resources and biodiversity, reaching far beyond their geographical limits (BISE, 2019). Most of these high-density cities, which have substantial carbon footprints, are situated in regions particularly vulnerable to climate change. Therefore, the pursuit of a climate-resilient future is closely linked to the development of cities that are shaped and informed by climate considerations.



Elements of urban greenery, such as street trees, parks, wetlands, protected areas, and urban gardens, along with green rooftops and other vegetated spaces, deliver a multitude of natural benefits. These include mitigating climate extremes like heatwaves and storms, filtering dust, absorbing toxins and noise, providing shade and cooling, and sequestering carbon.

They are not only relevant for food production, economic activities and community building but also play a significant role in biodiversity conservation, energy production, and waste management. The enhanced biodiversity within these green areas further contributes to species conservation. These spaces also promote social cohesion through collaborative activities, fostering social interactions, recreation, and education, and thereby enhancing overall well-being.

Volume 1

Introduction to Urban horticulture

Summary

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- The present book on Urban horticulture was prepared for the master students, as an introductory auxiliary material for their first steps into urban horticulture. The book includes aspects related to urban horticulture policy and urban planning, urban garden typologies and frameworks, urban flora diversity and classification, cultivation and care of urban gardens, presenting the essentials of urban garden management and finishes with a handbook for practical application of urban horticulture and practical examples of urban gardens, including those realized inside the ERAMSUS+ project titled "Enhancing practical skills of horticulture specialists to better address the demands of the European Green Deal", during a summer school or other activities.



Learning outcome descriptors

By the end of the module, the readers should be able to prove they acquired both general and transferable skills and knowledge, and that they have advanced knowledge of urban horticulture principles and gained skills in designing, implementing, and managing sustainable horticultural projects in urban environments.



General and transferable skills

1	Ability to conduct thorough research and applying them in practical urban horticulture scenarios.
2	Critically evaluate information, practices, and theories in urban horticulture and related fields
3	Familiarity with modern technologies and tools relevant to urban horticulture
4	Ability to adapt to new challenges, technologies, and evolving practices in urban horticulture
5	Commitment to ongoing professional development and staying current with advancements in urban horticulture

Knowledge, understanding and professional skills

1	In-depth knowledge of theories and principles in urban horticulture, including urban ecosystem services.
2	Ability to plan, execute, and manage horticultural projects
3	Understanding of sustainable cultivation techniques, soil management, pest control, and water conservation methods in urban settings.

Unit 1.1. Scope and importance of urban horticulture

Milena Yordanova, Oana Venat,
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Urban horticulture holds a central position in responding to the changing demands of sustainable urban development. The integration of diverse plant species within urban landscapes contributes to the conservation of biodiversity in anthropogenic environments (McPherson et al., 2016). This is particularly significant considering the ongoing urbanization trends that often lead to habitat fragmentation and loss (Ellis & Ramankutty, 2008). The cultivation of plant species in urban areas facilitates in situ conservation efforts, helping to maintain genetic diversity and preserve endangered species within the city confines (Heywood, 2011). In addition, urban horticulture fosters ecological connectivity, offering green corridors that support wildlife movement and enhance urban ecosystem resilience (Kowarik, 2011).

Moreover, the strategic placement of plant habitats in urban spaces contributes to the mitigation of environmental stressors. Green infrastructure, comprising urban horticultural elements, has been shown to mitigate the urban heat island effect (Oke, 1982). Trees and green spaces



provide shade and reduce surface temperatures, positively impacting both human comfort and energy consumption (Nowak et al., 2018).

From a biotechnological perspective, urban horticulture presents opportunities for enhancing fruit and vegetable quality through advanced breeding techniques and genetic modifications (Tester & Langridge, 2010). This aligns with your interest in biotechnologies for plants, opening avenues to develop crops resilient to urban conditions and addressing nutritional needs in densely populated areas.

In conclusion, urban horticulture is indispensable for urban sustainability, contributing to biodiversity conservation, ecological connectivity, and environmental amelioration. The integration of biotechnological approaches further enhances its potential, emphasizing the importance of a holistic and interdisciplinary approach to urban plant habitats.

Urban horticulture, from a scientific perspective, plays a multifaceted role in the modern world, contributing to various aspects of human well-being, environmental sustainability, and urban development. It encompasses the cultivation of plants, including the species you are particularly interested in, in urban environments. Let's delve into the key roles of urban horticulture:

Biodiversity conservation

Urban horticulture can serve as a means to conserve biodiversity within urban landscapes. By incorporating a diverse range of plant species and ornamental plants, urban environments can support a richer array of flora and fauna. This promotes ecological balance and enhances the overall biodiversity of urban areas.



Environmental benefits

Plant cultivation in urban areas contributes significantly to environmental sustainability. Plants aid in air purification, carbon sequestration, and temperature regulation. Through photosynthesis, they absorb carbon dioxide and release oxygen, mitigating the impacts of urban pollution and enhancing air quality.



Aesthetic and psychological well-being

Urban horticulture enhances the aesthetic appeal of urban landscapes, positively impacting residents' mental health and well-being. Green spaces, ornamental plants, and community gardens provide recreational opportunities, reduce stress, and contribute to an improved quality of life.

Food security and sustainable agriculture

The cultivation of food crops such as sweet potato and strawberry in urban areas contributes to local food security. Urban agriculture practices, including vertical farming and rooftop gardens, can provide fresh, locally grown produce, reducing the ecological footprint associated with food transportation.



Biotechnological innovations for crop improvement

Urban horticulture embraces biotechnological tools to enhance the genetic makeup of crops. Through genetic engineering, researchers can introduce desirable traits such as disease resistance, improved nutritional content, and enhanced productivity in plants like sweet potato and strawberry, contributing to the sustainable cultivation of horticultural crops in urban settings. (Nester, E. W., et al. 2001).



Resource-efficient urban agriculture

Horticulture in urban settings emphasizes resource-efficient practices. Hydroponics, aeroponics, and vertical farming are horticultural methods that optimize space, water, and nutrient use, allowing for the cultivation of crops in constrained urban environments. This approach is particularly relevant to your interest in sweet potato, potato, and strawberry cultivation. (Resh, H. M., 2012).

Cultivation of ornamental plants for urban green spaces

The selection and cultivation of ornamental plants are integral components of urban horticulture. Horticulturists focus on aesthetically pleasing and environmentally adaptable ornamental species, contributing to the creation of green spaces, landscaping, and urban beautification.



Integrated pest and disease management

Horticulturists employ integrated pest management (IPM) strategies to ensure plant health in urban environments. This includes the use of biotechnological solutions, resistant varieties, and environmentally friendly practices to manage pests and diseases, promoting sustainable horticulture.

The scope of urban horticulture in cities is expansive and encompasses a range of critical aspects that contribute to the well-being of urban environments. From addressing environmental challenges to enhancing the quality of life for residents, urban horticulture plays a pivotal role.

Urban horticulture, within the context of burgeoning urban development, presents a compelling avenue for sustainable integration of nature into the urban landscape. As cities expand and populations burgeon, the need for green spaces becomes increasingly paramount. This essay will delve into the scope of urban horticulture as a pivotal component of

urban development, considering its multifaceted contributions to environmental sustainability, human well-being, and the conservation of biodiversity.

The urban environment, characterized by **concrete jungles** and **steel structures**, often lacks the ecological balance found in natural landscapes. Urban horticulture, with its emphasis on cultivating plant life within the urban fabric, provides a mechanism to counterbalance this deficit. It fosters the creation of urban green spaces, such as parks, community gardens, and green rooftops, acting as essential habitats for various plant species. These green oases serve as **refuges for biodiversity**, promoting the coexistence of diverse plant species and facilitating ecological balance in the urban milieu.



Within plant biodiversity conservation, urban horticulture functions as a platform for cultivating native and threatened species under urban conditions. The emphasis is placed on producing planting material adapted to typical urban stressors such as heat, soil compaction, irregular water supply, and pollution. By selecting and propagating resilient genotypes, genetic diversity is maintained while ensuring functional performance and long-term persistence within urban ecosystems.

Moreover, urban horticulture contributes to the overall well-being of urban dwellers. Green spaces have been linked to physical and mental health benefits, mitigating the negative impacts of urban stressors. The presence of plants in urban areas has been associated with improved air quality, reduced noise pollution, and enhanced psychological well-being. These positive effects underscore the potential of urban horticulture not only as a conservation tool but also as a means to create healthier and more livable urban environments.

In conclusion, the scope of urban horticulture in the context of urban development is expansive and multifaceted. From biodiversity conservation and the promotion of human well-being, urban horticulture emerges as a linchpin for sustainable urbanization. As cities evolve, the incorporation of urban horticulture into urban planning becomes not just a necessity but a visionary approach to foster resilient, sustainable, and harmonious urban habitats.

Unit 1.2. History of urban horticulture

Milena Yordanova, Adrian Asănică,
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Roxana Ciceoi

Urban horticulture's roots date back from the Hanging Gardens of Babylon in Mesopotamia (3500 BCE) through ancient Egypt's (2500 BCE) urban gardens and orchards developed for various purposes, till the Aztecs' (1100 CE). chinampas - a complex garden plot and canal system, which started as small-scale "floating gardens" and were implemented on a large scale and within urban areas.

(<https://thegreenconspiracy.com/history-urban-gardening/>)



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In the Middle Ages, gardens developed mainly in monasteries and palaces, as well as in some private homes. They served both to feed the elite and to feed the inhabitants of the cities. Fruits, leafy vegetables, medicinal plants, and spices were grown in the gardens. (Nadal, et al. 2015).

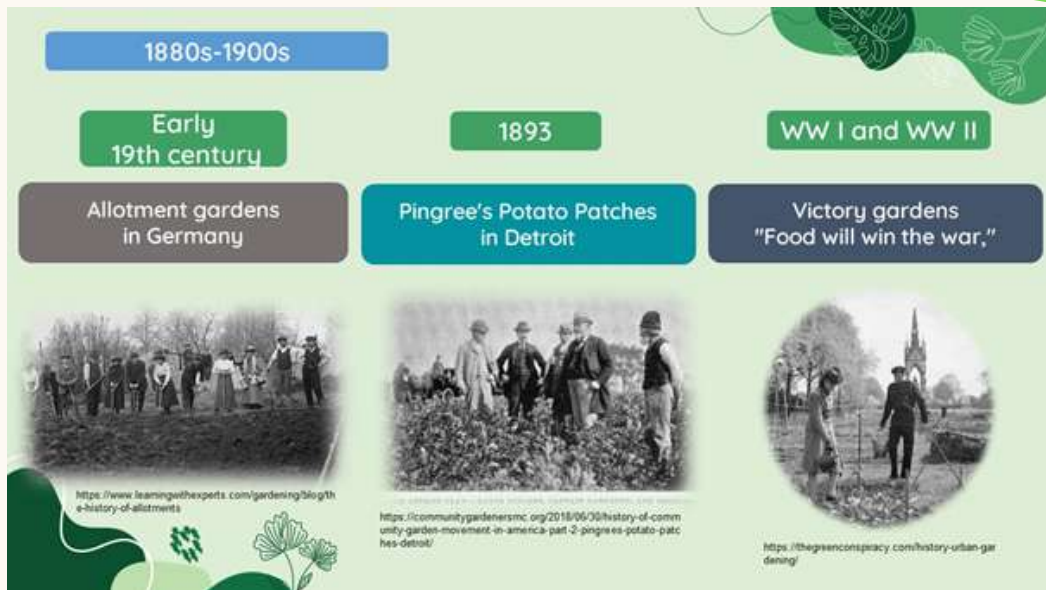
According to Dobeles and Zvirbule, (2020), until the 17th century, the understanding of urban agriculture was defined by population growth and the formation and development of cities, and they pointed out three essential features of urban agriculture: that it is part of the city and that it leads for its development and autonomy; different irrigation systems are used, depending on the climate of the given region; it is the main source of food for the population of the city.

Until the Industrial Revolution, agriculture, including horticulture, was an inevitable part of cities because they provided fresh food for the nutrition of their inhabitants. After the Industrial Revolution (18th century), agriculture was mainly concentrated in rural areas, while industrial production began to develop on vacant land in cities (Dobeles and Zvirbule, 2020). The development of industry leads to the beginning of population migration to cities with developed industries. Population growth in cities is leading to food insecurity, and this is rekindling interest in urban agriculture. A more marked upsurge in urban horticulture was reported in

1880-1900. Between 1880 and the early 1900s, allotment gardens were started in European cities, including Stockholm, London, and Paris, to help the urban poor become self-sufficient by providing garden plots in suburban areas.

Nadal et al. (2015) point out that the first urban gardens in England were established in the late nineteenth century, the first being in Bedford Park (1877-1897) by Norman Shaw, followed by Letchworth Garden City (1903) and Hampstead Garden Suburb (1907), by Raymond Unwin and Barry Parker. Their historical overview of urban gardening states that in France and Belgium allotment gardens were created for workers to improve the social order. Allotment gardens were first established in Germany in the early 19th century as a response to poverty and food insecurity.

During the Great Depression in the United States (1893 and 1929), Pingree's Potato Patches appeared, which were related to a program established in Detroit in 1893 to produce money, supply food, and promote independence. Victory gardens were established in the US, Canada, and the UK during World Wars I and II when people tried to reduce the strain on food production needed for the war effort by growing their own fruits, vegetables, and herbs.



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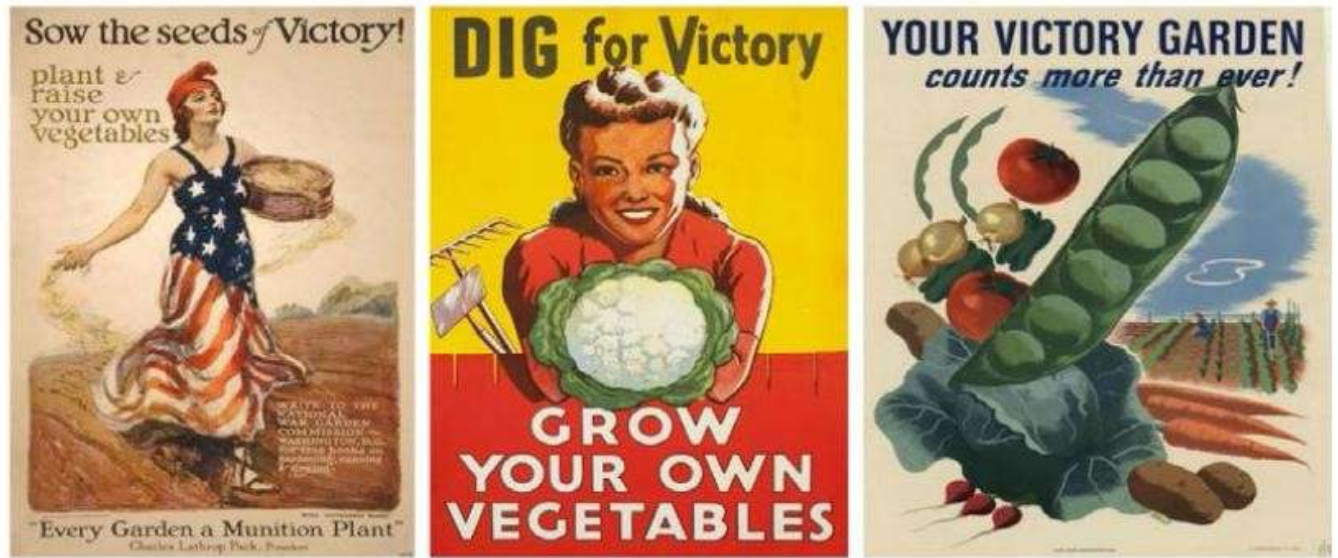




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Again, Nadal, et al. (2015) summarize that during World War I, urban gardens served to produce an additional amount of food, organizing the United States School Garden Army, the Women's Land Army of America, and the Liberty Gardens. In World War II, the importance of urban agriculture continued to be promoted

through various campaigns, such as Victory Gardens, (popular in the US), which was endorsed by the War Administration Foods and Dig for Victory (UK, 1940). Corrêa, et al. (2020) add that in the UK the "Dig to Win" campaign was created by the British and Scottish Departments of Agriculture. Propaganda efforts called for locals to "dig for victory" in wartime victory gardens as agriculture developed on land begun during the Great Depression in the United States. "Food will win the war," declared Woodrow Wilson in 1917, and Eleanor Roosevelt created a victory garden in the White House during World War II. (<https://assignmentpoint.com/history-urban-gardening/>)



Propaganda effort. Source: Corrêa, et al. (2020)

More recently, urban agriculture, particularly urban gardening, began to revive in the 1970s. This is due in part to continued urbanization, new movements for alternative food production, to the idea of self-sufficiency and an ecological lifestyle. (Sousa and Batista, 2013). According to Nadal, et al. (2015) on the revitalization of urban agriculture in the 1970s, allotments mattered to support the community and promote social cohesion. Various community movements have been cited as important to this revival - New York's Green Guerrilla, which bombards abandoned urban spaces with clay balls and seeds; "Urban Farms and Community Gardens" - a campaign in Europe that first appeared in the Netherlands and then spread to the UK.

From the end of the last century until now, urban gardening has been on the rise, due to the increased migration of people to large

cities and megacities, the need for fast delivery of fresh food, and the desire to self-satisfy needs, for health and social reasons. It is also developing in newer directions, especially in megacities where there is a shortage of land, looking for ways to produce on and in public and residential buildings, thus developing roof gardening, vertical gardening, etc. Some of the benefits of urban gardening are:

➔ Formation of mini-ecosystems in urban environments

Urban horticulture can provide an ideal platform for the formation of mini-ecosystems in urban environments. This is because plants and animals depend on each other for survival, and urban horticulture provides habitat and food for various species of wildlife, such as birds, insects, and small mammals. Additionally, urban horticulture can provide microclimates that support different types of plants, promote biodiversity, and conserve native species.

➔ Conservation of biodiversity in the cities

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Sustainable cities

Sustainable urban development is one of the goals of modern urban planning. Urban horticulture can contribute to sustainable cities by providing environmental, social, and economic benefits. It can reduce environmental problems like pollution, reduce the urban heat island effect, and improve air quality.

Bringing urban gardening closer to natural ecosystems is also obtained by recycling all waste and turning it into a resource. (Sousa and Batista, 2013).



Urban gardening can also serve as a platform to build communities, improve public health, and provide economic opportunity for urban residents.

Unit 1.3. Evolution and trends in urban horticulture

Milena Yordanova, Claudia Fabian,
Oana Venat, Roxana Ciceoi

Urban horticulture, a dynamic field at the intersection of agriculture, ecology, and urban planning, has undergone a remarkable evolution over the years. As cities continue to grow and face the challenges of sustainability, the trends in urban horticulture have adapted to address the complexities of urban environments. We can have a look at a comprehensive overview of the evolution and trends in urban horticulture, with a particular focus on biodiversity conservation and sustainable development in cities.



Evolution of Urban Horticulture

Urban horticulture has evolved significantly from its traditional roots as a means of local food production to a broader and more integrated approach within urban landscapes. Historically, community gardens and allotments were common, serving as spaces for individuals to cultivate their own produce. However, as urbanization intensified, these traditional practices faced challenges, leading to the emergence of innovative solutions. The evolution of urban horticulture represents a nuanced journey marked by a transformative shift from its initial role as a localized means of food production to a sophisticated, integrated approach

deeply woven into the fabric of urban landscapes. In tracing its historical roots, we find that community gardens and allotments once stood as commonplace manifestations of urban horticulture. These spaces served as sanctuaries where individuals could actively engage with the cultivation of their own produce, fostering a sense of self-sufficiency and community cohesion.

However, the intensification of **urbanization**, with its associated pressures of population density, land scarcity, and environmental challenges, posed formidable hurdles to these traditional horticultural practices. The burgeoning urban landscape demanded innovative solutions to reconcile the inherent conflict between the expanding urban footprint and the imperative to maintain green spaces. This critical juncture in the evolutionary trajectory of urban horticulture prompted a departure from conventional norms and spurred the emergence of novel approaches that could harmonize with the changing urban dynamics.

In response to these challenges, urban horticulture has undergone a paradigm shift, embracing technological advancements, scientific insights, and inventive methodologies to meet the demands of a rapidly urbanizing world. The evolution is marked by the incorporation of cutting-edge practices, such as hydroponics, aquaponics, and vertical

farming, which not only maximize the efficient use of limited urban space but also challenge the traditional notions of soil-based cultivation. These contemporary methods reflect the adaptability of urban horticulture, transforming it into a dynamic and forward-looking discipline.

Moreover, the evolution of urban horticulture is intricately linked to the increasing recognition of its multifaceted benefits beyond mere **food production**. It has evolved into a holistic approach that considers environmental sustainability, social well-being, and ecological resilience. The integration of green roofs, living walls, and urban forestry into urban planning exemplifies a shift toward creating aesthetically pleasing, environmentally responsible, and socially enriching urban spaces.

In essence, the evolution of urban horticulture stands as a testament to human ingenuity in the face of *urban challenges*. It is not merely a historical progression but an ongoing narrative of adaptation and innovation. As urban landscapes continue to evolve, urban horticulture is poised to play a pivotal role in **shaping sustainable, resilient, and livable cities**, where the coexistence of urban development and nature is not just a necessity but a harmonious reality.

In recent decades, the integration of technology and scientific advancements has revolutionized urban horticulture.

Techniques such as *hydroponics*, *vertical farming*, and *precision agriculture* have gained prominence, allowing for efficient use of limited urban space. Additionally, the adoption of in vitro plant multiplication methods has facilitated the conservation of plant biodiversity within urban settings.

Trends in Urban Horticulture

There are several key trends define the current landscape of urban horticulture:

Vertical Farming and green roofs

Vertical farming represents a revolutionary departure from traditional agricultural practices, embracing a three-dimensional approach to cultivation. In this method, crops are strategically grown in vertically stacked layers, often within controlled indoor environments. The utilization of vertical space allows for a substantial increase in crop yield per unit area, making it a highly efficient and space-saving solution. This trend has gained traction due to its potential to transform disused urban structures, such as warehouses or high-rise buildings, into productive agricultural hubs.

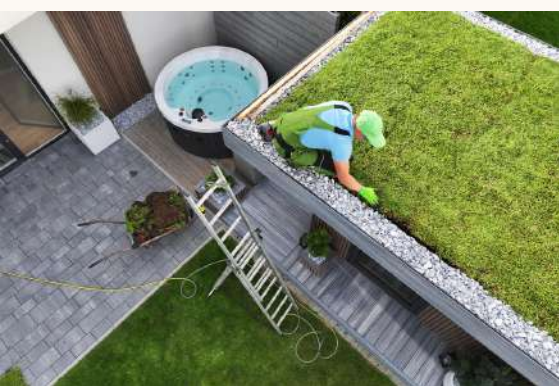
Beyond the sheer optimization of space, vertical farming contributes to resource efficiency and sustainability. Controlled environments facilitate precise control over factors like temperature, humidity, and light, minimizing water usage and

reducing the need for chemical inputs. Additionally, the proximity of vertical farms to urban centers reduces the carbon footprint associated with transportation, further aligning with the goals of environmentally conscious urban development.



Green roofs

Green roofs, an integral component of sustainable urban design, involve the cultivation of vegetation on building rooftops. This practice not only transforms conventional rooftops into aesthetically pleasing green spaces but also serves multiple ecological and functional purposes. Green roofs contribute to biodiversity by providing habitats for insects and birds, and they act as a natural insulation layer, reducing energy consumption for both heating and cooling. The implementation of green roofs goes beyond the aesthetic and environmental aspects; it has tangible benefits for the buildings and their occupants.



The layer of vegetation serves as a natural barrier, absorbing and filtering rainwater, thus mitigating urban runoff and enhancing water quality. Furthermore, the insulation provided by green roofs contributes to improved energy efficiency, reducing the urban heat island effect and providing a more comfortable microclimate within urban structures.



Together, vertical farming and green roofs represent a synergistic approach to maximizing the use of **vertical space in urban areas**. By stacking agricultural layers in vertical farms and cultivating green spaces atop buildings, these practices contribute to a harmonious integration of nature into the urban landscape. This approach not only optimizes land use but also addresses the pressing challenges associated with **population growth, food security, and environmental sustainability** in urban settings.

Community and rooftop gardens

Community gardens have become vibrant hubs within urban landscapes, perpetuating a sense of community engagement and contributing significantly to the sustainable cultivation of local produce. These communal spaces serve as more than just areas for planting and harvesting; they foster social cohesion, providing a shared platform for residents to connect, share knowledge, and collectively participate in the cultivation of fruits, vegetables, and ornamental plants. As these community gardens thrive, they become catalysts for neighborhood bonding, fostering a sense of ownership and pride among participants. Beyond the tangible benefits of local food production, community gardens often serve as educational centers, imparting valuable knowledge about horticulture, sustainability, and environmental stewardship to urban residents.

Community gardens have become vibrant hubs within urban landscapes, perpetuating a sense of community engagement and contributing significantly to the sustainable cultivation of local produce. These communal spaces serve as more than just areas for planting and harvesting; they foster social cohesion, providing a shared platform for residents to connect, share knowledge, and collectively participate in the cultivation of fruits, vegetables, and ornamental plants. As these community gardens thrive, they become catalysts for neighborhood bonding, fostering a sense of ownership and pride among participants. Beyond the tangible benefits of local food production, community gardens often serve as educational centers, imparting valuable knowledge about horticulture, sustainability, and environmental stewardship to urban residents.



Similarly, rooftop gardens represent an innovative approach to urban green spaces. By converting otherwise unused rooftop areas into lush gardens, urban planners and residents alike capitalize on the vertical potential of the cityscape. These elevated green spaces contribute significantly to urban biodiversity by providing habitats for birds, insects, and other pollinators. Moreover, rooftop gardens offer recreational sanctuaries, allowing residents to escape the concrete jungle and connect with nature. The aesthetic appeal of rooftop gardens, coupled with their positive impact on mental well-being, positions them as integral components in the creation of sustainable and resilient urban environments.

Both community and rooftop gardens align seamlessly with the escalating interest in fostering sustainable and resilient urban communities. These green spaces not only enhance the quality of life for residents but also contribute to the overall health of the urban ecosystem, addressing the multifaceted challenges associated with urbanization.

Biotechnological Interventions

The advent of biotechnological interventions has ushered in a new era in urban horticulture, offering unprecedented possibilities for cultivating crops that can withstand the unique stressors of urban environments. New production techniques have become indispensable tools in the development of plant varieties with enhanced resilience and adaptability.

The utilization of biotechnological interventions in urban horticulture addresses critical challenges such as limited space, pollution, and climate variability. By cultivating crops with enhanced resistance and adaptability, urban areas can achieve higher agricultural productivity while minimizing the environmental impact. This trend aligns with the imperative of developing resilient plant species that can contribute to sustainable food production in the face of urbanization and global environmental changes. As biotechnological advancements continue to evolve, they offer promising solutions to enhance the sustainability and productivity of urban horticulture.

Biodiversity conservation in Urban Horticulture

Urban horticulture serves as a critical instrument in the conservation of biodiversity within urban environments, elucidating a complex interplay between cultivated green spaces and the rich tapestry of plant life. Biodiversity, a cornerstone of ecological health, encompasses the variability among living organisms, encompassing genetic, species, and ecosystem diversity within a given habitat.

Green spaces as biodiversity habitats

Green spaces within urban landscapes, comprising parks, gardens, and urban forests, function as dynamic and multifaceted habitats nurturing a diverse spectrum of plant species. Biodiversity, scientifically characterized by its three

hierarchical levels - genetic, species, and ecosystem diversity - is fostered within these urban oases. Genetic diversity refers to the variety of genes within a species, species diversity encompasses the number of different plant species coexisting in a given area, and ecosystem diversity pertains to the variety of ecosystems present in the urban landscape. Scientifically quantifying biodiversity involves various metrics and indices. For instance, the **Simpson Diversity Index** evaluates the probability that two individuals randomly selected from a sample belong to the same species, providing insights into species dominance. The **Jaccard Index** measures the similarity between two different communities based on the presence or absence of species. These metrics, rooted in ecological science, help assess the health and resilience of urban biodiversity.

[Link here](#) for more information.

Local ecosystem support

The role of urban horticulture in supporting local ecosystems is inherently tied to the ecological services provided by green spaces. These services, scientifically recognized as ecosystem services, encompass processes and functions that directly or indirectly benefit human well-being. In the context of urban biodiversity, green spaces act as reservoirs of ecosystem services such as habitat provision, air and water purification, and climate regulation. Habitat provision within green spaces is crucial for maintaining biodiversity.

Habitat heterogeneity, a concept in ecology, emphasizes the importance of diverse habitats within an ecosystem, fostering varied niches for different species. The provision of multiple habitat types within urban green spaces contributes to a diverse plant assemblage, promoting a resilient and adaptable urban ecosystem.

Urban biodiversity conservation

The overarching aim of urban horticulture is to contribute to the conservation of biodiversity within urban settings. Scientifically, urban biodiversity conservation involves strategies to counteract the negative impacts of urbanization on plant diversity. These impacts include habitat fragmentation, pollution, and the introduction of invasive species. Urban horticulture mitigates these effects by creating interconnected green spaces, implementing sustainable landscaping practices, and promoting native plant species.

Sustainable cities development approach

The seamless integration of urban horticulture into the tapestry of sustainable cities represents a strategic and holistic response to the environmental challenges posed by rapid urbanization. This approach emphasizes the creation of green infrastructure, an integral component comprising trees, plants, and expanses of green spaces that serves multifaceted purposes in fostering a resilient and sustainable urban environment.



Green infrastructure for environmental mitigation

Green infrastructure functions as an **environmental mitigator**, countering the adverse effects of urbanization on air and water quality. The integration of trees and plants into urban landscapes contributes to the reduction of air pollution by acting as natural air filters, capturing pollutants and enhancing overall air quality. This is particularly crucial in densely populated urban areas where vehicular emissions and industrial activities often contribute to elevated pollution levels.

Moreover, green spaces play a pivotal role in mitigating water pollution by serving as natural stormwater management systems. Scientifically, this process, known as **phytoremediation**, involves the uptake and filtration of

pollutants by plants, reducing the impact of runoff on water bodies. Sustainable cities, recognizing the scientific efficacy of green infrastructure, prioritize the incorporation of these natural systems into urban planning to achieve tangible improvements in air and water quality.

Addressing urban heat island effect

The scientific phenomenon of the urban heat island effect, characterized by elevated temperatures in urban areas compared to their rural surroundings, is effectively countered through the strategic integration of green spaces. Trees provide shade and employ the scientific principle of evapotranspiration, releasing water vapor into the air, which has a cooling effect on the surrounding environment. By strategically planting trees and creating green spaces, sustainable cities actively employ this natural cooling mechanism to mitigate the urban heat island effect, ensuring a more temperate and comfortable urban climate.

Heat islands are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas. Daytime temperatures in urban areas are about 0.6–3.9°C higher than those in outlying regions, while nighttime temperatures are roughly 1.1-2.8°C higher. Find more information on the [Learn About Heat Islands](#) page.

Link [here](#)

Addressing urban heat island effect

Green infrastructure, in the context of urban horticulture, serves as an **ecological sanctuary** that promotes biodiversity within urban landscapes. Scientifically, biodiversity is crucial for ecological resilience, ensuring that urban ecosystems can adapt and thrive in the face of environmental changes. The inclusion of green corridors and interconnected green spaces, scientifically known to facilitate species movement and ecological connectivity, enhances the overall biodiversity of urban areas.

Sustainable urban planning, rooted in scientific principles, prioritizes the creation of green corridors that allow for the movement of plant and animal species across the urban landscape. The interconnectedness of these green spaces fosters a **diverse array of habitats**, promoting a **resilient urban ecosystem** capable of withstanding the challenges posed by urbanization.

More information in next Unit.

Holistic and resilient urban environment

The foundation of sustainable cities development through urban horticulture lies in the recognition of green infrastructure as a **multifunctional tool for environmental mitigation, temperature regulation, and biodiversity promotion**. The inclusion of green corridors and interconnected green spaces within urban planning embodies a holistic and resilient approach to urban development, acknowledging the interdependence of human well-being and the health of urban

ecosystems. This scientifically informed strategy paves the way for the creation of sustainable, adaptable, and harmonious urban environments.

In conclusion, the evolution of urban horticulture reflects a dynamic response to the challenges posed by urbanization. The trends in this field underscore the importance of integrating technological innovations, community engagement, and technological interventions to create sustainable and biodiverse urban landscapes. As cities continue to expand, adopting a comprehensive approach to urban horticulture is imperative for fostering resilient, healthy, and sustainable urban environments.



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Unit 1.4 Environment and climate change in urban areas

Liliana Bădulescu
Oana Venat

Definitions of environment.



The air, water, and land in or on which people, animals, and plants live;

The conditions that you live or work in and the way that they influence how you feel or how effectively you can work.

<https://dictionary.cambridge.org/dictionary/english/environment>



The natural world: the complex of physical, chemical, and biotic elements that exist in nature;



The circumstances, objects, or conditions by which one is surrounded: the factors and influences that affect the growth, health, progress, functioning, etc., of someone or something.

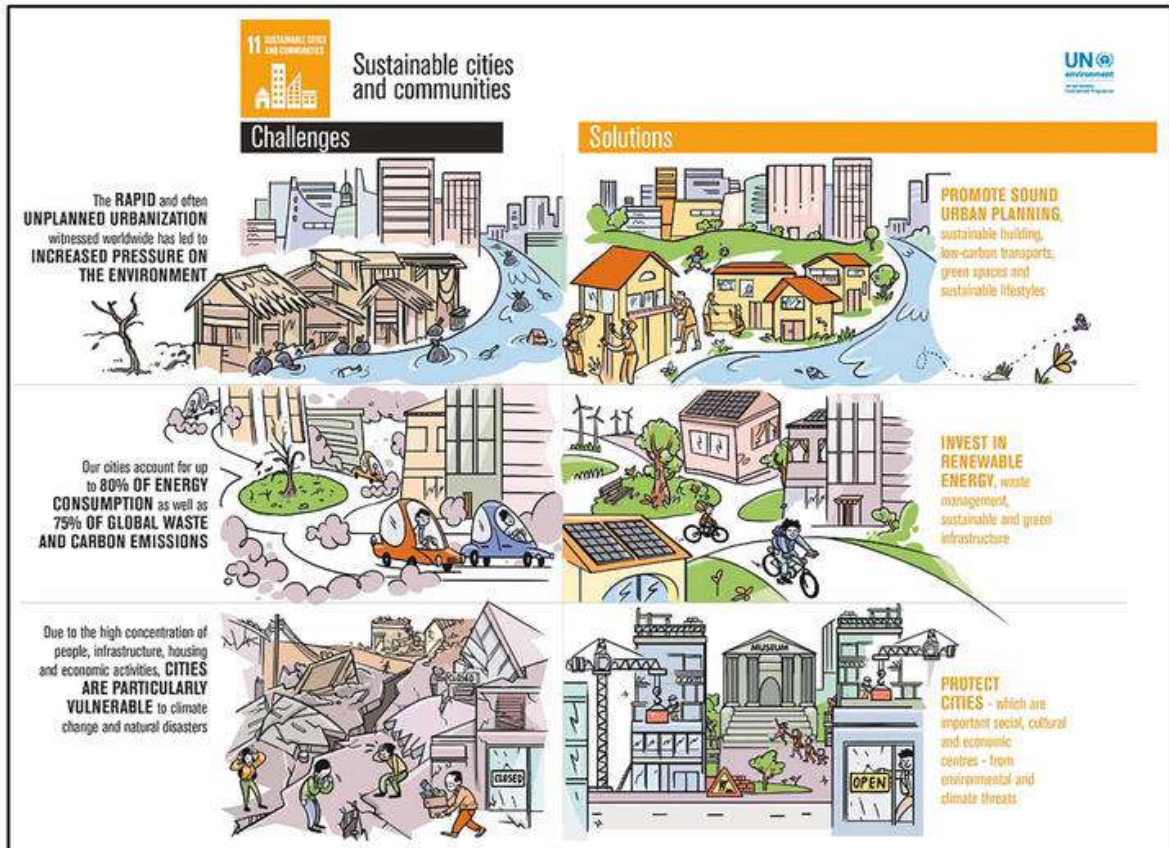
<https://www.merriam-webster.com/dictionary/environment>

The surroundings or conditions in which a person, animal, or plant lives or operates;



The natural world, as a whole or in a particular geographical area, especially as affected by human activity.

<https://languages.oup.com/google-dictionary-en/>



Hasan Rashed, A. (2023). The Impacts of Unsustainable Urbanization on the Environment. IntechOpen. doi: 10.5772/intechopen.110089
<https://www.intechopen.com/chapters/86023>



Key environmental issues in urban areas



Urban environmental issues stem from high population densities, including **air pollution** from vehicles and industry, inadequate **waste management** leading to **land and water contamination**, **water scarcity**, and **soil contamination**.



These issues are exacerbated by increased **energy consumption**, **urban sprawl**, runoff from **impervious surfaces**, and the **loss of natural habitats** and **biodiversity**.



Climate change, heatwaves, and flash floods further stress urban ecosystems.

What is the Urban Heat Island Effect?



 **Polypipe**

<https://middleeast.polypipe.com/blog/creating-green-benefits-urban-biodiversity>

Infographic: "What is the Urban Heat Island Effect?"
Polypipe Middle East Blog – Green Roofs and Landscaping in Arid Regions –
Is It Sustainable?

Retrieved from <https://middleeast.polypipe.com/blog/green-roofs-and-landscaping-arid-regions-%E2%80%93-it-sustainable>

Introduction to the Urban Heat Island (UHI) Effect

The Urban Heat Island (UHI) effect is a well-documented microclimatic phenomenon where urban areas exhibit higher temperatures than surrounding rural zones. This temperature disparity, typically ranging between 1–4 °C, arises primarily from **dense infrastructure, limited vegetation, and heat-absorbing materials** such as concrete and asphalt. The intensification of UHI contributes to increased energy demand, deteriorating air quality, and heat-related health risks, posing major challenges for urban sustainability (<https://www.mdpi.com/1999-4907/16/9/1450>)



Urbanization alters land use and surface characteristics, trapping solar radiation during the day and releasing it slowly at night. This thermal retention effect exacerbates nighttime heat and reduces natural cooling, particularly during heatwaves (https://www.nature.com/articles/s44284-024-00091-z.pdf?utm_source=consensus). Such microclimatic changes amplify urban vulnerability to climate change, necessitating adaptive and nature-based solutions.

The role of green infrastructure in mitigating UHI

Green infrastructure (GI) - encompassing urban trees, green roofs, vertical gardens, and green corridors - has emerged as one of the most effective nature-based strategies to counteract urban heat. GI mitigates UHI through shade provision, evapotranspiration, and increased surface albedo, thereby improving thermal comfort and reducing building cooling loads.

According to a pan-European study, urban vegetation can cool cities by an average of 1.07 °C, and up to 2.9 °C, depending on vegetation density and spatial distribution (<https://doi.org/10.1016/j.scs.2021.103564>.) Tree canopy coverage of at least 16% was found to reduce summer air temperatures by about 1 °C, making GI a quantifiable and scalable cooling tool.



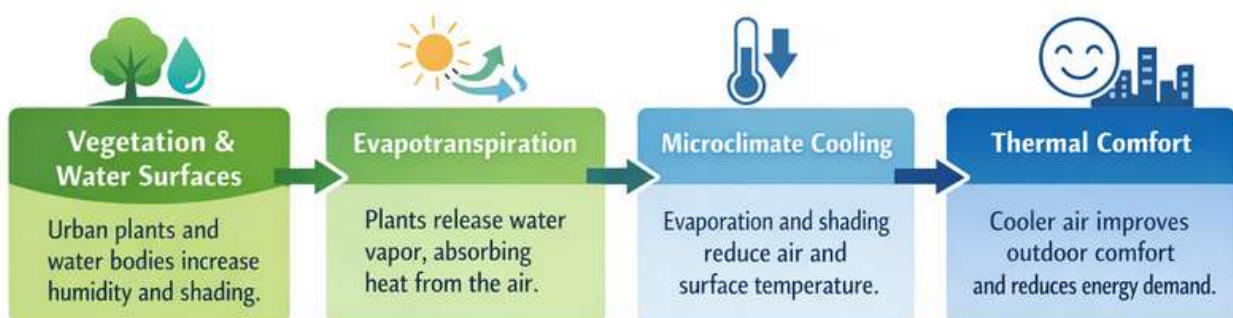
Recent research emphasizes that the integration of green roofs, facades, and urban forestry not only reduces surface temperatures but also improves air quality and human well-being.

Green roofs, for instance, have been shown to lower roof surface temperatures by up to 30-40 °C during peak summer, while reducing indoor temperatures by 4-11 °C (<https://doi.org/10.1038/s41598-024-60546-0>). Additionally, blue-green infrastructure (BGI) systems, combining vegetation and water bodies, can reduce air temperatures by up to 6 K through synergistic cooling effects. (<https://doi.org/10.3390/atmos16020134>).

Type of Infrastructure	Average surface temperature reduction	Cooling radius (local effect)
Urban trees & parks	2.0 - 3.0 °C	up to 300 m
Green roofs	4 - 11 °C (indoor temp)	building scale
Green walls	2 - 4 °C	façade/local
Blue-green systems (ponds + vegetation)	up to 6 °C	100 - 400 m
Community gardens	1 - 2 °C	50 - 100 m

Comparative cooling effectiveness of common green infrastructure types based on Visvanathan et al., 2024, Ming et al., 2025 and Balany et al., 2020.

How green infrastructure mitigates urban heat



*Simplified process of microclimate cooling through blue - green infrastructure.
(adapted from Ming et al., 2025)*

Urban horticulture as a climate-responsive strategy

Urban horticulture - through **community gardens, rooftop farms, and vertical greening** - forms a nodal subset of green infrastructure, offering both **microclimatic regulation** and **ecosystem service** enhancement. Plants used in horticultural systems contribute to **evapotranspiration, sequester CO₂**, and enhance **soil moisture retention**, all of which collectively mitigate UHI intensity.

Vegetation density and diversity are essential in optimizing cooling. Even small-scale urban gardens can reduce ambient temperatures locally by 1-2 °C and improve **thermal comfort indices** by **over 10 °C** under certain conditions (<https://doi.org/10.3390/su17031303>). In semi-arid regions, maintaining an optimal **green roof-to-ground green ratio** (GR/UGI ratio) of 0.0063 was associated with an average **air temperature reduction of 1.24 °C**, and a **surface temperature decrease of 4 °C** (<https://doi.org/10.4314/jfas.v13i1.12>).

Beyond temperature moderation, urban horticulture supports biodiversity, strengthens ecological connectivity, and fosters social resilience through community engagement – aligning with the principles of sustainable and climate-resilient urban development

(<https://doi.org/10.20944/preprints202009.0018.v1>).

Challenges and future directions

Despite the well-documented benefits, the widespread implementation of UHI mitigation strategies faces technical, economic, and governance challenges.

A major barrier remains the lack of legislative integration of green infrastructure into urban planning frameworks (<https://doi.org/10.3390/su151410767>).

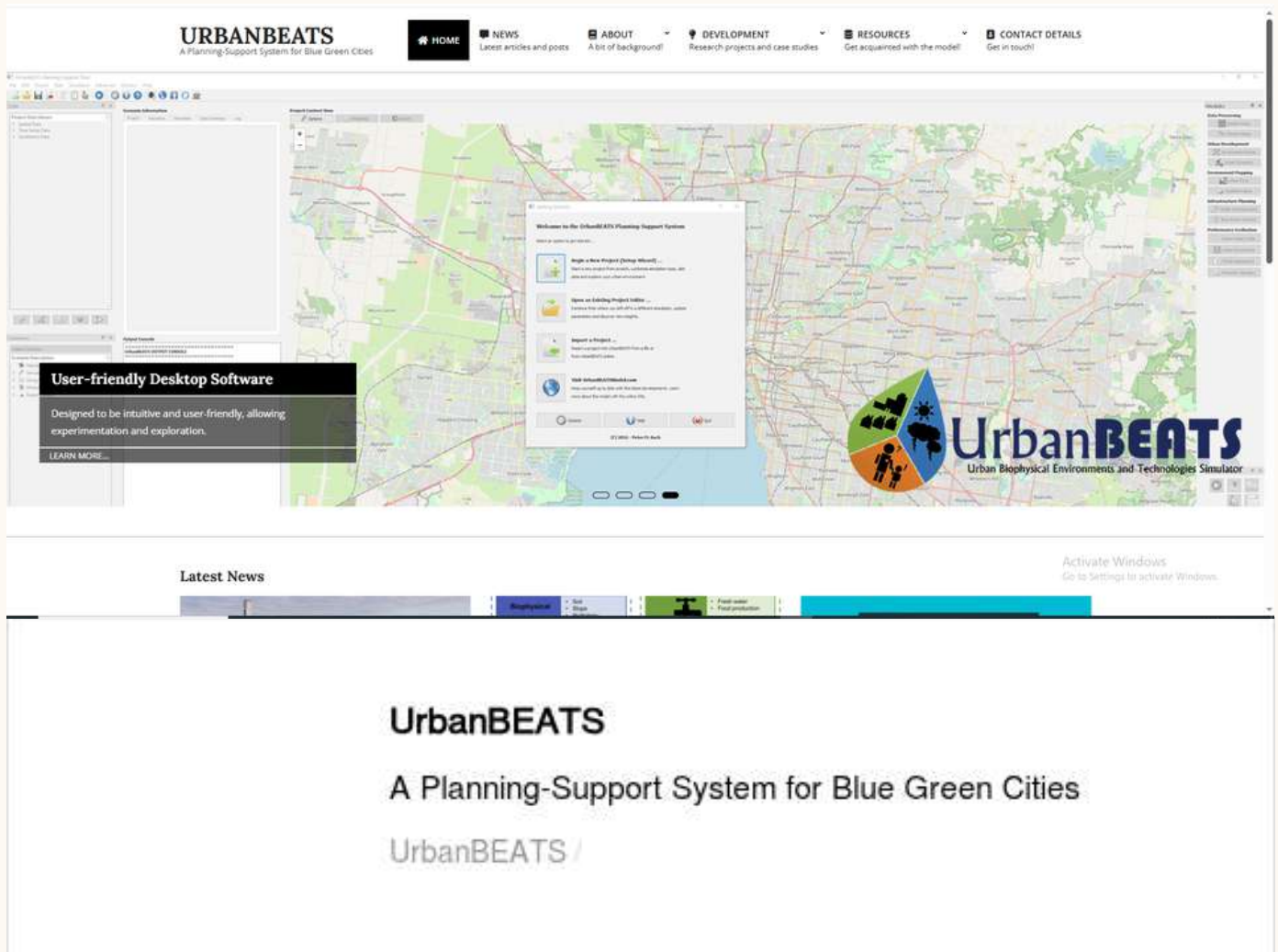
Furthermore, the maintenance costs of vegetation systems, especially in water-scarce regions, hinder long-term sustainability.

Emerging research trends focus on **AI-driven modeling tools** (e.g., **ENVI-met**, **UrbanBEATS**) that simulate thermal performance of vegetation and optimize spatial planting design (<https://cms.gnest.org/cest2023/p/cest202300287>).

Integration of citizen participation, environmental justice, and biodiversity metrics into future UHI studies is also expanding (<https://www.mdpi.com/1999-4907/16/9/1450>).



ENVI-met is a leader in holistic 3D modelling software with a focus on urban cooling and climate adaptive urban planning. As pioneers in sustainable urban development, our mission is to address the challenges of climate change.



The Urban Biophysical Environments and Technologies Simulator (UrbanBEATS) is an integrated modelling tool designed to support the planning of sustainable, liveable and resilient cities. With the ongoing challenges of urbanisation and population growth, climate change, biodiversity loss and, more recently, the SARS-CoV-2 pandemic, cities are facing a growing list of challenges to adapt. It is widely recognised that solutions in cities can no longer be mono-functional.

Key Environmental Issues in Urban Areas

Air Pollution

Primarily caused by vehicle emissions, industrial activities, and energy production, leading to poor air quality, increased greenhouse gas emissions, and respiratory health problems among urban populations.

Water Pollution

Results from untreated sewage, industrial discharges, and stormwater runoff carrying oil, heavy metals, and nutrients into surface and groundwater systems, affecting water quality and aquatic ecosystems.

Waste Management

The accumulation of solid and hazardous waste and the lack of proper disposal systems lead to land and water contamination, contributing to greenhouse gas emissions and public health risks.

Water Scarcity

High population density, urban expansion, and inefficient water use can deplete groundwater reserves, especially in arid regions, resulting in water shortages and increased vulnerability during droughts.

Soil and Land Degradation

Urban sprawl and deforestation degrade soil fertility, increase erosion, and contribute to habitat loss and land contamination through excessive sealing (impermeable surfaces) and construction.

Key Environmental Issues in Urban Areas

Noise Pollution

Heavy traffic, industrial zones, and dense population create elevated noise levels, which disrupt sleep patterns, increase stress, and reduce overall quality of life in cities.

Urban Heat Island Effect

Cities are often significantly warmer than surrounding rural areas due to heat-absorbing surfaces (concrete, asphalt) and reduced vegetation, intensifying heatwaves and increasing energy demand for cooling.

Key Takeaway

Urban areas face multiple, overlapping environmental challenges that are both causes and consequences of unsustainable urbanization.

Addressing them requires integrated solutions that combine:

-  Green infrastructure for cooling and air purification;
-  Sustainable water management;
-  Efficient waste and land-use planning;
-  Low-emission transportation and clean energy;

These strategies form the foundation of urban resilience and environmental sustainability.

Contributing factors to environmental issues in urban areas

Urban areas concentrate over half of the global population and account for nearly three-quarters of resource consumption and carbon emissions. This intense clustering of human activity creates environmental pressures that manifest as air and water pollution, waste accumulation, biodiversity loss, and urban heat island effects.

Recent research shows that population growth, urban sprawl, industrialization, and inefficient resource use act as interlinked forces amplifying these challenges (<https://doi.org/10.1088/1748-9326/ab7640>). These factors do not act in isolation - they reinforce one another through feedback loops that deepen urban ecological stress. As cities expand both horizontally and vertically, natural land is converted to impermeable surfaces, reducing water infiltration, raising ambient temperatures, and altering local climate dynamics. Meanwhile, industrial and energy systems dependent on fossil fuels further accelerate air pollution and greenhouse gas emissions (<https://doi.org/10.32479/ijeep.10366>).

Key Contributing Factors

A. High population density

Rapid population growth in urban centers increases the demand for housing, water, energy, and sanitation services. This concentration intensifies resource consumption and waste generation, resulting in air and water pollution and overburdened municipal systems. High population density also elevates energy demand, particularly for transportation and cooling,

thereby heightening CO₂ emissions (<https://doi.org/10.1177/01445987241252453>). Without parallel infrastructure expansion and governance, cities face deteriorating living conditions and reduced air quality.

B. Urban sprawl

Urban sprawl - the unplanned outward expansion of cities - consumes agricultural and natural land, increases reliance on cars, and contributes to flooding through the proliferation of impermeable surfaces. It leads to higher energy use, longer commuting distances, and fragmented ecosystems, undermining both environmental and social cohesion. Research shows that compact, mixed-use development can reduce sprawl-related emissions by up to 25% and preserve green infrastructure that supports biodiversity (<https://doi.org/10.36948/ijfmr.2023.v05i04.5645>; <https://doi.org/10.4172/2165-784x.1000290>).



Los Angeles

C. Inadequate infrastructure

Deficient urban infrastructure - particularly in waste management, sanitation, and transport - amplifies pollution and reduces environmental quality. Poorly designed drainage and waste disposal systems lead to water contamination and vector-borne diseases, while insufficient public transport increases traffic congestion and emissions. Lack of green spaces and stormwater management further heighten the urban heat island and flood risks (<https://doi.org/10.1051/e3sconf/202124401008>). Investing in sustainable, climate-resilient infrastructure is essential to break this degradation cycle.

D. Industrialization and energy consumption

Industrial production and fossil-fuel-based energy systems remain primary drivers of urban pollution and greenhouse gas emissions. Heavy industries release particulates, sulfur oxides, and other pollutants into air and water systems. Simultaneously, high energy consumption - particularly in transport and manufacturing - accelerates carbon accumulation in the atmosphere. The carbon-intensive growth model of many cities deepens climate vulnerability and resource depletion. Transitioning toward renewable energy, energy-efficient technologies, and circular economy practices is crucial for mitigation.

(<https://doi.org/10.52223/jess.2024.5113>;
<https://doi.org/10.52131/pjhss.2023.v11i4.1994>).

E. Urban governance and policy gaps

Weak environmental governance, fragmented planning, and lack of enforcement exacerbate environmental problems. Rapid urban growth often outpaces policy capacity, leading to informal settlements, inadequate services, and poor waste management. Governance deficiencies limit the integration of climate adaptation measures into urban plans, undermining resilience and sustainable growth. Recent studies confirm that aligning urban policies with environmental, social, and governance (ESG) principles significantly enhances urban sustainability outcomes, yet persistent gaps in institutional coordination and enforcement remain. Empirical evidence from South and Southeast Asia shows that climate adaptation policies are often undercut by limited interagency cooperation, inadequate data use, and poor financing mechanisms, weakening their implementation. Similarly, multi-level governance frameworks emphasizing stakeholder participation and institutional learning have been shown to improve climate resilience and environmental management efficiency.

(<https://doi.org/10.9734/ijecc/2023/v13i113531>;<https://sci-hub.se/10.1002/sd.2407>; <https://doi.org/10.3390/land14040890>.)

Effective solutions therefore require cross-sector coordination, participatory governance, and long-term investment in sustainability frameworks that bridge local implementation with national and global climate goals.

F. Socio-economic inequality

Urban environmental issues are unevenly distributed. Low-income communities often live in highly polluted, flood-prone, or heat-exposed areas, lacking access to clean air, water, and green space. This spatial inequality reflects the link between poverty and environmental degradation, where marginalized groups bear the greatest health burdens (<https://doi.org/10.36948/ijfmr.2024.v06i03.20366>). Urban environmental justice must therefore be integrated into sustainability agendas, ensuring equitable access to healthy and safe environments.



Video Link [here](#)

Impacts of environmental issues in urban areas

Environmental challenges in cities generate far-reaching consequences for human health, ecosystem stability, and resource security.

As urbanization intensifies, pollution, heat stress, and ecosystem degradation interact to threaten public well-being and undermine sustainable development goals.

Recent studies highlight that air pollution, contaminated water, and heat exposure are among the leading environmental health risks in urban environments, collectively responsible for millions of premature deaths annually.

In addition, the expansion of impermeable surfaces and loss of green cover accelerate biodiversity loss, strain natural resources, and intensify climate-related hazards such as floods and droughts.

The impacts are multidimensional: environmental degradation affects air and water quality, reduces urban livability, and exacerbates social inequalities.

Communities in marginalized or informal urban areas face disproportionate exposure to pollution, limited access to clean resources, and higher vulnerability to environmental hazards.

Impacts

- 🏥 Health problems: poor air and water quality lead to respiratory, cardiovascular, and infectious diseases; heat stress increases vulnerability.
- 🐝 Biodiversity loss: habitat destruction and pollution reduce species diversity and disrupt ecosystem balance.
- 💧 Strain on natural resources: growing demand for water, land, and energy intensifies depletion and threatens sustainability.
- ⚡ Economic and social effects: reduced productivity, higher health costs, and deeper inequalities in urban populations.
- 🌡️ Climate feedbacks: pollution and land-use changes amplify greenhouse gas emissions and urban heat island effects.



Environment increase of biodiversity

Biodiversity in urban areas represents the variety of living organisms - **plants, animals, fungi, and microorganisms** - that coexist within cities and their surrounding landscapes.

Urbanization often leads to **habitat fragmentation, pollution, and species loss**, but evidence shows that cities can also serve as biodiversity refuges when planned with ecological principles.

Integrating nature into cities enhances ecosystem services such as **air purification, temperature regulation, and mental well-being**, contributing to healthier and more resilient urban environments.

([https://doi.org/10.1007/978-94-007-7088-1_11](https://doi.org/10.1007/978-94-007-7088-1_11;);
<https://doi.org/10.3389/frsc.2023.1281430>;
<https://doi.org/10.1111/ecog.07366>).

Benefits of urban biodiversity

Social benefits

Improved public health and well-being: regular contact with green spaces reduces **stress, anxiety, and cardiovascular risks**.

Enhanced community cohesion: urban gardens and parks foster social interaction and environmental awareness.

Recreational value: access to biodiversity-rich areas supports outdoor activities and quality of life

Environmental benefits

Improved air quality: vegetation filters pollutants and absorbs CO₂.

Cooling effect: green areas mitigate the urban heat island (UHI) effect, lowering local temperatures by 2–8°C.

Water regulation: trees and soil vegetation enhance infiltration and reduce flood risks.

Habitat support: native species and ecological corridors maintain local fauna populations

Economic benefits

Higher property values: access to green infrastructure can increase land value by 5–20%.

Reduced energy costs: shade trees and vegetated surfaces reduce cooling demands in buildings.

Urban tourism and recreation: biodiverse green spaces attract visitors and stimulate local economies

Urban biodiversity also acts as a natural buffer against climate change impacts. Vegetation moderates microclimates, sequesters carbon, and improves stormwater absorption, linking ecological restoration directly to climate resilience. Integrating biodiversity into climate policies enhances urban adaptability and ecosystem functionality.

The Passionate Pursuit of Biodiversity in Urban Areas

As urbanisation increases on a global scale, loss of biodiversity is becoming a growing issue.



 **Polypipe**

<https://middleeast.polypipe.com/blog/spreading-green-5-benefits-urban-biodiversity>

<https://middleeast.polypipe.com/blog/spreading-green-5-benefits-urban-biodiversity>

Climate change in urban areas

Climate change adaptation in urban areas refers to the process of designing and managing cities to withstand rising temperatures, extreme rainfall, and resource scarcity. The IPCC AR6 (2023) identifies cities as critical arenas for climate mitigation, emphasizing compact design, renewable energy transitions, and ecosystem-based adaptation. International frameworks such as the Paris Agreement and the EU Green Deal encourage the integration of green infrastructure and circular economy principles into urban planning.

By 2023, the global average temperature had risen by 1.1°C above pre-industrial levels, and the year became the warmest on record, according to the IPCC 2023 Synthesis Report. Cities - which occupy less than 3% of Earth's land area - are responsible for nearly 75% of global CO₂ emissions and house over 56% of the world's population

<https://doi.org/10.1111/padr.12632>;
<https://supforclimate.com/sup-volume-3/>



This concentration of **people, infrastructure, and energy** demand makes urban areas both major drivers and primary victims of climate change. **Rising temperatures, erratic rainfall, and extreme weather** events are reshaping how cities function. For instance, the **Nature Communications global flood model** projects that urban flood exposure will increase by 33% by 2100, primarily in low-income regions. Meanwhile, prolonged heat waves are already causing **up to 50% higher mortality rates** in dense urban centers compared to surrounding rural zones, driven by the urban heat island effect.

<https://doi.org/10.1038/s41467-025-56654-8>.
<https://doi.org/10.1007/s00704-015-1658-9>.

The vulnerability of cities is not only environmental but also social.

The IPCC emphasizes that the poorest 10% of the global population contribute less than 5% of greenhouse emissions, yet they face disproportionate climate impacts, including water scarcity, air pollution, and displacement.

At the same time, new data highlight that cities could be at the forefront of climate solutions.

Urban green and blue infrastructure, nature-based solutions, and low-carbon energy systems have the potential to reduce urban emissions by up to 50% by 2050, while improving quality of life and resilience.

IPCC?

The Intergovernmental Panel on Climate Change (IPCC) is the UN body responsible for assessing climate science and guiding global policy responses. Established in 1988, it provides periodic assessment reports that summarize current knowledge on climate change, its impacts, and strategies for mitigation and adaptation.

<https://doi.org/10.3197/jps.63799953906870>; <https://doi.org/10.56261/built.v22.251630>;
<https://doi.org/10.1038/s41893-022-01036-x>.
https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

Key global facts

 2023 was the warmest year on record, with global average temperature ~1.45 °C above pre-industrial levels.

 Urban areas contribute a majority (~ two-thirds) of global CO₂ emissions.

Key global facts

 Climate change is increasing the frequency and intensity of extreme weather events, including heatwaves and floods, which disproportionately affect cities (variable estimates depending on region and model).

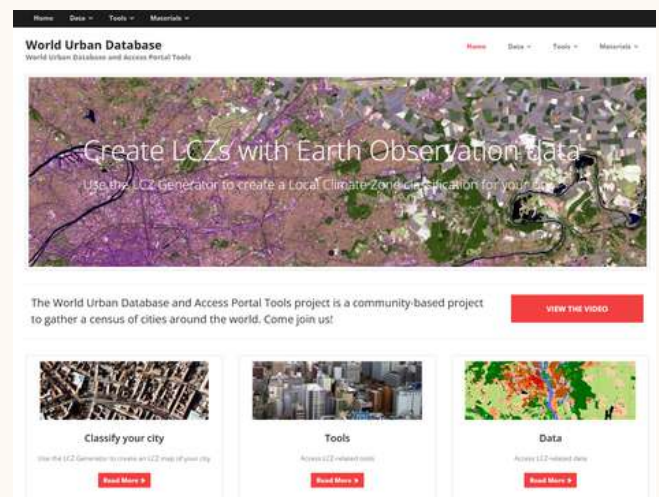
 The urban heat island effect can substantially amplify local temperatures compared with surrounding non-urban areas (case studies typically report +2 °C or more).

 Vulnerability to climate impacts is unevenly distributed, with low-income urban populations often at greatest risk (IPCC and social science assessments).

Emerging research and innovation in urban climate adaptation (2022–2025)

a) Technological innovation: AI and modeling systems

Modern urban adaptation relies increasingly on AI-based environmental simulations and high-resolution mapping platforms: WUDAPT (**World Urban Database and Access Portal Tools**) provides standardized urban morphology data for climate impact modeling. Integration of machine learning enhances predictive accuracy for urban heat islands, allowing targeted green infrastructure interventions.



<https://doi.org/10.37256/gbce.4120232287>

b) Nature-based solutions (NbS) and ecological urbanism

NbS are central to current adaptation research. Models show that green corridors, permeable surfaces, and blue-green systems can reduce air temperatures by 4 - 6 °C and improve stormwater absorption by 30%.

- Studies using ENVI-met confirm that tree shading and water features significantly lower the Physiological Equivalent Temperature (PET), improving thermal comfort in dense cities.
- At the urban planning scale, climate-responsive models guide master plans integrating NbS in European cities such as Verona and Lahti

<https://doi.org/10.3390/su13126851>;

<https://doi.org/10.3390/urbansci9050152>;

<https://doi.org/10.3390/atmos16020146>;

Insight: NbS not only mitigate heat but also enhance biodiversity, social well-being, and landscape aesthetics - positioning urban horticulture as a climate adaptation tool.

c) Smart materials and sustainable infrastructure

Innovation extends beyond greenery into AI-driven material science. Integration of machine learning with smart materials (e.g., self-healing concrete, thermochromic façades, phase-change materials) increases energy efficiency by 18–35% and reduces maintenance-related emissions

Insight: Smart infrastructure complements NbS by regulating thermal mass and albedo, creating hybrid urban systems that respond dynamically to heat and moisture fluxes.

<https://doi.org/10.7717/peerj-cs.3042>;

<https://doi.org/10.1016/j.jclepro.2022.134203>.

d) Citizen science and participatory adaptation

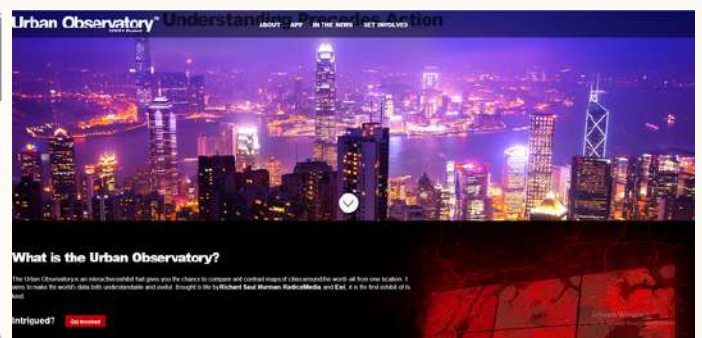
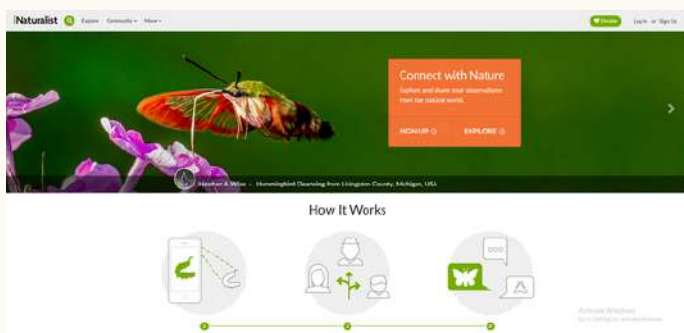
Recent work underlines the value of citizen engagement in climate monitoring and co-design.

- A 2025 study in Pune (India) and Cologne (Germany) used community-installed sensor networks to validate ENVI-met microclimate data and foster local awareness of adaptation measures (Eingrüber et al., 2025, <https://doi.org/10.5194/jsss-14-13-2025>).
- Participatory data collection not only improves spatial accuracy but builds public ownership of adaptation projects.

Insight: Citizen science bridges the gap between expert modeling and real-world resilience, ensuring equitable, context-sensitive adaptation outcomes.

Citizen science platforms (e.g., iNaturalist, Urban Observatory) crowdsource biodiversity and temperature data.

Participatory design engages residents in co-creating green spaces, especially in climate-vulnerable neighborhoods.



Unit 1.5 Interdisciplinary nature of urban horticulture

Oana Venat, Florin Stănică
Arzu Aydar, András Szekacs

The interdisciplinary nature of urban horticulture is a dynamic and multifaceted concept that underscores the integration of various fields and knowledge domains in the cultivation and management of plants within urban settings. Unlike traditional horticulture that often focuses on rural or agricultural contexts, urban horticulture extends its scope to address the unique challenges and opportunities presented by the urban environment.

Urban horticulture collaborates closely with urban planners and designers to optimize the layout of green spaces, parks, and gardens within urban landscapes. Through thoughtful design, it seeks to enhance the aesthetic appeal of urban areas, promote community well-being, and contribute to the overall quality of life for urban residents. Environmental science provides a critical analytical framework for assessing the ecological implications of urban horticulture. As an inherently interdisciplinary field, it examines how urban green spaces function as regulatory components within cities, contributing to the mitigation of air and water pollution, the attenuation of urban heat island effects, and the maintenance of biological diversity. Through the integration of ecological

assessment, environmental monitoring, and sustainability principles, environmental scientists support the alignment of urban horticultural practices with long-term environmental resilience and responsible urban development.

Urban horticulture also intersects with sociology by addressing community participation, social cohesion, and the strengthening of local food systems. Through collaboration with sociologists and community development specialists, urban horticultural initiatives are designed as inclusive spaces that encourage shared responsibility and local engagement. Community gardens function not only as sites of plant cultivation, but also as platforms for social interaction, informal learning, and collective empowerment.

The link between urban horticulture and public health constitutes a significant interdisciplinary connection. Access to urban green spaces is consistently associated with improved mental health, reduced stress levels, and enhanced physical well-being. In this context, public health professionals collaborate with urban horticulturists to design green spaces that contribute measurably to the overall health of urban populations.

Landscape architects play a central role in shaping the physical form and structure of urban horticulture projects. Their expertise in spatial organization, plant selection, and aesthetic coherence supports the creation of green spaces that are both functional and visually integrated within the urban landscape.

The interdisciplinary nature of urban horticulture is reflected in educational programs and research initiatives that draw from diverse fields. Academic institutions bring together expertise from botany, ecology, sociology, and other disciplines to train professionals capable of addressing the complex challenges of urban horticulture. Ongoing research explores innovative approaches to enhance the sustainability and effectiveness of urban horticulture practices

The economic aspects of urban horticulture involve considerations of resource allocation, cost-benefit analysis, and the economic impact of green spaces on property values. Collaboration with economists and urban development experts helps optimize the use of resources and demonstrates the economic value of incorporating horticultural elements into urban planning.

In essence, the interdisciplinary nature of urban horticulture encapsulates a collaborative approach that goes beyond traditional disciplinary boundaries. By integrating knowledge from diverse fields, urban horticulture aims to create **resilient, sustainable, and livable urban environments** that benefit both the ecological landscape and the well-being of urban communities.

Conceptual and scientific foundations

Urban horticulture cannot be defined as a reduced-scale version of conventional horticulture. It represents a fundamentally interdisciplinary field, positioned at the intersection of plant sciences, environmental sciences, engineering, social sciences and public policy. The urban context imposes a convergence of biological, ecological, technological and socio-economic constraints, transforming urban horticulture into a complex socio-ecological-technical system.

From a biological perspective, urban horticulture relies on plant physiology, crop ecology, adaptive genetics and plant–environment interactions. Urban environments are characterized by heat island effects, atmospheric pollution, anthropogenically altered soils, limited water availability and spatial fragmentation. These factors significantly modify plant physiological processes, including photosynthesis, respiration, transpiration, nutrient uptake and the accumulation of primary and secondary metabolites.

In parallel, urban horticulture is deeply embedded in urban ecology. Cultivated plants coexist with spontaneous vegetation, soil microbiota, insects and urban wildlife. As a result, horticultural production in cities cannot be dissociated from ecosystem services such as microclimate regulation, carbon sequestration, stormwater retention, biodiversity support and human well-being.

Urban horticultural systems therefore function simultaneously as food-producing units and ecological infrastructures.

The interdisciplinary nature of urban horticulture also reflects the need to integrate quantitative analytical methods. Assessment of yield, nutritional quality, phytochemical composition and environmental impact requires analytical chemistry, statistics, data science and harmonised methodologies. This analytical dimension is essential for evidence-based decision-making in urban food systems.

Discipline	Primary contribution to urban horticulture
Plant physiology	Plant responses to abiotic stress (heat, drought, pollution)
Urban ecology	Plant–soil–microbiome–fauna interactions
Genetics and breeding	Selection of cultivars adapted to urban environments
Soil science	Management of anthropogenic soils and artificial substrates
Environmental sciences	Ecosystem services and pollution mitigation
Food chemistry and nutrition	Nutritional and functional quality of urban produce
Statistics and data analysis	Interpretation and comparability of results

This multidimensional integration makes urban horticulture both an applied and experimental field, where scientific knowledge is continuously tested under real-world, highly variable conditions.

Technological and engineering interfaces in urban horticulture

A defining component of the interdisciplinary nature of urban horticulture is the integration of engineering and advanced technologies into plant production systems. Urban space constraints limit access to natural soils and drive the development of alternative cultivation systems, including substrate-based cultivation, hydroponics, aeroponics, aquaponics and vertical growing systems.

These systems require a solid understanding of engineering principles, physics and chemistry. Environmental parameters such as light intensity and spectrum, temperature, humidity, nutrient composition and water flow must be precisely controlled. This has led to the adoption of sensors, automated monitoring systems and feedback-controlled environments, positioning urban horticulture within the broader framework of precision agriculture and controlled-environment agriculture. At the same time, urban horticulture serves as a bridge between plant biotechnology and local food production.

At the same time, urban horticulture serves as a bridge between plant biotechnology and local food production. Techniques such as in vitro propagation, clonal selection, use of elicitors to enhance bioactive compounds, and stress priming are increasingly transferred from laboratory research to urban pilot systems and commercial applications. approaches enable both yield optimisation and targeted improvement of nutritional and functional traits. Urban horticultural systems also interact with architecture and urban planning.

Systems	Disciplines involved
Soil-based urban gardens	Horticulture, soil science, urban ecology
Substrate-based systems	Material science, plant nutrition
Hydroponic systems	Plant physiology, chemistry, fluid mechanics
Vertical farming	Engineering, automation, plant biology
Rooftop horticulture	Architecture, structural engineering, horticulture
Aquaponics	Ecology, aquaculture, plant nutrition

Rooftop gardens, green walls and productive landscapes must comply with structural, safety and regulatory constraints. As a result, collaboration between horticulturists, engineers and architects is essential to ensure technical feasibility, sustainability and long-term performance.

Socio-economic, nutritional and policy dimensions of urban horticulture

Beyond biological and technological aspects, urban horticulture is intrinsically linked to social sciences, economics and public policy. Urban food production systems influence food security, dietary diversity, public health and social cohesion. Their performance must therefore be evaluated not only in terms of yield, but also accessibility, equity and societal impact.

From a nutritional perspective, urban horticulture contributes to the availability of fresh, minimally processed fruits, vegetables and herbs. Nutritional composition is influenced by cultivar choice, growing conditions, substrate composition and environmental stressors. Interdisciplinary collaboration between horticulturists, nutritionists and analytical chemists is essential to ensure accurate assessment and interpretation of nutritional data.

Urban horticulture also plays a role in education, community engagement and behavioural change. Community gardens, school gardens and living laboratories function as platforms for knowledge transfer, citizen science and awareness-raising regarding sustainable food systems. These social dimensions require input from sociology, education sciences and behavioural economics. At the policy level, urban horticulture intersects with urban planning, environmental regulation, food safety legislation and sustainability strategies. Harmonisation of methodologies, terminology and data reporting is necessary to align urban horticultural research and practice with international frameworks such as EFSA guidelines, ISO standards and sustainable development policies.

Dimension	Key aspects
Nutrition and public health	Dietary quality, micronutrient availability
Socio-economic factors	Accessibility, community resilience, local economies
Education and outreach	Knowledge transfer, citizen engagement
Urban planning	Land use, green infrastructure integration
Policy and regulation	Food safety, sustainability standards



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References

- Agrios, G. N. (2005). Plant pathology. Academic Press.)In conclusion, urban horticulture, stands as a dynamic discipline that harnesses cutting-edge techniques to address urban challenges.
- Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education*, 40(2), 15-38.)
- Cilliers, S. S., Siebert, S. J., & Du Preez, D. R. (2013). Green infrastructure: A landscape-based approach for enhancing urban planning for biodiversity. *Infrastructure Planning Review*, 30(1), 51-66.)
- Ellis, E. C., & Ramankutty, N. (2008). Putting people in the map: anthropogenic biomes of the world. *Frontiers in Ecology and the Environment*, 6(8), 439-447.
- Francis, M., & Chadwick, M. J. (2013). Urban horticulture and human wellbeing: A typology and evaluation of the therapeutic and community benefits. *Journal of Applied Horticulture*, 15(2), 103-110.)
- Heywood, V. H. (2011). Why conserve biodiversity? In *Biodiversity conservation* (pp. 1-19). Springer.
- Keniger, L. E., et al. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health*, 10(3), 913-935.)
- Kowarik, I. (2011). Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution*, 159(8-9), 1974-1983.
- Kuo, F. E., & Sullivan, W. C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior*, 33(3), 343-367.)
- Kuo, M. (2015). How might contact with nature promote human health? Promising mechanisms and a possible central pathway. *Frontiers in Psychology*, 6, 1093. doi:10.3389/fpsyg.2015.01093
- McClintock, N., et al. (2016). From industrial garden to food desert: Unearthing the root structure of urban agriculture in Oakland, California. *Environmental Planning A*, 48(8), 1490-1512.)
- McPherson, E. G., et al. (2016). A framework for urban forest ecosystem services, carbon storage, and management in the United States. *Urban Forestry & Urban Greening*, 23, 11-22.
- Nowak, D. J., et al. (2013). Urban trees and forests of the Chicago region. Resource Bulletin NRS-84. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.)

- Nowak, D. J., et al. (2013). Urban trees and forests of the Chicago region. Resource Bulletin NRS-84. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.)
- Nowak, D. J., et al. (2018). Effects of urban tree management and species selection on atmospheric carbon dioxide. *Journal of Arboriculture & Urban Forestry*, 44(4), 183-193.
- Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society*, 108(455), 1-24.
- Resh, H. M. (2012). *Hydroponic food production: A definitive guidebook for the advanced home gardener and the commercial hydroponic grower*. CRC Press.)
- Smit, J., et al. (2000). Urban agriculture for sustainable cities: Using wastes and idle land and water bodies as resources. *Environment and Urbanization*, 12(2), 141-152.)
- Smith, P., & Jones, A. B. (2018). *Urban Horticulture: Ecology, Landscape, and Agriculture*. Routledge.
- Tester, M., & Langridge, P. (2010). Breeding technologies to increase crop production in a changing world. *Science*, 327(5967), 818-822.
- Thompson, K., et al. (2003). Urban domestic gardens (IV): the extent of the resource and its associated features. *Biodiversity and Conservation*, 12(12), 2293-2318.)
- Wakefield, S., Yeudall, F., Taron, C., Reynolds, J., & Skinner, A. (2007). Growing urban health: Community gardening in South-East Toronto. *Health Promotion International*, 22(2), 92-101.)
- Corrêa, C. J. P., Tonello, K. C., Nnadi, E., & Rosa, A. G. (2020). Seeding the city: History and current affairs of urban agriculture. *Ambiente & Sociedade*, 23.
- Dobele, M., & Zvirbule, A. (2020). The concept of urban agriculture—Historical development and tendencies. *Rural Sustainability Research*, 43(338), 20-26.
- Grewal, P. S., & Grewal, S. K. (2012). Can cities become self-reliant in food? *Cities*, 29(S1), S1-S11.
- Nadal, A., Cerón Palma, I., Cuerva Contreras, E., Gabarrell Durany, X., Josa Garcia-Tornel, A., Rieradevall Pons, J., ... & Sanyé-Mengual, E. (2015). Urban agriculture in the framework of sustainable urbanism. *Temes de disseny*, (31), 92-103.
- Orsini, F., Smith, J., & Gianquinto, G. (2013). Urban agriculture in the developing world: A review. *Agronomy for Sustainable Development*, 33(4), 695-720.
- Ramalho, R., & Adélio, J. (2016). *Urban agriculture and sustainable cities: Growing food on rooftops and vertical gardens*. Springer.



Selmi, W., & Khiari, R. (2017). The contribution of urban horticulture to sustainable urban development: The case of the city of Tunis, Tunisia. Sustainability, 9(11), 2095.

Sousa, R., & Batista, D. (2013). Urban agriculture: The allotment gardens as structures of urban sustainability. InTech.

Veen, E. J., Lacin, B., & Veen, E. G. (2016). Urban agriculture as a strategy for sustainable urban development: A review. Sustainability, 8(7), 1-17.

FAO. (2019). Biotechnologies for Agricultural Development. Retrieved from <http://www.fao.org/3/ca4686en/ca4686en.pdf>

<https://assignmentpoint.com/history-urban-gardening/>

<https://communitygardenersmc.org/2018/06/30/history-of-community-garden-movement-in-america-part-2-pingrees-potato-patches-detroit/>

<https://eos.org/articles/ancient-nile-tributary-may-have-aided-pyramid-construction>

<https://thegreenconspiracy.com/history-urban-gardening/>

<https://www.learningwithexperts.com/gardening/blog/the-history-of-allotments>

https://www.worldhistory.org/Hanging_Gardens_of_Babylon/



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