BIODIVERSITY THRIVES IN THE BUILT ENVIRONMENT

Six city visions aimed at improving the link among spaces, human inhabitants, and non-human inhabitants.

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There is now a broad consensus that the planet's health depends on the coexistence between rapidly growing cities and the natural world (Mansur et al., 2022). One strategy to improve this coexistence is to incorporate urban planning, management, and design approaches that recognize the value of complex interactions between society and nature in built environments (Alberti et al., 2018; Mansur et al., 2022). This chapter presents conceptual approaches that address cities from a systemic perspective in which nature and biodiversity can be integrated into the urban matrix. These interventions can improve the quantity and quality of habitats for diverse species as well as considering how citizens perceive and reclaim biodiversity, encouraging citizen participation, and promoting equitable access to nature's benefits.

In this context, we propose six visions of BiodiverCities that highlight the necessary transitions in the traditional urban development narratives and practices for creating scalable policies and actions that allow us to take advantage of the opportunities offered by biodiversity in the construction of fairer, healthier, more sustainable and resilient urban futures. These visions reflect comprehensive approaches to the role of biodiversity and nature in the urban matrix. Beyond being tools to solve specific urban challenges, they are scenarios in which diverse actors' interests, values, and expectations converse and disciplines such as ecology, planning, and urban design meet.

Although the dramatic speed and scale at which urbanization processes occur increasingly lead to the conclusion that the planet of the 21st century is an urban planet (Elmqvist et al., 2019; Zhou et al., 2019), this era is not only recognized for the challenges it implies, but also for the critical opportunities available to transform the way we relate to nature and how we build, design, plan and govern our cities (McPhearson et al., 2021; Mansur et al., 2022). Some authors agree that to advance in this transformation, it will be essential to strengthen a systemic, relational, and transformative perspective of the urban environment in which nature is recognized as the axis of sustainable development (Frantzeskaki et al., 2021; Grimm et al., 2008; Alberti et al., 2018). This means that, from the systemic perspective, integrative solutions are required to understand cities as ecosystems dominated by human activities in which the interactions between biological, social, and technological-artificial elements define the system's functionality.

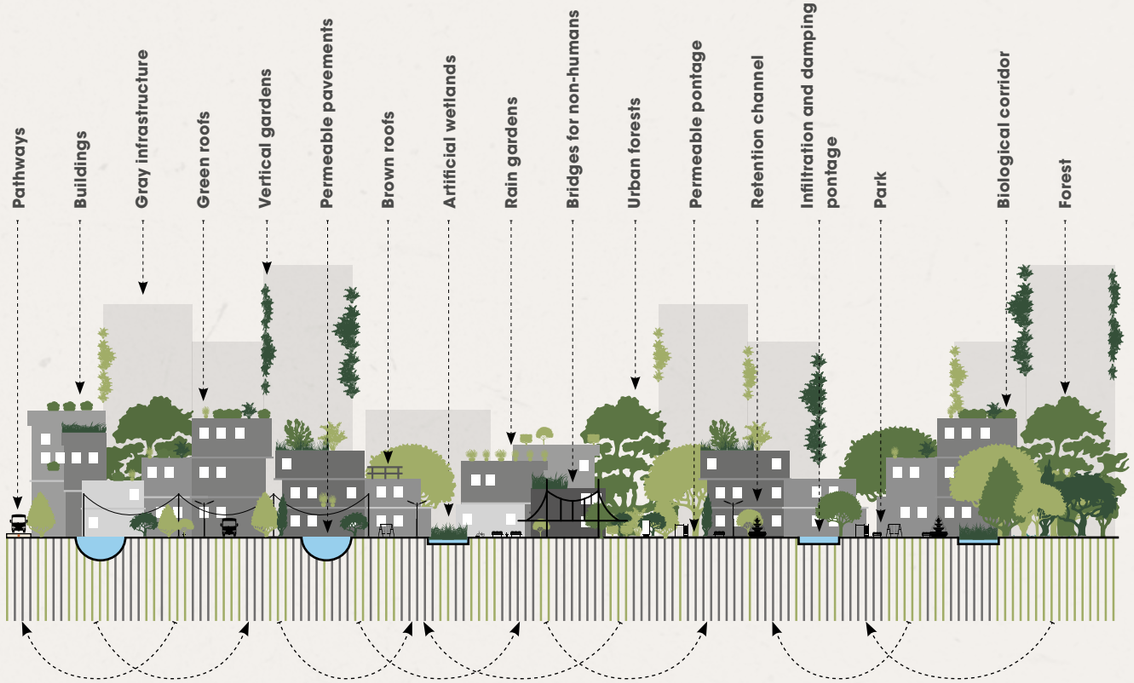
From the relational perspective between citizens and their immediate environment, coordinated and innovative actions are also required to link people, places, meanings, visions, and ecosystems. In this perspective, city spaces should be understood as a web of narratives, meanings, stories, and cultural symbols in which social and natural capitals, as well as social innovation, are manifested and contribute to urban sustainability (Frantzeskaki et al., 2021; Faldi et al., 2021). Finally, the transformative perspective allows us to face profound changes in governance systems, relationships, and policies that potentialize the development of innovative actions and reorient urban growth patterns towards sustainability (Alberti et al., 2018; Westley et al., 2011; Wolfram and Frantzeskaki, 2016). In all three cases, the comprehensive management of biodiversity and its contributions for the people´s well-being within the urban matrix is a key tool that requires articulated efforts of various actors and disciplines, with ecological and socio-economic implications.

Under this systemic and relational conception of cities, the interactions and interdependencies between social-cultural-economic-governance, climatic-biophysical-ecological, and technological-infrastructure dimensions determine urban patterns and processes, and thus the generation and access to nature's contributions by citizens (McPhearson et al., 2021; Markolf et al., 2018, Keeler et al., 2019). A city that designs and manages its matrix by promoting these interactions can increase the supply of ecosystem services at the local scale, reduce its dependencies and pressures on peri-urban and rural ecosystems, and strengthen equitable access to these services (Alberti et al., 2018; Keeler et al., 2019) (see Figure 1).

The following six city scenarios are proposed based on visions that recognize the complexity and dynamism of urban systems and shed light on concrete strategies to improve the link between spaces, human inhabitants, and non-human inhabitants. This exalts the hybrid nature of cities, the role of built infrastructure and technology as mediators of society-nature relationships, the importance of recognizing local capacities, and each context's biological and cultural capital. These visions are complementary and can operate jointly. Still, they are based on different ways of understanding the urban matrix in space and time, drawing from design, ecology, and territorial planning approaches. Each vision highlights the narratives and paradigms that must move towards new ways of integrating the biological, social, and technological dimensions and, thus, achieve cities that contribute to biodiversity conservation, development, and human well-being.

Figure 1. Comparative types of urban matrix including: 1) urban matrix that demands ecosystem services generated mainly by peripheral and rural ecosystems (left) and 2) Urban matrix in which the ecosystem services are generated at the local scale that contribute to the generation of ecosystem services at the local scale (right).

Source: Prepared by the authors.



1. FROM THE HUMAN CITY TO THE METAHUMAN CITY

WHAT IS A PARROT AIMING FOR?

In the city of Medellín, Colombia, there is a recent case of a building that caused more than one headache for its managers due to the constant repairs they had to make to the cork panels of the building's facades after they were punctured by non-human neighbors: parrots. The architects and designers considered dozens of factors when selecting materials for their projects. Still, none of them took into account the needs of non-human life forms, at least not those that shared their habitat with the building. An interesting win-win situation would have been for the building to integrate nesting spaces and other requirements of these birds into its architecture.

In theory, cities were conceived as agglomeration centers that sought to raise the quality of life of human beings (Allen, 2010; Birkeland, 2008). However, the reality of many cities today is far from this purpose. They deepen adverse conditions that have neglected other ways of life and affected dimensions of human well-being, including mental and physical health or social segregation (Gruebner et al., 2017; Vandecasteele, 2019; Clichevsky, 2000; Grant, 2012; Ibáñez, 2019; Kraas, 2008). This suggests that, on an increasingly urbanized planet, the health of different life forms depends

GREEN INFRASTRUCTURE ABOVE THE GROUND OR IMPLEMENTATIONS ON THE GROUND? WHAT IS BEST FOR BIODIVERSITY?

There is no need to repeteadely discuss the benefits of green installations in cities. We know that greener is better for all living creatures, from microorganisms to human beings. Just one thing: washing and painting green vertical and horizontal surfaces mean nothing if the selection of the invited plant species is not carefully managed. A green installation will be sustainable only if high plant diversity is introduced, each species being installed in the right place according to its genetic and behavioral requirements. The result will be, perhaps, the creation of a new urban ecosystem. Of course, with about four billion human beings living in the world's cities, creating new ways for urban biodiversity is a real challenge.

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on how cities are designed and how this ensures the integrity of ecosystems (Ibáñez, 2019; Birkeland, 2008; Cole, 2012; Reed, 2007).

The distortion of the original purpose of cities can be reversed through the path of biodiversity. The metahuman city starts with the question of what or who inhabits the urban landscape and, therefore, reflects on the coexistence of diverse life forms. It overcomes the vision of the "user" or "client" and understands that human well-being is closely linked to the health of other living beings (Forlano, 2017). This decentering of the human being as the sole representative of life that governs the city's destinies invites us to rethink the relationship of human populations with other life forms and how the design and management of the urban matrix influence this relationship. How do we reconcile the needs of human comfort with those of a tree's roots in a public space? Why are temporary hotels important for pollinators? How can the noise produced by a city affect the communication of birds? How can we address the challenges associated with coexistence between humans and other species in relation, for example, to conflicts with the emergence of zoonotic diseases?

ATTRIBUTES OF THE METAHUMAN CITY

- It maximizes positive interactions between different life forms, considering the services and disservices offered by nature in urban contexts.
- It explores new methods for identifying non-human requirements related to, for example, habitat availability or conditions to ensure the mobility of certain species.
- It recognizes natural cycles and the behavior of life forms in relation to these cycles.
- It integrates life at different scales of urban planning and management.

The world's biodiversity represents a unique opportunity and a huge challenge to take advantage of the natural and cultural capitals of the territory in urban environments. How should urban centers generate habitats for birds and design adequate infrastructures for visitors who practice bird watching?, and how can the great diversity of orchids, bromeliads, lichens, and bryophytes be used to enrich urban infrastructures (Ibáñez, 2014)? These questions suggest that urban planners, architects, and designers should incorporate knowledge generated by other disciplines - such as biology, ecology, or social sciences - and work together on innovative design proposals that promote healthy spaces for diverse life forms (Tzoulas et al., 2007). Another area of particular interest for the future of the metahuman city is the use of new information technologies and the articulation between various sectors of society (Forlano, 2017).

2. FROM THE GREEN CITY TO THE WILD CITY

HOW MANY SQUARE KILOMETERS DOES A BEE MEASURE?

Natural ecosystems are expressed in numbers that seem to defy common sense. A beehive is a tiny thing, but its reach over a territory is unimaginable: one bee can visit up to 7,000 flowers in a single day (National Geographic, 2019). Orlando González is a citizen of Bogotá, Colombia, who created a habitat for nine hives on the terrace of his house. Above his home, an aerial highway of tiny, winged insects is seen every day coming and going in the direction of the Botanical Garden of Bogotá. Without intending to, his 50-square-meter terrace expanded to an entire urban district with one of the most necessary ecosystem services to maintain life on the planet: pollination.

Historically, the biotic dimension of urban environmental quality has been related, above all, to two parameters: the number of square meters of green areas and the number of individual planted trees (Díaz et al., 2014, Bolund et al., 1999). While these indicators facilitate the understanding of the presence of biodiversity in a city and usually contribute to organizing and managing the benefits they can provide to its inhabitants, they are limited in accounting for the potential that this set of natural or semi-natural parts can offer to the quality of life and sustainability of urban space (Grant, 2012; Ibáñez, 2019). While urban growth is accelerating in many regions stimulating the creation of "megacities" (Kraas, 2008), divergent trends have been observed in areas of economic decline where "wild" ecosystems have begun to appear in urban-industrial areas (Kowarik and Körner, 2005). This illustrates the ecological and social potential of urban environments and spontaneous vegetation to increase green areas' biodiversity and reduce costs in their management (Sikorska et al., 2020).

The case of bees and Orlando González shows how a small green area with diverse vegetation can positively impact other nearby green areas by providing resources for insect species that contribute to pollination and, therefore, to the social-ecological functionality of those areas. Following this logic, a large green area dominated by alien grasses may provide fewer ecosystem services than a smaller diverse ecosystem.

The wild city has the challenge of giving attention to environmental quality and performance indicators beyond the amount of vegetated area or tree inventories. Therefore, it is necessary to explore strategies that decrease human intervention in managing urban green areas considering the benefits this represents for biodiversity (Bonthoux et al., 2019; Sikorska et al., 2021) and the associated challenges with human comfort and health or infrastructure maintenance.

Japanese botanist Akira Miyawaki developed the idea of gardens bearing his name, planted in limited-area sites the size of a pocket park or basketball court. The idea is to create small, very dense, and biodiverse forests, replicating the dynamics of a wild environment. This public space intervention method produces an area that grows 10 times faster, is 30 times denser, and is 100 times more biodiverse than conventional city naturalization methods (Hewitt, 2021; Urban Forests, 2021).

ATTRIBUTES OF THE WILD CITY

- It builds a vision of the relationship between biodiversity and urban quality of life beyond green area indicators and the number of individual trees planted per inhabitant.
- It seeks to maximize interactions between social and ecological systems.
- It prefers the complexity of the relationships among various life forms to the simplicity of the individual.
- It balances human maintenance and control with self-regulation and adaptation.
- It allows for spontaneity and values it as a form of resilience.

Natural ecosystems express themselves in diverse and complex ways. Explicitly incorporating them into city planning, structurally and functionally, requires progress in knowledge management and tools that measure effectiveness and predict the cost-benefit of strategies, such as the intentional abandonment of certain areas or the promotion of natural succession (Sikorska et al., 2021). In practice, disciplines such as restoration ecology, biology, architecture, and urban planning should work hand in hand to include these types of actions in managing the urban matrix. This mitigates the possible risks for humans and non-human species that inhabit the city and considers each region's bioclimatic, social, and cultural context.

3. FROM THE COMPLETE CITY TO THE UNFINISHED CITY

DID IT TRULY BEGIN WHEN THEY THOUGHT IT WAS ITS END?

The High Line Park in New York City in the United States is an important reference point for public space in recent urban history due to its exciting transformations and evolution over more than a century. This mobility axis has changed its essence and face several times, without these transformations having been foreseeable from urban planning. As an elevated linear park, it is a palimpsest that contains many lessons for cities and several layers of history written on the same parchment: the stretch of Manhattan's western rail line. Initially, the rail line at ground level carried freight. However, by the early 19th century, it had run over nearly 600 people, causing their deaths. Therefore, the decision was made to raise the railway line using a sort of viaduct built in concrete and steel. With the massification of the use of freight trucks, some sections of the elevated rail line stopped operating in the 1960s, and the entire line canceled all operations by 1980 (Kim et al., 2018).

The last page of the High Line's history was written against all odds by biodiversity. As calls grew for the total demolition of what was left standing of the building, nature reclaimed the underutilized space, and plants began to grow spontaneously, creating habitats for birds, insects, and other non-human life. Hundreds of people came together for the common purpose of caring for that new space. It is now an elevated park recognized worldwide for completely changing the face of Manhattan's west side by creating wild places for recreation, contemplation, citizen gathering, urban agriculture, and arts and cultural events (Kim et al., 2018).

ATTRIBUTES OF THE UNFINISHED CITY

- It recognizes cities as dynamic socio-ecosystems in constant change.
- It contemplates several future scenarios considering the opportunities for collective conception and production of the urban habitat.
- It designs and builds in uncertainty, even in the absence of accurate information.
- It prioritizes adaptability in urban design processes.
- It enables the participation of communities and citizens in the city's construction.
- It formulates strategic interventions at strategic points to trigger new processes in the future.
- It values urban planning actions that strengthen flexibility and adaptability over time.
- It values spontaneous citizen initiatives.

In the developing world, the (un) finished city is a common dynamic that has existed since the emergence of urban settlements. More than 20% of a megacity like Bogotá has an informal origin, with settlements characterized by inadequate or absent infrastructure in high-risk areas and limited access to essential public services (López Borbón, 2018). Given that the process of formalizing these neighborhoods is complex, slow, and tedious, thousands of citizen groups come together to intervene in public spaces with works that seek to improve the quality of life of their inhabitants and strengthen citizen identity through participatory activities that involve the entire community (Ibáñez et al., 2014). To walk through these neighborhoods is to see a mosaic of unfinished citizen interventions in constant transformation: graffiti, tactical urbanism, signage, ecological restoration, public space, parks, markets, and urban agriculture. Likewise, planting food and ornamental plants in urban spaces is common in the informal areas of Bogotá, such as Ciudad Bolivar. This area has become an enclave of urban farmers, seed and food preservers, and leading defenders of biodiversity and local nature since many of its inhabitants come from rural territories.

In the (un)finished city, the collective conception and production of the urban habitat are valued based on recognizing the specific conditions of each territory.[1] Promoting planning as a dynamic process facilitates the inclusion of the perceptions, interests, and expectations that communities have about the city's development. This includes the different ways in which citizens relate to nature, which is contrary to a linear and static process defined by actors other than those who inhabit each territory.

4. FROM THE SEGMENTED CITY TO THE OVERLAPPING CITY

A FOREST WITH A FACADE OR A BUILDING WITH A CANOPY?

From one angle, it looks like a modern, corporate building that has been covered by reverberating vegetation fodder that tops out over an urban park. From another angle, it looks like a lush mountain forest. In reality, it is a facade of modern building materials that enlivens the avenue on the north side of the property. Architect Emilio Ambasz's Acros building in Fukuoka City, Japan, multiplies the functionality and use of an urban site by placing the green elements on top of what is built. What should be on this urban site: a park or a building? That's a difficult choice for city planners when both are required. However, perhaps it's easier than it sounds: you can have the two spaces overlapping.

The possibility of buildings being crowned with large parks or green and biodiverse surfaces is not the only option, nor the best. Still, there are various ways to overlap living space and built space to multiply activities and functionalities according to each place's needs and spatial characteristics (Pauleit et al., 2020; Ibáñez et al., 2019).

Architect James Ramsey set in motion an idea as far-fetched as it was brilliant: to build the world's first subway park, the Low Line, in an abandoned and underutilized underground urban space on Manhattan's east side subway line. The key to the project's success was enabling photosynthesis in a dark space due to its location below street level. This was achieved by incorporating optical devices in the urban space to capture, reflect and redirect solar radiation into the subway space (*The Low Line*, n. d.).

RESTORATION, RENATURATION, REGENERATION, OR REHABILITATION IN URBAN CONTEXTS?

Infiltrating nature and the natural world into the urban environment, on a transformational scale, at every opportunity, and as the background to (and context for) everyday life is urgent and essential for meeting the enormous environmental, social, and economic challenges we all face. By definition, this means that places will look different, be used differently, be used by different people, and be looked after differently compared to how we do things now. It's a radical ecological approach, a restorative ecology, repairing damaged places, bringing together human community and rich biodiversity. And it's challenging for all concerned, including ecologists, because we must stop looking backward all the time, to the past, as the only source of our ecological reference points. Instead, we also have to look forwards, and embrace a new nature, a 'Future Nature' that's fitted to the disturbing urban environment and the changing climate: a Novel Ecosystem. A joyful and productive interaction, a cosmopolitan mix, poised and adapted for decades to come, putting people at the heart of nature in cities.

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ATTRIBUTES OF THE OVERLAPPING CITY

- It assigns the land several uses and functions simultaneously.
- It builds spatial relationships in three dimensions, not two.
- It integrates human activities into areas destined for biodiversity conservation.
- It incorporates compatible uses into protected areas, which reduces conflicts.
- It accepts and promotes biodiversity conservation outside protected areas.
- It operates like a forest, as different things happen at various levels and win-win interactions are built, generating co-benefits.
- It promotes and constructs buildings and inert infrastructure with green roofs and other elevated elements and creates corridors.

In cities, avenues connect distant places of origin and destination but have fractured relations of proximity and pedestrian connectivity. The overlapping city suggests that these road mobility axes, especially the depressed sections, be covered by living surfaces that attract biodiversity and articulate the urban fractures caused by road axes for pedestrians (Ibáñez, 2014). The Bicentennial Park in Bogotá, built on a depressed section of El Dorado Avenue, is a starting point for this strategy of efficient use of space to be replicated in other parts of the city and urban centers in Colombia. Likewise, in Medellin, another Colombian city, the Articulated Life Units are an excellent example of the overlapping city, as recreational spaces and biodiversity enclaves were created on pieces of functional city infrastructure, such as water storage tanks.

These cases demonstrate that, contrary to popular belief, if we know how to take advantage of these spaces and advance in the necessary research on the conditions and requirements of organisms in these environments, cities with high occupancy density rates still have space available for biodiversity. Interventions that make more efficient land use in cities can significantly and positively impact biodiversity and socio-economic development. This brings nature back into the built environment, reduces the infrastructure footprint, frees up land for nature, and generates new economic value (World Economic Forum, 2022).

5. FROM THE PUNCTUAL CITY TO THE BIO-PERFORMATIVE CITY

USING THE CLOCK OR THE PARROTS SONG?

In Hong Kong, at 7 p.m. sharp, hundreds of people gather on the Avenue of Stars to appreciate the colorful performance of music and laser lights that the city displays on the other side of Victoria Harbour in an impressive display of artificial intelligence-assisted coordination. In Leticia, the capital of the department of Amazonas in Colombia, at every sunset, a cloud of parakeets, swallows, and other birds covers Santander Park producing a sublime natural spectacle for the eyes and ears of tourists and locals who come to see and hear this staging of biodiversity. In different populations, it is not the clock that accompanies human activities but the natural rhythms that produce a profusion of sounds, shapes, colors, and aesthetic experiences that mark the daily lives of millions of people. Likewise, in rural territories, the workday begins with the crowing of roosters before dawn. In some environments close to water, the tides determine changes in human activities or milestones throughout the day, such as meetings and gatherings (Ibáñez, 2021).

Many modern cities are asynchronous with natural phenomena and are designed primarily for visual appreciation, like a mosaic of static landscapes adorning a photo. Ignoring the other senses in city planning and, above all, their synchrony with natural rhythms creates a disconnection between inhabitants and the life experience of biological cycles, the types of light the sun produces throughout the day, the seasons, weather changes, atmospheric phenomena, plant phenology, and water cycle dynamics. The term bio-performative is used here in the same sense as "performative architecture" (Kolarevic, 2005), which refers to how one or more environmental events determine a space or place; in this case, events caused by non-human life forms and natural cycles.

ATTRIBUTES OF THE BIO-PERFORMATIVE CITY

- It connects and communicates urban human inhabitants with natural cycles, life processes, and, in general, environmental phenomena, thus promoting the incorporation of such phenomena in the design of public spaces and built structures.
- It incorporates the circadian cycles of human beings and the biological cycles of non-human

Figure 2. Cities typologies that describe the different relationships between social challenges, ecological conditions and capacities of local communities that converge in urban areas. Opportunities to face characteristic social challenges based on the cities biodiversity are presented.

DENSIFIED MOUNTAIN CITY CLOSE TO STRATEGIC ECOSYSTEMS FOR WATER SUPPLY

INFILTRATION/RETENTION

Green covers, rain gardens, urban systems of sustainable drainage (vegetated gutters, permeable pavements). Protected urban areas to ensure water supply.

PIEDMONT OR RIVERSIDE CITY

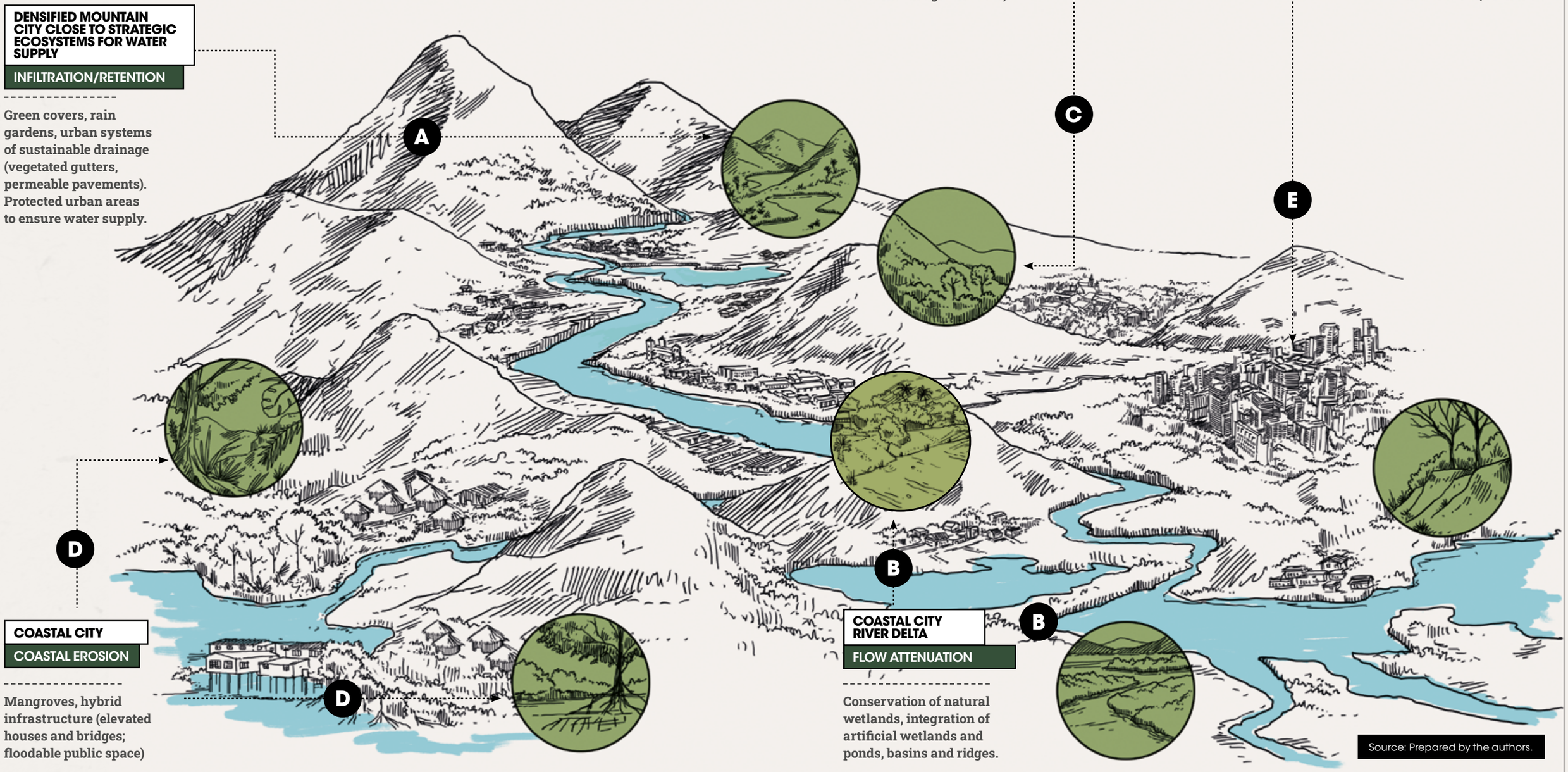
FLOW ATTENUATION

Riparian forests, hybrid solutions to retain soil and water (example: built networks and green cover)

HOT AND HARDENED CITY (CONSOLIDATED)

EVAPOTRANSPIRATION, MICROCLIMATE REGULATION/ HEAT ISLANDS

Urban forest, green roofs (urban gardens can be integrated), bodies of water, orchards.



COASTAL CITY

COASTAL EROSION

Mangroves, hybrid infrastructure (elevated houses and bridges; floodable public space)

COASTAL CITY RIVER DELTA

FLOW ATTENUATION

Conservation of natural wetlands, integration of artificial wetlands and ponds, basins and ridges.

Source: Prepared by the authors.

beings into urban planning and design processes.

How do we incorporate the potential of biodiversity in the connection of people with their immediate environment in cities of the present and future? Some conditions define the environmental behavior of the territory and characterize aesthetic experiences. Cities and architecture must be a sounding board that amplifies these experiences, for example, the sound of animals, the management of water and rain as an integral element of the inhabited space, or the incorporation of natural light. The bioperformative city understands the biological and climatic changes that occur over time and in each territory and seeks to incorporate them into the design of infrastructure and public space.

6. FROM THE ORNAMENTAL CITY TO THE BIOMIMETIC CITY

HOW LONG HAS IT BEEN WORKING WELL?

In 2019, the Global Biomimicry Institute announced the winning entry in its global nature-inspired design competition: Bryosoil, a modular, porous pavement system for managing water in cities (Ibáñez, 2019; Biomimicry Institute, n.d.). This design was inspired by the bryophyte plants of the world's largest *páramo*, the Sumapaz *páramo* (a high, cold plateau, similar to moorland) in the Colombian Andes. The Colombian team behind Bryosoil started with a question: How do we replace impermeable pipe systems and containers with a solution that allows multifunctionality so that rainwater management systems do not collapse when cities expand?

Every city in the world relies on systems of linear pipes and container spaces to evacuate rainwater and prevent flooding. However, these conventional systems become obsolete as cities grow because they, in turn, produce a greater volume of runoff water that must be evacuated due to the catchment of impervious surfaces. Bryosoil was developed from the morphological characteristics of *páramo* mosses to promote the functions of natural soil: conducting, evaporating, infiltrating, reducing flow, redirecting, filtering, and separating water. The result is a hand-portable and multifunctional three-dimensional module that works similarly to the mosses in the *páramos* and improves soil performance to protect communities settled in areas at high risk of flooding.

The case of Bryosoil shows that, although biodiversity can be incorporated directly into cities and their infrastructure, it can also be present as a mentor and reference when designing solutions and technologies that solve functional problems in the artificial world. This is achieved by studying the practical principles of organisms and ecological processes that are adapted to local environmental conditions, identifying their biological strategies, their abstraction to turn them into technological strategies, and validating their advantages in a scenario of application in real situations (Ibáñez, 2019).

Although biomimicry or nature-inspired design is recent and little implemented, it is estimated to produce at least 30% of economic growth in several technology sectors globally, including construction and architecture (Ivanic et al., 2015; Kennedy et al., 2015). At the city scale, biomimicry has explored how some characteristics of natural systems can guide strategies to improve the resilience of urban infrastructures. Among these strategies, the inclusion of diversity in different dimensions and scales of the system, the strengthening of multifunctional design and urban-regional relationships, and the management of local biodiversity from the ecosystem-based adaptation approach stand out (Helmrich et al., 2020; Biomimicry 3.8, 2013).

ATTRIBUTES OF THE BIOMIMETIC CITY

- It integrates strategies inspired by the functioning of organisms and biological systems.
- It uses climate adaptation strategies of local species and ecosystems.
- It prioritizes principles and patterns of operation over form.
- It replaces traditional technologies with solutions based on how nature works.
- It creates an environment of innovation based on the study and local biodiversity research.

TOWARDS POSSIBLE FUTURES

Although cities offer opportunities as global centers of transformative innovation, catastrophic visions of their future still prevail, hindering the implementation of plans and policies for creating more positive scenarios, both locally and globally (Bennett et al., 2016; McPhearson et al., 2021; Iwaniec et al., 2021). The visions presented in this chapter seek to contribute to more positive discussions about the future of urban environments and thus motivate actions and inspire processes that will generate transformative changes in the years to come from a relational and systemic perspective. For example, the vision of an overlapping city increases the possibilities for relationships among citizens and between citizens and nature within the urban matrix; likewise, the vision of an (un)finished city recognizes city-building as a complex and emerging phenomenon resulting from the interaction among multiple socio-ecological factors (Alberti et al., 2018).

Increasingly, governments and academia are adopting approaches that promote green and inclusive cities through concepts such as sustainable urban development, urban ecosystem services, green infrastructure, or nature-based solutions. However, it is necessary to strengthen languages and approaches that transcend the instrumental conception of nature and human activities as drivers of negative transformations towards socio-ecological models that recognize the multidimensionality of society-nature relationships in the context of each territory (Kohler et al., 2019; Mansur et al., 2022).

In this sense, some authors have proposed conceptual and methodological frameworks, such as nature-based thinking (Randrup et al., 2020; Maller, 2021), which suggest transcending the use of nature as an isolated solution to specific urban challenges to think and act in order to build regenerative and biophilic cities that provide spaces for biodiversity and ecological processes. All this while effectively integrating cultural diversity and the particular way in which local communities relate to nature. This perspective is relevant in constructing the six proposed visions in which biological and cultural capital constitutes a real opportunity to integrate communities' values, expectations, and capacities that relate to nature in different ways.

This diversity offers multiple alternative solutions in cases where economic and institutional capacities are limited, fosters the collective construction of knowledge, and provides scenarios for innovation, promotion of local technologies, experimentation, and transdisciplinarity. For biodiversity to thrive in the urban matrix, understanding how various aspects - such as diversity of human groups, histories, governance schemes, environmental characteristics, and urban forms - jointly influence the creation of barriers or opportunities to manage biodiversity and ecosystem services within cities is required (Mansur et al., 2020; Shih et al., 2020).

IS BIODIVERSITY MANAGED BY GOVERNMENTS OR BY PRIVATE CITIZENS/ENTITIES?

Biodiversity is recognized as universal welfare but is dangerously decreasing. We, therefore, need to coordinate all the elements and actors involved to avoid this upcoming problem. Coordination means inclusion and not exclusion (not only versus), with the participation of academia, administration, enterprises, NGOs, and individuals. The challenge is how to organize the actions. The experience from Spain shows University research and teaching activities, with a Germplasm Bank in the UPM that has been preserving native species since 1973, integrated into ESCONET. The Ministry of Climate Change develops programs with Biodiversity Foundations at the administration level. In addition, both the Regional Administration and the City Hall in Madrid have special projects (Metropolitan Forest) which involve biodiversity issues. However, pending subjects are green roofs and walls, where native species may be recovered with citizen participation.

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KEY MESSAGES

- **Promote interactions among the biological, social, and technological-artificial elements that constitute the urban landscape.** This interaction increases the supply of ecosystem services at the local scale, reduces the dependencies and pressures that cities generate on peri-urban and rural ecosystems, and strengthens equitable access to their benefits.
- **Incorporate the hybrid nature of cities in their planning.** This implies recognizing the role of built infrastructure and technology as mediators of society-nature relationships and the particular opportunities offered by local capacities and the biological and cultural capital of each context.
- **Promote integrated approaches to the role of biodiversity in the urban matrix.** Beyond being a tool to solve specific challenges, these approaches should serve as a scenario for the dialogue of interests, values, and expectations of various stakeholders and the meeting of disciplines, such as ecology, territorial planning, and urban design.
- **Transform the way we build, design, plan and govern our cities from a biodiversity perspective.** This change requires a systemic and relational perspective in which cities are understood as complex and dynamic socio-ecosystems and in which coordinated and innovative actions are promoted to link people, places, meanings, visions, and ecosystems.