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Bringing Nature Back to Cities. Governing, Communicating and Living with Urban Biodiversity in the Mediterranean

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Preface

Massimo Labra

When we launched the National Biodiversity Future Center, we did so with the conviction that if we want to conserve, restore, monitor and enhance biodiversity in Italy and in the wider Mediterranean, cities cannot be treated as a marginal chapter of the story. They are one of its main stages. This book, *Bringing Nature Back to Cities. Governing, Communicating and Living with Urban Biodiversity in the Mediterranean*, edited by Monica Bernardi, Pablo Gómez-Iniesta and Nunzia Borrelli, is a concrete expression of that conviction.

The volume is rooted in the work of *Spoke 7, "Biodiversity and Society: Communication, education and social impact"*, which I have always imagined as the place in NBFC where science walks out of the laboratory and deliberately seeks confrontation with institutions, schools, associations, media and citizens. Within NBFC, and in close dialogue with the hub-wide efforts on urban biodiversity carried out by Spoke 5, Spoke 7 was designed precisely to explore how biodiversity is narrated, taught, governed and lived in everyday contexts; to experiment with tools that shorten the distance between scientific evidence and collective choices; and to do so by building alliances among very different forms of expertise and fields. This book grows out of that collective laboratory and carries its signature, with an explicit attention to social justice and the conviction that knowledge only becomes fully meaningful when it supports shared action.

I am particularly pleased that the book takes cities as its main vantage point. For a long time, biodiversity was associated almost exclusively with remote ecosystems, protected areas or "wilderness". Here, by contrast, urban biodiversity is treated as what it really is, namely a decisive frontier of the ecological transition. The authors show that the living fabric of the city – its soils and rivers, trees and insects, parks and interstices – is not a decorative accessory, but a relational infrastructure that sustains health, well-being, climate resilience, environmental sustainability and social cohesion. To speak of biodiversity in Milan, Florence, Genoa, Palermo or Tirana therefore means speaking about rights, inequalities, governance choices and everyday practices as much as about species and habitats.

What does this volume offer to readers? First, it provides a clear and accessible framework for understanding what urban biodiversity is and why it matters today in Europe and in the Mediterranean. The opening chapters walk the reader through the major international and European reference points – from the Convention on Biological Diversity and the post-2020 Global Biodiversity Framework to the EU Biodiversity Strategy for 2030, the Green Deal and the new Nature Restoration Regulation – and explain how these global and continental agendas translate into very concrete obligations and opportunities for cities. Urban greening plans, targets for green space and tree canopy, indicators for monitoring… are unpacked and connected to real governance challenges faced by municipalities.

Secondly, the book proposes a shift "from green to life", towards a new understanding of biodiversity as a common good and as a more-than-human urban citizenship. Governance is read not only in terms of instruments and competences, but also as a negotiation of access, responsibilities and ecological justice.

A third contribution lies in the reconstruction of the institutional and policy architecture within which cities operate. The volume maps the evolution of models for governing nature in cities – from sectoral, technocratic approaches to more integrated and participatory ones – and describes the multilevel governance system that now links local authorities, regions, the state, the European Union and international networks. It discusses regulatory tools, economic incentives, voluntary agreements, participatory devices and informational instruments, showing how they can work together, but also where they generate fragmentation or "expectations without capacity".

Methodologically, the research is grounded in an empirical work based on document analysis and semi-structured interviews with experts, public officials, practitioners and stakeholders in Milan, Florence, Genoa, Palermo and Tirana, through which the authors reconstruct how different cities position themselves in international networks, how they structure environmental governance, how they communicate biodiversity, how they disseminate knowledge and engage citizens, and how they deal with issues of climate and environmental justice. The comparative lens allows to understand different contexts preventing any easy "best practice" rhetoric and instead inviting readers to think in terms of families of problems and context-sensitive solutions. Milan is analysed as a mature metropolitan system closely embedded in European agendas; Tirana as a fast-changing capital aligning itself with EU standards; Florence, Genoa and Palermo

as distinctive Mediterranean configurations where heritage, port economies and socio-economic vulnerabilities shape biodiversity choices in different ways.

The book also speaks directly to the communicative and educational mission of Spoke 7, thanks to a whole section devoted to how biodiversity is narrated in urban policies, media campaigns, citizen science projects and educational initiatives. The authors revisit the history of environmental and sustainability communication, analyse framing strategies (health, economy, equity, co-benefits) and explore the role of digital platforms, social networks, influencers and participatory monitoring in shaping perceptions and behaviours. Citizen science emerges here not as a marginal activity, but as a key structure for "measuring with society", as a way to democratise data production, build ecological literacy, strengthen the bond between residents and their local environments, creating a new sense of belonging. These reflections are closely aligned with the broader work that NBFC is carrying out on citizen science with the creation of the first National Citizen Science Table, the development of a national open-source platform and the launch of the Biodiversity Sampling Week.

Who, then, can benefit from this volume? Researchers will find a well-documented synthesis of debates on urban biodiversity, governance and communication; public administrators and policy makers can use the book as both a map and a toolbox, since it clarifies the policy environment, highlights enabling conditions for local action and illustrates concrete instruments that can be adapted to different contexts, such as urban greening plans, participatory budgeting and collaboration pacts; educators and those working in museums, eco-museums, schools and informal learning spaces, can access conceptual materials and examples that can be translated into curricula, exhibitions, workshops or citizen projects; finally, civil society organisations and active citizens, can learn languages and arguments to make claims, to dialogue with institutions, to imagine new forms of co-governance and shared care of urban nature.

We are living through a coupled biodiversity and climate crisis that is reshaping ecosystems, economies and daily life while, at the same time, facing a crisis of trust in institutions and scientific literacy, making the urgency of the work presented here evident. Evidence often struggles to enter public debate in a clear and constructive way; policies are not always evaluated on the basis of their ecological and social impacts; and citizens may feel disoriented or excluded from decision-making processes. This book seeks to address these intertwined challenges head-on, by connecting analysis with accessible language, by showing

how measurement can support transformation and by insisting on participation and justice as structural components of biodiversity governance.

I would like the reader to approach these pages not only as a diagnosis of problems, but also as an invitation. An invitation to administrators to use the proposed frameworks to rethink plans, budgets and regulations; to practitioners to test new forms of partnership and co-management; to teachers to build educational paths that start from the city and speak to the imagination of younger generations; to citizens to recognise themselves as custodians of a living urban commons. The cities portrayed in the book are not perfect models, but laboratories, with all their contradictions, but able to speak to many other contexts, in Italy and beyond.

I invite you to read this book with curiosity and a sense of responsibility, letting it suggest new questions to ask in your neighbourhoods, in your institutions, and in your professional practice. "Bringing nature back to cities" is not just a slogan but a demanding, long-term commitment in which we are all called to take part, and this volume shows that we already have much of the knowledge, tools, and alliances we need, what is required now is to use them together.

Introduction

The National Biodiversity Future Center and this book

Nunzia Borrelli

The erosion of biodiversity is not an abstract or distant phenomenon, but one of the most urgent dimensions of the ecological crisis we are experiencing in the twenty-first century. Climate change, soil degradation, the loss of habitats, and the unsustainable use of resources are processes that intersect with urbanisation and profoundly shape the quality of life in cities (Millennium Ecosystem Assessment, 2005; IPBES, 2019). Scientific research is crucial for identifying and monitoring these dynamics, yet it cannot succeed in isolation. Equally, advocacy and awareness campaigns, while essential, are insufficient if their outcomes do not find resonance in institutions, policies, and collective practices. What is needed is the integration of knowledge, governance, and civic participation into coherent strategies of ecological transition.

This book takes shape within this broad horizon and chooses Mediterranean cities because here the intertwined crises of biodiversity loss and climate change are experienced in very concrete ways. Heat waves that last longer each year, intense rainfall that overwhelms drainage systems, coastal erosion that reshapes shores, and recurring episodes of air pollution all interact with the dense urban fabrics, the already rooted historical inequalities, with fragile infrastructures and contested public spaces. These phenomena do not affect all residents in the same way of course but intersect with social and territorial divides making visible who has access to shade, clean water, safe housing and quality green areas and who does not.

At the same time, Mediterranean cities often face fragile trust in institutions and weak channels through which scientific knowledge can inform decisions, so environmental policies may feel fragmented, technical language distant from everyday concerns, and participatory processes sporadic or absent. As a result, many citizens perceive that neighbourhood transformations, the redevelopment of disused areas, and choices about parks, trees, and public spaces are made

elsewhere and communicated too late, and in this context ecological transition risks remaining a slogan unless it becomes tangible change in the lived city.

The **National Biodiversity Future Center**, NBFC, was established in response to this complex scenario. It represents the first national hub entirely dedicated to the study, conservation, restoration, and enhancement of biodiversity, with an interdisciplinary approach that integrates life sciences, environmental sciences, technological innovation, and socio-economic perspectives. Funded through the National Recovery and Resilience Plan and the European programme NextGenerationEU, NBFC, mobilises over two thousand stakeholders, including universities, research centres, and public institutions, with the aim of generating advanced knowledge, developing nature-based solutions, supporting evidence-based policies for biodiversity protection and sustainable development, making results accessible to local actors, and contributing to systemic change. In doing so, NBFC positions itself as a strategic infrastructure for addressing the ecological crisis, fostering science-policy-society interfaces, and promoting Italy's contribution to global biodiversity targets. Within this framework, **Spoke 7 "Biodiversity and Society: Communication, Education and Social Impact"** has the specific mandate to investigate the social and institutional dimensions of biodiversity, to promote new forms of communication, and to strengthen the connections between scientific evidence, governance tools, and citizen engagement.

The research presented in this book grows out of NBFC Spoke 7, and the work conducted at the University of Milano-Bicocca under my scientific coordination is structured around three interrelated lines of inquiry.

- The first concerns **museums and ecomuseums** as cultural infrastructures capable of mediating between scientific knowledge and public engagement.
- The second line addresses the **emotional and symbolic dimension** of biodiversity, exploring the role of art and photography in narrating biodiversity, building connections, and mobilising ecological awareness.
- The third line, to which this volume belongs, focuses on **cities** as strategic laboratories where governance, communication, and citizen practices around biodiversity converge.

This line starts from a simple but demanding question: what happens when we treat urban biodiversity not as a marginal technical issue, but as a constitutive element of how cities function, evolve, and are governed. Looking at biodiversity through the lenses of urban and territorial sociology means paying attention to

institutions, regulations, economic interests, social movements, everyday practices, and the concrete geographies of inequality that shape access to living environments, focussing on who decides what counts as "nature" in the city, where it is located, how it is maintained, and for whose benefit. Within this perspective, urban biodiversity can be understood as a *relational infrastructure*, a set of ecological and social relations embedded in the very fabric of cities. This means that it is not only a stock of resources to be protected, but a dynamic infrastructure that underpins resilience, enables social interactions, and mediates between human and non-human actors. At the same time, it constitutes a dimension of urban governance and citizenship, since the way it is managed, distributed, and made accessible reflects broader negotiations of rights, responsibilities, and ecological justice. Accordingly, communication is not only dissemination but a process of framing and participation; governance is not only the design of policies but the negotiation of trade-offs and responsibilities; and urban life is not only consumption of resources but the co-production of ecological futures.

The volume has three main objectives. First, it seeks to bring together knowledge and tools that are often dispersed across different disciplines and policy domains. Research on urban biodiversity has developed within ecology, planning, geography, environmental sociology, and communication studies, while public institutions have experimented with nature-based solutions, green and blue infrastructures, participatory budgeting, and collaborative management of public spaces. By weaving these strands together, the book offers a shared vocabulary and a set of analytical lenses that can be used by researchers, policy-makers, practitioners, and activists who work on Mediterranean cities.

Second, the book aims to make visible the alliances and practices already active on the ground, in urban contexts marked by a dense, sometimes fragile, web of collaborations among municipalities, metropolitan authorities, universities, cultural institutions, schools, associations, informal groups, and residents. These partnerships generate projects ranging from urban greening and riverfront regeneration to environmental education, community gardens, and citizen monitoring of air and water quality, and the chapters gathered here read them not as isolated experiments but as part of a broader field of action on urban biodiversity, examining the conditions under which they can consolidate and expand.

Third, the volume proposes an integrated perspective that understands "bringing nature back to cities" as a collective commitment to create new ways for people

and other forms of life to coexist more fairly in urban spaces. How? Aligning strategies at different scales, from European and national frameworks to municipal plans and neighbourhood projects and building stable interfaces between science, policy, and society, so that knowledge can inform decisions and, at the same time, local experiences and conflicts can feed back into research agendas.

The book is structured to accompany the reader through this multi-layered field. A first part clarifies the notion of urban biodiversity and situates Mediterranean cities as specific socio-ecological contexts. A second part focuses on governance, communication, and engagement, examining how biodiversity enters urban policies and plans, which instruments are used to implement nature-based solutions, how narratives about urban nature are constructed, and which forms of citizen participation are activated. In this section the support of experts voices also opens a first stage of reflection. A third part presents the empirical core of the research, with case studies in Milan, Florence, Genoa, Palermo, and Tirana. Each city is explored in its own trajectory, highlighting how biodiversity is articulated within climate strategies, regeneration processes, cultural policies, and everyday practices. A final part reflects on the lessons that emerge from the comparison, identifies enabling conditions and persistent obstacles, and sketches possible directions for future research and action proposing a blueprint.

The aim is not to provide ready-made recipes, but to offer tools for reading the complexity of cities and for recognising both the constraints and the opportunities that shape efforts to integrate biodiversity into urban life. The hope is that, by following the trajectories traced in the following chapters, readers will find not only a diagnosis of problems, but also indications of possible pathways. As stressed at the opening of this introduction, the biodiversity crisis is systemic, and systemic responses are needed; cities, far from being marginal, are strategic arenas where new models of sustainability, justice, and resilience can be tested. In doing so, this research contributes to the broader mission of the National Biodiversity Future Center (NBFC), that is to place biodiversity at the heart of Italy's, and Europe's path towards sustainability, resilience, and justice.

Part I

Setting the scene:
Understanding Urban Biodiversity

Chapter 1

Understanding Urban Biodiversity. Concepts and Contexts

Monica Bernardi

1.1 Urban Nature and Urban Biodiversity

Urban biodiversity refers to the variety and variability of life in urban areas, encompassing all living organisms (plants, animals, fungi, microorganisms) and the ecological complexes they form within cities (GPSC, 2021). In essence, it is the "biological diversity" of urban environments, including genetic diversity, species diversity, and the range of habitats found in and around dense human settlements (WWF Canada, 2024). Notably, *urban biodiversity* is often discussed in tandem with *urban nature*, which denotes the green and blue spaces themselves (parks, gardens, street trees, rivers, wetlands, etc.) that host this life. Different elements of urban nature can harbour different levels of biodiversity; for example, a large park with woodlands, a stream, and a pond may support many tree, bird, and amphibian species, whereas a park of mostly mowed lawns and paved areas sustains far fewer (GPSC, 2021).

While these concepts can be separated for analytical clarity, in practice they are deeply intertwined; the way urban nature is planned and governed largely determines who has access to biodiversity, under what conditions, and with what quality.

Although the international framework, marked by agreements such as the Convention on Biological Diversity (CBD), sets overarching goals, it is the local level, within municipalities, that biodiversity is effectively negotiated, implemented, and contested. Local planning instruments, zoning regulations, maintenance regimes, and administrative capacities are where the broader ambitions of biodiversity governance are translated into lived reality (Puppim de Oliveira et al., 2011). Thus, the design, management, and regulation of cities decisively shape whether biodiversity is conserved or eroded, both within and beyond their administrative boundaries.

Definitions of urban biodiversity in academic literature reflect these tensions. Some of them stress native species and ecosystem integrity, others adopt a broader perspective that includes all organisms (native or non-native) that live within city boundaries, and still others expand the scope to genetic variation and the diversity of urban habitat types (Puppim de Oliveira et al., 2014). Despite these nuances, a common thread is that urban biodiversity comprises the multitude of living organisms co-existing with humans in the built environment.

Beyond definitions, three reasons, ecological, social and economic, explain why urban biodiversity matters for cities.

In *ecological* terms, research shows that biodiversity supports essential ecosystem functions and strengthens system resilience, making it the foundation of ecosystem services that sustain human health and well-being (Marselle et al., 2021). Where there is richer biodiversity, the ecosystems tend to be more effective in regulating air and water quality, moderating microclimates through shade and cooling, supporting pollination, and reducing flood risk. This perspective also opens a sociological implication, because shifting the discussion from mere "benefits" to issues of *rights* and *accountability* requires careful attention to questions of access, distribution, and equity. It becomes crucial to ask who enjoys these ecosystem services, how evenly they are spread across the urban fabric, and whether their quality varies among neighbourhoods. For instance, healthy urban wetlands and soils (with diverse biota) filter water and reduce runoff, trees sequester carbon and mitigate heat islands, and diverse plantings support pollinators that urban food gardens rely on.

From a *social and public-health* perspective, exposure to biodiverse urban spaces is associated with better mental and physical health and generally improved well-being. Green spaces rich in species diversity (such as parks with varied plant and bird life) are linked to stronger psychological benefits than simplified, biologically poor spaces (Gavi, 2023). Residents also derive cultural and aesthetic value from biodiverse places, indeed flowering plants and songbirds enhance the everyday beauty of neighborhoods, while community gardens and schoolyards provide opportunities for environmental education and direct experiences of nature, particularly for children. Urban biodiversity can also strengthen social cohesion (Jennings et al., 2024); indeed, collective forms of stewardship (such as volunteer park maintenance or urban farming) bring people together, reinforcing social ties and cultivating a sense of place. Public health benefits extend further since diverse ecosystems regulate pests and disease vectors (for instance, by supporting natural predators of mosquitoes), while also enriching the microbial

environment in ways that may strengthen immune system development (the so-called "hygiene hypothesis") (Marselle et al., 2021). Not all dimensions are positive, of course, cities must also manage disservices, from pollen allergies to conflicts with urban wildlife such as rodents or invasive species. On balance, however, the evidence suggests that protecting and enhancing urban biodiversity should be considered a public health investment in its own right.

The *economic* dimension is also significant. Urban biodiversity and the ecosystem service it supports generate both tangible value and cost savings for cities. Vegetation reduces cooling costs for buildings, intercepts stormwater to lower flooding risks, and improves air quality with measurable impacts on healthcare expenditure; pollination by urban insects benefits urban agriculture and community gardens; the presence of biodiverse green space has been shown to increase property values and to attract businesses and tourism, sometimes described as the "economic premium" of green cities. A well-known example is Milan's *Bosco Verticale* ("Vertical Forest"), two residential towers covered with vegetation designed to enhance biodiversity and regulate microclimates. The innovative towers not only provide habitat for dozens of plant and animal species on its planted balconies but have also become an iconic real estate development that increased surrounding property values (van Remortel, 2021). Yet, as several scholars argue, such high-profile greening projects can also trigger concerns about ecogentrification, green gentrification, and the financialization of urban nature, processes through which environmental amenities become catalysts for real-estate valorization and socio-spatial exclusion (Gould & Lewis, 2016; Anguelovski et al., 2019). Nevertheless, despite these tensions, the integration of nature into urban design, through green roofs, living walls, rain gardens, and other *nature-based solutions* (NbS), is increasingly promoted as a win–win strategy for ecology and the economy, creating employment in planning, landscaping, and horticulture while strengthening long-term urban resilience to climate risks.

A global study by Aronson et al. (2014) found that collectively cities still harbour a significant fraction of global biodiversity – about 20% of all bird species and 5% of all plant species were recorded in a survey of 54 cities worldwide. This paradoxical finding underscores that those urban areas, often thought of as "biodiversity deserts," can contribute to conservation by serving as shelters for wildlife (e.g., in parks, cemeteries, brownfields) and by connecting people to nature in their daily lives. However, it should be noted that urban biodiversity typically consists of a mix of native and non-native species, and cities often have biotic communities that differ from surrounding natural regions due to human

influences. Maintaining native biodiversity in cities is a challenge but is crucial for preserving regional ecological heritage and functions (Aronson et al., 2014).

Urban biodiversity has consequently emerged as a multidisciplinary field of study, and scholars (planners, ecologists, sociologists, public health scholars) have approached it from various angles. Global projections suggest that urban areas worldwide are indeed expected to expand by 1.2 million km² by 2030, with serious implications for biodiversity hotspots and critical habitats (Seto et al., 2012). Biologists and ecologists often focus on quantifying the patterns of species richness and composition in cities and understanding how urban conditions alter those patterns (e.g., comparing urban vs. rural species assemblages). For instance, one key finding is that urban floras and faunas tend to be a filtered subset of the regional biota, usually missing sensitive species but sometimes harbouring hardy native species alongside cosmopolitan non-natives (Aronson et al., 2014). Landscape ecologists emphasize the configuration of green space in cities (patch size, connectivity, and habitat quality) as crucial drivers of urban biodiversity, emphasising that connectivity can mitigate fragmentation and allow the movement of organisms between parks and natural areas, counteracting the fragmenting effect of urban development. Turrini and Knop (2015), for example, used a landscape ecology approach and identified key drivers of urban biodiversity in Swiss cities, finding that the amount of green cover and connectivity of habitats significantly influenced arthropod diversity (Fischer et al., 2016). Their work highlights that even within highly built-up landscapes, thoughtful planning (e.g., creating green corridors or stepping-stone parks) can bolster biodiversity by linking otherwise isolated populations. Another approach is through ecosystem services and NbS; some researchers and city practitioners frame urban biodiversity in terms of the services it provides humans (pollination, cooling, recreation, etc.) and advocate for integrating "biophilic" designs that maximize those benefits. This approach often involves disciplines like urban planning, public health, and environmental economics to evaluate and communicate the value of biodiversity within city policymaking.

At the same time, debates persist about what kind of biodiversity cities should prioritised. Conservation biology has historically privileged wilderness, marginalising urban nature. Today, there is greater recognition that conserving biodiversity in situ within cities is both important and possible. The debate is still open, with ongoing discussions on whether cities should prioritize native species and ecosystems or instead adapt to novel ecosystems made up of both native and non-native species as the new reality (Aronson et al., 2014). Some scholars call

for a pragmatic approach that recognises the contribution of certain novel ecosystems when they provide important ecological functions without creating unacceptable risks; others emphasise the restoration of native habitats as a way to support local ecological heritage and cultural identity. Public perceptions further complicate this field, since charismatic species such as birds and butterflies tend to be celebrated and generally welcomed, while pests or disease vectors (rats, pigeons, mosquitoes) are targeted for control and met with resistance. Managing this complexity requires inclusive governance and communication strategies that enable citizens to understand the value of biodiversity, while also addressing its less desirable aspects through humane and context-sensitive management.

Education and communication are thus central. Across the world, cities have launched urban biodiversity campaigns, citizen science projects (e.g., the City Nature Challenge, iNaturalist observations in cities), and biodiversity action plans that try to engage local communities (IUCN & FOEN, 2012) (see chapters 4 and 5). These efforts help to broaden the concept of urban biodiversity from an academic idea to a living reality that city dwellers can observe and contribute to.

Concluding, urban biodiversity can be defined in multiple ways, but the underlying message is that cities are ecosystems too; protecting and enhancing urban biodiversity and ensuring the conservation and sustainable coexistence of humans and non-humans in urban contexts is now seen as an essential component of creating healthy, liveable, and resilient cities.

1.2 Urbanisation and Biodiversity. Ecological patterns and challenges

Having established what is meant by urban biodiversity and urban nature and why it matters for human well-being, the focus now shifts from conceptual definition to ecological dynamics, examining how urbanisation processes reshape living systems, what has changed in scientific understanding over time, and which patterns, drivers, benefits and risks are most consistently supported by evidence. The aim is to synthesise the state of knowledge about cities as habitats for non-human (or – better – *more-than-human*) life highlighting that they are not merely social or infrastructural entities, but ecological environments expanding at unprecedented rates and exerting mounting pressures on surrounding ecosystems.

Recent datasets confirm both the speed and the ecological significance of urban growth. Global mapping of nighttime lights and ancillary data shows a tripling of built-up extent since the early 1990s, with urban land increasing from roughly 0.22% to 0.69% of Earth's land surface between 1992 and 2020 (Zhao et al., 2022). Forward-looking assessments indicate that where cities expand is as important as how much they expand. A global analysis projects that urban land will continue to grow markedly by mid-century and that this expansion will be a contributing driver of habitat loss for roughly a third of terrestrial vertebrates, with up to 855 species facing particularly large impacts under certain development pathways (Simkin et al., 2022). Looking further ahead, complementary modelling suggests that 11–33 million hectares of natural habitat could be lost to urbanisation by 2100 across socio-economic scenarios, with disproportionately high fragmentation near urban areas and above-average expansion within biodiversity priority regions (Li et al., 2022). Taken together, these studies reinforce a strategic point for this book: cities are not peripheral to biodiversity outcomes. They are increasingly central to them.

The ecological understanding underpinning this conclusion has matured over five decades. Early urban ecology borrowed from island biogeography, treating urban parks and remnants as habitat "islands" in a hostile matrix and emphasising species–area and isolation effects (MacArthur & Wilson, 1967; Davis & Glick, 1978; Faeth & Kane, 1978). Landscape ecology reframed cities as heterogeneous mosaics where patch size, quality and configuration interact with the permeability of the built matrix to shape movement, metapopulations and community assembly (Forman, 1995; Hanski, 1998). More recently, the notion of novel ecosystems has foregrounded that urban assemblages commonly mix native and non-native species under altered soils, hydrology, microclimates and disturbance regimes, and that these assemblages can sustain ecological functions even where historical analogues are absent (Hobbs, Higgs, & Harris, 2009; Hobbs et al., 2014; Kowarik, 2011). Empirically, a nuanced picture has emerged. Cities are sites of biotic homogenisation and environmental stress, yet they also retain non-trivial biodiversity and can even harbour species of conservation concern, particularly where expansion overlaps high-diversity regions (McKinney, 2006; Aronson et al., 2014; Ives et al., 2016). The question is therefore not whether biodiversity can persist in cities, but which combinations of spatial structure and management sustain it, for which taxa[1] and at which scales.

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[1] According to the Oxford English Dictionary, a taxon is defined as "a taxonomic group of any rank, such as a species, family, or class."

Across taxa and cities, a first consistent theme is the joint role of *habitat quantity and quality*. Total area of vegetated and aquatic habitat is a robust predictor of richness at city scale, especially for plants and birds (Aronson et al., 2014; Beninde, Veith, & Hochkirch, 2015). Yet area alone is a weak guarantee of ecological performance. Numerous studies show that small patches can punch above their weight when they are designed and managed for structural complexity and botanical diversity. Layered vegetation, native-rich species palettes and microhabitat features often elevate richness and functional diversity, sometimes approaching or matching larger but ecologically simplified spaces (Nielsen, van den Bosch, Maruthaveeran, & van den Bosch, 2014; Strohbach, Lerman, & Warren, 2013; Matthies, Rüter, Schaarschmidt, & Prasse, 2017). For birds, widely used as indicators, threshold effects recur, diverse assemblages of urban adapters tend to require tens of hectares, whereas forest-interior specialists demand larger extents and lower matrix disturbance (Fernández-Juricic & Jokimäki, 2001; Chamberlain, Gough, Vaughan, Vickery, & Appleton, 2007; Donnelly & Marzluff, 2004; Jokimäki, 1999). Less mobile organisms and habitat specialists are typically more sensitive to both patch extent and isolation, with consequences for viability when suitable habitat is scarce or fragmented (Evans, Chamberlain, Hatchwell, Gregory, & Gaston, 2011). In practice, quantity, quality and spatial distribution need to be considered together, rather than privileging any single metric.

Heterogeneity is a second recurrent theme. Within sites, structural complexity expands niche availability. Features such as vertical layering, dead wood, water bodies and microtopography support richer assemblages across multiple taxa (Nielsen et al., 2014; Kang, Minor, Park, & Lee, 2015). Across urban landscapes, a diversity of green space types (woodlands, wetlands, brownfields, community gardens, riparian zones, verges, pocket parks and green roofs) creates complementary resource environments that raise city-wide richness for comparable total area (Baldock et al., 2015; Beninde et al., 2015; Goddard, Dougill, & Benton, 2010). The benefits of heterogeneity are not automatic. Specialists profit only if microhabitats exceed viable thresholds in size or quality, and if maintenance regimes avoid homogenising conditions through extensive mowing or uniform ornamental planting (Lepczyk et al., 2017). Planning and management therefore need to design, and then maintain, a mosaic of structurally rich habitats, not simply distribute green space evenly.

Connectivity and *matrix permeability* form a third theme. Fragmentation is a defining feature of urban landscapes. Corridors and stepping-stone networks can mitigate isolation by facilitating movement, gene flow and recolonisation, but

their performance is taxon-specific and sensitive to design, edge effects and disturbance (Beier & Noss, 1998; Douglas & Sadler, 2011; Hanski, 1998). Landscape genetics confirms that fragmentation reduces connectivity for a range of taxa, increasing isolation and local extinction risk (Delaney, Riley, & Fisher, 2010; Jha & Kremen, 2013; Munshi-South, 2012). Corridors along rivers, railways and greenways sometimes function as both conduits and habitats. In dense cores, stepping-stone habitats (gardens, courtyards, pocket parks and green roofs) are often more feasible and can be effective for mobile insects and some birds (Rudd, Vala, & Schaefer, 2002; Braaker, Ghazoul, Obrist, & Moretti, 2014). The built matrix is not uniformly impermeable: tree-lined streets, riparian edges and vegetated verges can act as partial conduits that increase neighbourhood-scale connectivity (Tremblay & St. Clair, 2011). A pertinent evidence gap remains: many studies document movement through networks, but fewer demonstrate improved demographic performance attributable to connectivity interventions. Longitudinal, multi-taxon monitoring is required to move from correlation to causation.

Population viability also hinges on life-cycle constraints and resource continuity. Species often require different habitats or resource conditions for breeding, foraging, shelter and dispersal. Ground-nesting bees need suitable nesting substrates and sustained floral resources within foraging range; birds and bats may require spatially separate nesting and foraging areas; amphibians need fish-free breeding ponds linked to terrestrial refugia with appropriate moisture regimes (Lowenstein, Matteson, Xiao, Silva, & Minor, 2014; Pearce & Walters, 2012; Holtmann, Philipp, Becke, & Fartmann, 2017). Even apparently high-quality patches can fail if a single critical resource is missing or too distant. Planning that focuses on resource continuity across seasons and life stages, not merely on the presence of habitat in general, is essential.

The composition of urban biotas raises further questions. Novel-ecosystem thinking encourages evaluation of assemblages by function, risk and trajectory rather than origin alone, while keeping native biodiversity and ecological integrity as primary goals (Kowarik, 2011; Hobbs et al., 2014). In practice, some non-native plants provide nectar and pollen during seasonal gaps, or structural features used by fauna; others are invasive and transform ecosystems. A critical pragmatism has emerged in which non-native elements may be retained or introduced where they demonstrably support target functions without unacceptable risk, and are prevented or eradicated when they are invasive or otherwise harmful. This does not relativise conservation goals. It calibrates means to context and function in service of those goals.

Despite these opportunities, urbanisation remains a powerful driver of biotic homogenisation, favouring generalists over specialists and often suppressing reproductive performance in disturbance-sensitive taxa (McKinney, 2006; Chamberlain, Cannon, Toms, Leech, Hatchwell, & Gaston, 2009; Evans et al., 2011). Several stressors are repeatedly implicated in shaping urban ecosystems.

- Artificial light at night that disrupts navigation, foraging and predator–prey dynamics for nocturnal insects and other taxa, with both behavioural and energetic consequences (Bates et al., 2014).
- Chronic noise interferes with acoustic communication and can alter behaviour and physiology in birds and other organisms.
- Air and water pollutants have direct and indirect effects on organisms and on soil and aquatic microbiomes.
- The urban heat island modifies microclimates and phenology, favouring heat-tolerant taxa while stressing others.
- Impervious surfaces alter hydrology, increasing flashiness and pollutant transport.

NbS can mitigate these stressors by increasing canopy cover and evapotranspiration, restoring soil–water interactions and filtering stormwater, but outcomes are contingent on-site design, plant palettes, soil function and maintenance (Elmqvist et al., 2013).

A particular concern is the emergence of ecological traps and sink habitats. Traps occur where familiar habitat-selection cues no longer correlate with true habitat quality, leading organisms to prefer sites where survival or reproduction are insufficient to sustain populations (Battin, 2004; Robertson, Rehage, & Sih, 2013). In cities, examples include songbirds nesting in vegetation structures that expose them to subsidised predators such as domestic cats and corvids (Bonnington, Gaston, & Evans, 2015), nocturnal insects attracted to artificial light with consequent energetic costs and predation (Bates et al., 2014), and amphibians breeding in stormwater basins that contain fish predators or unsuitable hydroperiods (McCarthy & Lathrop, 2011). Sinks differ in that they are occupied when better habitats are saturated, yet both phenomena can depress populations. Risks rise in small, isolated or degraded patches. Auditing and redesigning such sites is therefore a necessary element of biodiversity-positive urban management.

Alongside risks are significant benefits and co-benefits. Biodiversity underpins ecosystem functions that matter where people live. Pollinator-friendly,

structurally diverse plantings enhance pollination and pest regulation; vegetation cools microclimates through shade and evapotranspiration; trees and soils intercept and infiltrate stormwater; and vegetation can improve air quality through deposition and sequestration (Elmqvist et al., 2013; Baldock et al., 2015). There is growing evidence that biodiverse green spaces are perceived as more restorative than simplified ones and are associated with mental and physical health benefits, although the exact dose–response relationships remain an active area of inquiry (Barton & Pretty, 2010; Marselle et al., 2021; Shwartz, Muratet, Simon, & Julliard, 2013). These gains are not automatic. They depend on design and maintenance choices, and they must be balanced against potential disservices such as allergenic pollen or poorly maintained vegetation that negatively affects perceived safety.

Two pragmatic observations about urban form are relevant here. First, everyday places count. Private gardens, courtyards, school grounds and roadside verges together represent a large share of urban land. Cumulatively, they can transform ecological character at neighbourhood scale and act as distributed stepping stones that link larger habitats (Goddard et al., 2010; Rudd et al., 2002). Second, small but numerous interventions can be powerful where large reserves are infeasible. Evidence from community-led greening indicates that modest increases in habitat quality in small sites can yield measurable biodiversity gains (Strohbach et al., 2013; Shwartz et al., 2013). These insights are particularly pertinent in compact historic fabrics typical of many European and Mediterranean cities, where constraints on space are significant but social capacity for stewardship is often high.

Important evidence gaps remain. Birds and vascular plants in temperate cities are comparatively well studied; invertebrates, soil biota, herpetofauna and fungi are under-represented, as are cities in the Global South where urbanisation is rapid and coincides with high endemism (Cilliers, Cilliers, Lubbe, & Siebert, 2013; Lepczyk et al., 2017; McDonald et al., 2020). Much of the literature relies on presence–absence or richness measures. There is a need for demographic endpoints – birth, death, immigration and emigration – that link interventions to population viability, especially for understudied taxa (Lepczyk et al., 2017; McDonald et al., 2020). Size, quality and connectivity thresholds are comparatively well characterised for some birds but poorly defined for many other groups. Multi-taxon studies across spatial scales are required to identify synergies and trade-offs, since designs that benefit one group may be neutral or detrimental to others (Matthies et al., 2017; Melliger, Rusterholz, & Baur, 2017). Connectivity remains a plausible lever, but further longitudinal research is needed

to test whether corridors and stepping-stone networks improve demographic performance, not just movement, and under which designs and maintenance regimes (Beier & Noss, 1998; Douglas & Sadler, 2011). Finally, systematic identification of ecological traps and sinks in different urban contexts, and testing of mitigation strategies, would help avoid well-intended but counterproductive interventions (Battin, 2004; Robertson et al., 2013).

From a planning and design perspective, five propositions summarise the implications of this evidence base.

1. First, maximise feasible vegetated and aquatic area, but never equate area with success. Where space is constrained, pursue fine-grain gains by reclaiming under-used surfaces and rights-of-way and by improving quality.

2. Second, elevate habitat quality and structural complexity by replacing uniform lawns and low-diversity plantings with layered vegetation, functionally appropriate palettes, soil restoration, dead wood where safe and water features, while reducing pesticides and planning for seasonal resource continuity.

3. Third, design for life-cycle needs at appropriate scales, providing nesting, foraging and shelter resources within movement ranges for target taxa and ensuring proximity between complementary habitats.

4. Fourth, plan connectivity strategically, combining corridors where realistic with dense stepping-stone networks, and improve matrix permeability through street trees, verges and linear features.

5. Fifth, audit and avoid traps and sinks by aligning habitat cues with true quality, managing subsidised predators and mitigating light and noise where they repeatedly depress reproduction or survival. Measurement frameworks can support these moves. The Singapore Index on Cities' Biodiversity provides a practical indicator set for extent and configuration of nature, biodiversity, ecosystem services and governance, and has been applied by municipalities to establish baselines and track progress (Centre for Liveable Cities, 2015). Coupling such indices with targeted ecological monitoring can align biodiversity aims with climate adaptation, health and equity agendas in ways that are locally legible and politically durable.

Why, then, should cities care now? Because urbanisation will shape biodiversity trajectories over the next decades both directly, through land conversion in and around hotspots and protected areas, and indirectly, through teleconnections of

resource demand and waste. Cities concentrate the institutional capability, infrastructure and publics needed to experiment, learn and scale solutions quickly. They are also where many people experience nature most frequently. The literature reviewed here shows not only that biodiversity can persist in cities, but that ecological design and management choices – about quantity, quality, heterogeneity, connectivity and stressor mitigation – make a measurable difference. Attending to those choices is central to credible urban conservation and to the wider co-benefits for climate resilience, health and social cohesion that make biodiverse cities better places to live.

1.3 Contextual framework in Europe

Urban biodiversity governance in Europe operates within a robust multi-level framework of policies, strategies, and institutions. The European Union (EU) has emerged as a global leader in biodiversity conservation and sustainable urban development, providing a comprehensive contextual framework that guides member states and cities (Rando, 2020). At the highest level, the EU subscribes to international agreements such as the Convention on Biological Diversity (CBD) and the UN Sustainable Development Goals, but it also develops its own binding legislation and strategies. Two cornerstone legal instruments for biodiversity in Europe are the Birds Directive (Directive 2009/147/EC) and the Habitats Directive (Directive 92/43/EEC), which together establish the Natura 2000 network of protected areas.

These directives require member countries to protect habitats and species of European importance, some of which are located at the urban fringe or even within urban boundaries. In fact, more than 11,000 Natura 2000 sites lie in or partly in cities (about 15% of the entire network by area) (EU, 2020a). This means many European cities have a direct responsibility for managing protected natural areas and species, integrating biodiversity conservation into urban planning (for example, cities like Sofia and Rome contain Natura 2000 sites that must be maintained amid urban growth). The implementation of these directives in urban contexts exemplifies the multi-level governance structure: the EU sets targets and legal standards, national governments transpose them into laws and conservation plans, and local authorities often carry out on-the-ground management and monitoring of urban-adjacent reserves or species (Rayner & Jordan, 2013; 2016).

In recent years, the EU has scaled up its ambition through the European Green Deal, a sweeping policy agenda launched in 2019 that aims to transform the EU into a sustainable, climate-neutral economy by 2050 (EC, 2019). The EGD explicitly links climate action with protection of biodiversity and public health, acknowledging that greener cities are essential for a greener Europe. As part of the EGD, the European Commission introduced the EU Biodiversity Strategy for 2030: Bringing Nature Back into Our Lives in May 2020. This strategy is a comprehensive roadmap to halt and reverse biodiversity loss across the EU, and it contains several provisions highly relevant to urban biodiversity governance. Notably, it calls for making cities greener and sets specific commitments: "*European cities of at least 20,000 inhabitants [should] develop ambitious Urban Greening Plans by the end of 2021*" and implement these plans by 2030 to systematically bring nature back into the urban environment.

These Urban Greening Plans are expected to include measures such as creating new parks, green roofs and walls, planting native trees, restoring urban wetlands or rivers, and connecting urban green areas with ecological corridors (EU, 2020a). The Strategy also proposes that by 2030 there should be no chemical pesticides used in sensitive areas like public parks and playgrounds in cities, recognizing the need for healthy, biodiversity-friendly urban environments. Moreover, it encourages cities to "halt the loss of urban green spaces" and suggests increasing the overall green space and tree canopy cover in European cities as a contribution to broader EU biodiversity and climate goals. These targets under the EU Biodiversity Strategy 2030 effectively push urban authorities to mainstream biodiversity considerations into city planning and development. The strategy's headline commitments – such as protecting 30% of land and sea, planting at least 3 billion trees by 2030, and restoring degraded ecosystems – also have urban dimensions (for example, many of those 3 billion trees are intended to be planted in or near cities, as urban and peri-urban forestry).

To support and monitor these ambitions, the European Commission launched the Green City Accord in 2020, a voluntary initiative engaging city mayors across Europe to commit to environmental improvements in five key areas: air, water, nature and biodiversity, waste/circular economy, and noise (EU, 2020b). By signing the GCA, cities pledge that by 2030 they will make significant progress in "*conserving and enhancing urban biodiversity, including through an increase in the extent and quality of green areas in cities, and by halting the loss of and restoring urban ecosystems*". They also agree to improve access to green spaces for citizens. This initiative complements regulatory frameworks by fostering a network of cities that share best practices and report on their achievements. It works in synergy with other EU programs like

the European Green Capital Award, which each year recognizes one city for exemplary sustainability including nature protection, and the Green Leaf Award for smaller cities (EC, 2024). These programs have created a positive competition and learning platform – cities like Ljubljana, Lisbon, and Stockholm (Green Capital winners) have showcased ambitious urban biodiversity projects (e.g., Ljubljana's bee-friendly city initiative, Lisbon's Green Infrastructure Plan) that serve as models for others (Eurocities, 2021).

EU policy also encourages NbS and green infrastructure in urban areas. The EU Green Infrastructure Strategy (2013) and the updated EU Adaptation Strategy (2021) both emphasize using natural systems in cities to provide ecological and climate adaptation benefits. For instance, restoring river floodplains in a city not only reduces flood risk but also creates wetlands for biodiversity; planting trees helps with heat reduction and provides habitats. Many of these ideas are now backed by EU funding instruments: the LIFE Programme has funded urban nature restoration projects, and research initiatives under Horizon 2020/Europe have invested in demonstration projects for urban NbS (like the URBAN GreenUP and Connecting Nature projects). Thus, European cities have access to financial and knowledge support to implement biodiversity-friendly measures (NetworkNature, 2020).

Governance structures across European cities vary, but there is a trend toward more integrated and participatory approaches in urban environmental management (Reiners & Grimm, 2020). City governments are increasingly developing dedicated biodiversity strategies or Action Plans at the municipal level, aligning with EU and national objectives. For example, cities such as London, Paris, Barcelona, and Berlin each have urban biodiversity plans or green infrastructure strategies that set local targets for habitat conservation, invasive species control, and citizen engagement. Many cities appoint "biodiversity officers" or create working groups that include NGOs, scientists, and community representatives to guide implementation (Eurocities, 2021). This reflects the understanding that biodiversity governance benefits from involving stakeholders beyond the city planning department alone – parks agencies, education departments, civil society, and the public all have roles to play. European city networks and associations facilitate exchange on governance innovations: ICLEI's "Cities with Nature" platform, for instance, and EUROCITIES working groups on green areas, allow municipalities to share experiences in implementing the EU framework at local level.

Policy implementation still faces challenges. A mid-term assessment by the European Environment Agency noted that despite progress, urban sprawl and land take continue to cause fragmentation of habitats in parts of Europe (EEA, 2024). Enforcement of EU directives can be inconsistent – some cities struggle to meet air and water quality standards which indirectly affect urban biodiversity (e.g., nitrogen pollution can degrade urban ecosystems). Additionally, there are disparities in resources and capacity: larger or wealthier cities in Northern and Western Europe often have more funding and expertise to devote to green planning than smaller cities or those in economically weaker regions. The EU addresses some of this through cohesion funds and specific support (for example, the URBACT program (Urbact, 2024) has facilitated projects on urban pollinators and green space planning for medium-sized cities in Eastern Europe). Governance is also complicated by the multi-level nature of competence: while the EU sets broad targets, detailed land-use decisions are local. This means that achieving the EU's urban biodiversity goals will depend on effective vertical integration – i.e., national governments translating EU strategies into supportive legislation (such as requiring urban green plans, as mandated) and providing incentives, and local governments taking ambitious action on the ground.

Several European countries have already experimented with national initiatives on urban biodiversity that anticipate or complement EU strategies. For instance, in France the *Nature en Ville* - "Nature in Cities" program has been running since 2017, requiring municipalities to conduct biodiversity inventories prior to urban development and encouraging the use of ecological planning tools at local level (EEA, 2019). Germany, for its part, has incorporated a set of urban ecological indicators into its National Biodiversity Strategy including metrics on habitat connectivity, tree canopy, and species richness in cities, which are now monitored regularly and reported at the federal scale (Muller & Werner, 2024). Italy – as discussed below – has aligned its updated National Biodiversity Strategy with the objectives of the EU Biodiversity Strategy for 2020, explicitly referencing urban greening, NbS, and the integration of biodiversity into metropolitan planning (Ministero dell'Ambiente e della Sicurezza Energetica, 2023).

Against this backdrop of fragmented but converging national experiences, the European Union has taken a decisive step by adopting the Nature Restoration Regulation (also widely referred to as Nature Restoration Law in policy debates and communication). Regulation (EU) 2024/1991, in force since 18 August 2024, transforms what used to be voluntary goals into binding legal commitments (European Union, 2024). Rather than encouraging cities to experiment, the Regulation requires them to act, embedding urban biodiversity

within the EU's legal architecture of restoration. This represents a genuine scale jump because what was previously dispersed across national programs is now unified under a common baseline, shared indicators, and a mandatory reporting cycle. The implications for governance are significant. Cities and towns are no longer free to define their own monitoring systems but must align with EU-defined indicators and national frameworks. Local administrations will need to integrate biodiversity baselines into urban information systems, adapt planning instruments, and coordinate with regional and national authorities to meet binding targets. In practice, the NRR reconfigures the relationship between municipalities and the EU, shifting urban biodiversity from an optional dimension of environmental policy to a legally enforceable requirement with clear deadlines, responsibilities, and accountability mechanisms (IEEP, 2024).

Box 1 *The EU Nature Restoration Law*

What the EU Nature Restoration Law means for cities (Art. 8)

Regulation (EU) 2024/1991 entered into application on 18 August 2024 (European Union, 2024)

Article 8 introduces binding obligations on urban green space and tree canopy cover in all mapped urban ecosystem areas.

Obligations:

- *Baseline 2024*: reference year for monitoring.
- *By 2030*: no net loss of green space and canopy.
- *From 2031*: both indicators must show an increasing trend until what are defined as "satisfactory levels" are reached, levels that each Member State is required to determine by 2030 on the basis of a guiding framework that the European Commission will adopt by 2028 (Ibid).

The Regulation also requires the mapping of urban ecosystem areas across cities, towns, and suburbs, making clear that local authorities will need to align their GIS layers and monitoring systems with national definitions. Monitoring has already begun, data collection on green space and canopy started at the entry into force of the Regulation, and the first progress report is due by 30 June 2028. Thereafter, reporting will become periodic and compulsory, embedding urban biodiversity indicators into the EU's legal cycle of environmental accountability (Ibid).

An important nuance is that Member States may exclude from their calculations those urban areas where green space already exceeds 45% and canopy cover surpasses 10%. However, even in these cases, the Regulation stresses the importance of pursuing qualitative gains in terms of accessibility, connectivity, and equity, rather than relying solely on quantitative thresholds (European Union, 2024). Finally, the NRR requires that each Member State prepares a National Restoration Plan to be submitted to the Commission by 1 September 2026, where the role of cities in delivering Article 8 targets will be explicitly assessed (Ibid; IEEP, 2024).

In summary, Europe's contextual framework for urban biodiversity is characterized by a strong top-down vision (now reinforced by the Nature Restoration Regulation alongside the Green Deal strategies) combined with growing bottom-up action through city-led accords and local plans. European cities are increasingly viewed as key actors in meeting continental biodiversity goals. Governance is therefore multi-level: EU institutions provide direction, coordination, and funding; national governments adapt and enforce policies; and local authorities implement concrete measures and engage citizens. This nested governance model, while complex, has positioned Europe at the forefront of urban biodiversity policy. Many challenges remain – such as bridging the implementation gap and ensuring all cities, big or small, can progress – but the framework in place is unprecedented in scale and ambition. European experiences thus provide valuable lessons in how policy and governance can drive urban biodiversity conservation in practice.

1.4 The Mediterranean Area and Southern Europe

The Mediterranean region of Europe warrants special attention in the context of urban biodiversity because it combines exceptional ecological richness with intense anthropogenic pressures, pronounced climatic vulnerability, and enduring socio-institutional complexities that profoundly shape how biodiversity is protected, managed, and communicated in urban contexts (Buckley & Carret, 2024; Cuttelod et al., 2008). Southern European countries (e.g., Italy, Spain, Greece, Portugal) and neighbouring Mediterranean countries face unique environmental and socio-economic conditions that influence how EU biodiversity policies are applied on the ground (ScienceDaily, 2012). The

Mediterranean Basin is a recognized global biodiversity hotspot – it harbours an exceptionally high number of endemic species and diverse ecosystems, from marine habitats to coastal wetlands and mountain forests. This natural richness, however, intersects with ancient human settlements and some of the world's highest urbanization and tourism pressures along the Mediterranean coasts. Furthermore, the Mediterranean climate (hot, dry summers and mild, wet winters) poses distinct challenges for urban greenery, as water scarcity and heat stress can limit the survival of vegetation and wildlife in city environments. Governance in this region must therefore contend with balancing conservation and development under climate constraints and often with limited resources.

EU member states in the Mediterranean have embraced the broad goals of the European Green Deal and Biodiversity Strategy, but their trajectories can differ from their northern counterparts. Take Italy as an illustrative case – Italy is frequently highlighted as a biodiversity hotspot within Europe, boasting one of the highest numbers of animal and plant species on the continent. At the same time, about 68% of Italy's population lives in urban areas, meaning the success of biodiversity conservation nationally is intertwined with what happens in its cities. In 2012, the Italian Ministry of Environment adopted the National Biodiversity Strategy 2030, explicitly aligning it with the EU Biodiversity Strategy (Ministry of Ecological Transition, 2022). This national strategy reinforces key EU targets at the country level – for example, it calls for equipping all towns over 20,000 inhabitants with an ambitious urban greening plan and for eliminating pesticide use in sensitive urban areas, mirroring the EU's 2030 objectives. The strategy also emphasizes the creation of ecological networks in urban and peri-urban areas, seeing cities as essential nodes in Italy's ecological connectivity. The governance structure for implementing this involves Italy's regions and municipalities: guidelines and funding are provided from the national level, but city governments must craft and execute the local Urban Greening Plans (Piani del Verde Urbano) with concrete actions like expanding park systems, planting trees, and improving habitat quality in and around cities.

Italy has started to back these commitments with significant investment. Through the EU-funded National Recovery and Resilience Plan (PNRR), Italy earmarked €330 million for urban and peri-urban forestry projects in 14 metropolitan city areas, with a goal to plant 6.6 million new trees by 2024 (ISPRA, 2022). This massive tree-planting initiative (sometimes dubbed the "Metropolitan Forest" plan) aims to combat air pollution and climate change in cities while enhancing urban biodiversity. For instance, Milan's own program – ForestaMI – seeks to add 3 million trees across the greater Milan area by 2030,

and other cities like Naples, Rome, and Turin have parallel greening projects (Forestami, 2024). Such projects not only create habitats (continuous tree canopies, new urban woodlands) but are also heavily communicated to the public to build support – they tie in themes of climate justice, public health, and beautification that resonate with citizens. Italian cities, often characterized by dense historic centers with limited green space, are exploring innovative ways to increase biodiversity: green roofs and facades (inspired by Bosco Verticale's success), converting under-utilized lots into community gardens or pocket parks, and restoring urban rivers (e.g., Turin's renaturalization of the Po River banks).

However, governance challenges remain, especially in ensuring long-term maintenance of new green infrastructures and in equitably distributing green spaces. Socio-economic disparities in Italian cities can mean that affluent districts have lush parks while peripheral or low-income neighborhoods lack greenery, a point that municipal biodiversity plans are trying to address by prioritizing greening in underserved areas as a matter of environmental justice. Communication campaigns – from school education programs about urban nature to public outreach during the drafting of urban greening plans – are being used to involve residents in the process and to emphasize the shared benefits of urban biodiversity (for example, Milan's "Citizen Foresters" initiative invites volunteers to help plant and monitor trees, fostering a sense of stewardship) (Euronews, 2022).

In the Mediterranean context, it is also instructive to consider cities outside the EU, such as those in the Western Balkans, where European policies exert influence through accession processes and regional cooperation. Tirana, the capital of Albania, offers a compelling case of how urban biodiversity can become part of a broader political and diplomatic project. Albania is not yet a member of the European Union, but as a candidate country it has been aligning its environmental and urban policies with EU standards, including the drafting of an updated National Biodiversity Strategy and the expansion of protected areas (European Commission, 2023).

This EU-oriented trajectory is also visible in Tirana's urban development. Since the 1990s, the city has experienced explosive growth, with its metropolitan population now approaching one million. Rapid urban sprawl and informally built neighbourhoods initially lacked green infrastructure, exacerbating problems of overcrowding, urban heat islands, and flood-prone areas along rivers such as the Lana (UN-Habitat, 2016). In response, the city government has in recent years embarked on an ambitious transformation that prominently features

greening and biodiversity (EBRD, 2018). Initiatives such as large-scale tree-planting campaigns, the regeneration of riverbanks, and the creation of new parks are not only framed as local responses to environmental stress but also as visible markers of Albania's willingness to embrace European ecological values.

In this sense, Tirana's greening agenda functions as both an urban adaptation strategy and a soft power tool. By investing in urban biodiversity and presenting itself as a forward-looking, environmentally responsible capital, Albania seeks to strengthen its image within Europe and demonstrate its readiness for deeper integration. These initiatives allow Tirana to position itself as a "green frontrunner" among candidate cities, showing that EU norms are not only adopted formally in legislation but also embodied in everyday urban life and spatial planning (Bechev, 2018; Bonomi & Uvalic, 2020).

The broader Mediterranean region faces common challenges that strongly shape urban biodiversity governance. The climate crisis is particularly acute in Southern Europe, where projections point to more intense heatwaves, prolonged droughts, and recurrent wildfires (IPCC, 2022; European Environment Agency, 2020). Urban biodiversity strategies must therefore be climate-smart: selecting drought-tolerant native plant species, ensuring efficient irrigation and water reuse, and using NbS as part of climate adaptation (Kabisch et al., 2016). Cities such as Athens, with its emerging "pocket forests," or Barcelona, where Climate Refuge shelters double as biodiversity hubs, illustrate how ecological interventions can mitigate heat stress while providing social benefits (Santamouris, 2020; Ajuntament de Barcelona, 2021).

Socio-economic strain is another significant barrier. Economic crises and high unemployment in countries like Greece, Italy, and Spain often push biodiversity down the policy agenda. Yet there is increasing recognition that investing in green infrastructure can generate jobs in landscaping, urban farming, or ecotourism, while also improving public health and urban attractiveness (OECD, 2020). Indeed, both Italy and Spain have mobilised EU COVID-19 recovery funds to support green city projects, framing them as part of sustainable economic recovery (European Commission, 2021). Nonetheless, long-term maintenance of green areas remains a challenge for austerity-hit municipalities. Innovative governance solutions, from public–private partnerships in park management to community-led stewardship of neighbourhood green spots, are helping distribute responsibilities and keep citizens engaged (Buijs et al., 2016).

The Mediterranean also illustrates how EU-wide biodiversity and climate strategies are adapted to local contexts. Italy has aligned closely with European

frameworks, directing substantial resources towards urban biodiversity, while non-EU cities such as Tirana have embraced green planning as a pathway to modern, healthy urban living (Tjallingii, 2015; European Commission, 2023). Regional challenges (including water scarcity, heat stress, limited green space, and fiscal constraints) are being tackled through a combination of policy compliance, innovation, and community participation. Examples range from Rome's preservation of semi-natural peri-urban parks with high biodiversity value, to Seville's drought-resistant street trees or rooftop farming initiatives in Athens (Salvati et al., 2019).

Ultimately, governance in this context is not only about meeting EU targets but about shifting urban mindsets by encouraging planners to integrate ecological thinking into every project and helping citizens recognise that biodiversity is a foundation for liveability rather than a luxury. As Mediterranean cities increasingly share experiences through Euro-Mediterranean networks and as younger generations call for greener and more equitable environments, biodiversity is becoming embedded in both governance structures and urban identities across Southern Europe (McPhearson et al., 2021).

Chapter 2

Tracing the Research Path

Nunzia Borrelli and Monica Bernardi

2.1 Framing the inquiry

This book sets out a central question, namely how biodiversity is governed, communicated, and lived in contemporary cities, and what this reveals about the possibilities and limits of ecological transition.

The inquiry adopts a multi-site and multi-method design, centred on the institutional, discursive and socio-political processes that shape urban biodiversity action, in terms of governance arrangements, communicative strategies and engaging processes, so as to explain both what cities do and how they do it.

First, it investigates the *perspectives of experts* in the field, who provide insights into the current state of urban biodiversity, the progress achieved so far, and the emerging horizons for future work. Their contribution is particularly relevant since allows to understand progresses, challenges and future horizons. Second, the study turns to Milan, a large metropolitan system embedded in EU environmental agendas and transnational networks. Milan's policies, governance architecture, communicative strategies and engagement processes serve as a benchmark for understanding how biodiversity is mainstreamed within a mature urban system with strong administrative capacity and alignment with EU agendas. Then the analysis widens to three additional Italian cities, Florence, Genoa, Palermo, each representing distinctive socio-ecological configurations and governance trajectories. The multi-city comparison allows the study to identify shared patterns and divergences across Italian urban biodiversity governance, such as differences in institutional maturity, planning cultures, data infrastructures, departmental coordination, and the integration of biodiversity into climate transition narratives. The heterogeneous Italian cases provide an empirical terrain for identifying both structural constraints and promising innovations. The inquiry also introduces a cross-border perspective through the case of Tirana. As a rapidly transforming capital city undergoing European

alignment, Tirana illustrates how biodiversity governance evolves in contexts characterised by fast-paced development, uneven institutionalisation, and intense pressure on green systems. Its juxtaposition with Milan and the Italian cities illuminates how European frameworks, administrative capacity, and political agendas shape the uptake and localisation of biodiversity commitments in diverse Mediterranean settings.

Across these components, the study pursues a set of interrelated research objectives: to understand how urban biodiversity becomes a matter of governance and public action; to identify how global and European frameworks (from the post-2020 Global Biodiversity Framework to the EU Biodiversity Strategy 2030) are translated into urban policies; to assess how cities communicate biodiversity, mobilise actors, and cultivate public literacy; and to highlight actionable levers for strengthening implementation capacities.

The contribution is significant on multiple levels.

- Academically it advances scholarship on urban sustainability transitions by supplying Mediterranean-focused evidence, an area less covered than Northern Europe or North America. It traces how global and European frameworks (e.g., the EU Biodiversity Strategy 2030 and the post-2020 Global Biodiversity Framework) are translated locally, and how climatic, socio-economic, and historical specificities mediate outcomes.

- Conceptually, it frames biodiversity as a relational urban infrastructure, as a web of ecological and social relations embedded in the city's fabric that underpins resilience, distributes opportunities, and mediates human–non-human interactions. From this angle, biodiversity is simultaneously an ecological asset and a field of governance and citizenship, where rights, responsibilities, and ecological justice are negotiated.

- Practically it informs ongoing efforts. Many European and Mediterranean cities are revising or drafting greening and biodiversity plans considering evolving EU guidance and legally binding restoration objectives. The study speaks directly to these processes by highlighting both effective practices (e.g., public–private stewardship models for urban nature areas; targeted communication that demonstrably improves biodiversity literacy) and recurrent bottlenecks (e.g., departmental silos, data gaps for decision-making, uneven capacities). It points to areas where capacity building (training, data governance,

interdepartmental coordination) and enabling reforms (multi-level alignment, resourcing) can increase impact.

- In terms of transnational alignment, the research resonates with the post-2020 Global Biodiversity Framework, particularly goals related to urban areas and subnational governments' role in biodiversity. Cities are increasingly recognised in forums like the CBD's Conferences of the Parties and networks like the C40 Cities for their role in biodiversity action. The work done in NBFC's urban biodiversity study could thus inform not only local Italian or Albanian policies but also serve as a reference for other Mediterranean cities or feed into European Commission guidance on urban nature (especially as the EU considers making urban greening plans a more binding requirement in the future).

- Finally, the research is closely aligned with the mission and architecture of the National Biodiversity Future Center (NBFC), operating as a hub connecting scientific research, municipal action, and practitioner knowledge. By situating its findings within this multilevel system, the study speaks both to local implementation and to the broader transnational discussions that are elevating the role of cities in biodiversity governance (from the CBD's Conferences of the Parties to networks such as C40 and ICLEI). In addition, by situating recommendations within Mediterranean specificities, for instance, water scarcity, heat extremes, and heritage-dense urban fabrics, it avoids "one-size-fits-all" transfers. The evidence gathered here offers insights that are relevant for European and Mediterranean cities seeking to align local action with global biodiversity commitments while adapting them to their specific socio-ecological realities.

2.2 Designing the research

The methodological design of the study was guided by the ambition to explore urban biodiversity not as an isolated environmental concern, but as a field where governance, communication, and social practices intersect. The approach is therefore qualitative and multi-method in order to capture the contextual complexity and relational dynamics that shape how biodiversity is framed, implemented, and experienced across different cities. The three dimensions were

chosen exactly to provide a comprehensive framework for analysing how cities address biodiversity challenges and opportunities.

The first dimension, *governance* of urban biodiversity, examines the institutional frameworks, policies, and strategies cities employ to protect and enhance biodiversity. This includes understanding the roles and responsibilities of various stakeholders, decision-making processes, and the integration of biodiversity considerations into broader urban planning and development agendas. Urban governance is indeed increasingly recognized as pivotal in shaping ecological outcomes, particularly in the face of climate change and rapid urbanization (Bulkeley & Broto, 2013).

The second dimension focuses on *communication* and promotion strategies exploring how cities and public administrations raise awareness about biodiversity among citizens and stakeholders; it includes public campaigns, media strategies, and the use of digital platforms to engage diverse audiences. The theme of effective communication is critical not only for disseminating information but also for fostering a sense of shared responsibility and action toward biodiversity conservation (Moser & Dilling, 2011).

The third dimension addresses the *socialisation and education* of citizens about urban biodiversity, by including formal educational initiatives, community engagement programs, and participatory projects that aim to cultivate an ecological consciousness and active involvement in biodiversity-related activities. Scholars (among others: Gifford & Nilsson, 2014) referred that socialisation processes are essential for empowering citizens to become stewards of urban nature, bridging the gap between policy intentions and grassroots action.

To investigate these dimensions, the study adopted a qualitative research design that combines document analysis and semi-structured interviews with experts and local stakeholders at city-level with selected case studies in Mediterranean contexts. This multi-method approach enables a first exploration of practices, strategies, and challenges associated with urban biodiversity management, communication, and citizen engagement. It also makes it possible to capture the contextual and relational complexities of biodiversity initiatives, together with the perspectives of those directly involved in their implementation.

The comparative design of the research is centred on Milan and Tirana, with the ambition to capture contrasting yet complementary trajectories within the Mediterranean context. The idea was not to establish a hierarchy or to identify a "model" of best practice, but rather to highlight how distinct urban, institutional, and political contexts shape the way biodiversity is positioned, governed, and communicated. Milan a large metropolitan system embedded in the European

Union's environmental and urban agendas, where biodiversity has become increasingly visible within strategies for climate adaptation, green infrastructure, and sustainable urban development. The city is deeply involved in transnational networks and European projects, which provides opportunities for innovation and exchange, but interviews and document analysis reveal persistent challenges of coordination across administrative levels and sectors. These tensions make Milan a particularly instructive case, not because it exemplifies an "advanced" model, but because it illustrates the difficulties and negotiations inherent in translating ambitious goals into coherent governance and citizen-oriented strategies even in advanced contexts. Tirana, in contrast, offers the perspective of a fast-transforming capital city in the Western Balkans, where environmental governance is progressively aligning with the European acquis as part of Albania's candidacy for EU membership. Here biodiversity policies are shaped by processes of institutional reform, international influence, and rapid urban expansion. The case of Tirana allows us to examine how emerging governance frameworks interact with developmental pressures, and how narratives of ecological transition are mobilised in contexts marked by implementation gaps and uneven institutional capacity. Taken together, the two cities enable a comparative exploration of urban biodiversity governance across different stages of institutionalisation and European integration. This pairing highlights not only divergence in trajectories, but also shared challenges such as balancing ecological ambitions with socio-economic constraints, negotiating multi-level governance, and engaging citizens in meaningful ways. By situating the two cities side by side, we do not claim to offer a polarity between "advanced" and "lagging" cases, but rather to show how diverse urban systems grapple with the complexity of integrating biodiversity into broader climate and sustainability agendas.

To extend the comparative framework three further Italian cities, Florence, Genoa, and Palermo, were incorporated into the analysis. They were selected for their distinctive geographical, cultural, and socio-political profiles in the Mediterranean context. Florence offers a distinctive setting where ecological policies unfold within a city globally recognised for its cultural heritage and historic urban fabric. The inclusion of Florence allows examination of how biodiversity and environmental agendas intersect with the conservation of monumental landscapes, and how ecological transition is negotiated in a context where cultural identity and tourism exert powerful pressures on planning priorities. Genoa, by contrast, is a major port city whose ecological challenges are closely tied to its coastal and maritime position. Biodiversity governance in this context must contend with marine ecosystems, industrial legacies, and port-related externalities, while also engaging with issues of resilience to flooding and landslides. Genoa thus represents an important case for

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understanding how maritime and coastal pressures reshape urban ecological governance and require integration across land-sea interfaces. Palermo illustrates yet one dimension: the dynamics of biodiversity governance in Southern European urban contexts marked by socio-economic fragility, resource constraints, and uneven institutional capacities. The city's environmental initiatives are confronted with structural inequalities, limited administrative continuity, and competing social priorities; the case makes visible how biodiversity governance intersects with broader struggles for social equity, economic resilience, and territorial cohesion. The inclusion of these three cities therefore expands the analytical scope beyond the two principal cases of Milan and Tirana, enabling the identification of both convergent dynamics and context-specific divergences. Together, Florence, Genoa, and Palermo highlights how urban biodiversity Is negotiated across diverse Institutional landscapes, highlighting the extent to which ecological strategies are shaped by cultural heritage, maritime geographies, and socio-economic vulnerabilities. Rather than constructing a hierarchy among cases, this selection allows us to map diversity and uncover patterns of convergence and divergence across contexts.

Regarding data collection, the primary method was semi-structured interviews, useful to address a common set of themes while leaving room for participants to articulate their own interpretations, experiences, and narratives (Silverman, 2020). In total, twenty-one interviews[2] were conducted

- Six interviews were carried out with experts in urban biodiversity, including academics, consultants, planners, environmental journalists, and political ecologists, selected for their recognised expertise and active engagement in biodiversity research and practice.
- A further six interviews focused specifically on the case of Milan, engaging local experts and practitioners directly involved in biodiversity-related planning and initiatives.
- Similarly, six interviews were conducted in Tirana, with stakeholders active in urban planning, environmental governance, and biodiversity management.
- Finally, one interview was held with a representative of the public administration in each of the three additional Italian cities, identified based on their roles in urban planning, environmental policies, or biodiversity initiatives within the local administrative departments, in order to capture city-specific institutional perspectives.

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[2] We warmly thank all interviewees who generously shared their time, experience and insights with us. Their contributions were essential to shaping the analyses presented in this book.

The interviews in Tirana were administered in presence in September 2024, while all the interview in Milan, Florence, Genoa and Palermo took place online between October 2024 and January 2025 via video conferencing platforms (except for one). Each interview lasted approximately 60 minutes and was recorded with the participants' consent. The transcription was made through NVIVO Transcription to ensure the accuracy and reliability of the data. Ethical considerations, including informed consent and data confidentiality, were strictly adhered to throughout the research process (Silverman, 2020).

The methodological design combined two complementary levels of analysis. At the level of city profiling, four analytical parameters were employed: city positioning, environmental city governance, environmental communication, and the climate justice framework, briefly reported in chapters 7, 8 and 9. These parameters, derived from a broader collective research effort (Bernardi et al. 2025; Terenzi et al., 2025), were operationalised through document analysis of urban biodiversity policies, strategic plans, and public communication materials from the selected cities; the aim was to situate each city within wider institutional and discursive landscapes and to provide a consistent lens through which international positioning, governance capacity, communication strategies, and equity considerations could be assessed (Bowen, 2009).

- The first parameter, *city positioning*, considers a city's membership in international networks (such as C40, ICLEI, or Eurocities), its involvement in transnational agreements, and the visibility acquired through environmental awards and affiliations. This dimension highlights how cities define and project their ecological identity at multiple scales.
- The second parameter, *environmental city governance*, focuses on the presence and coherence of policies, plans, and programmes related to biodiversity and broader environmental agendas, as well as on the constellation of actors involved in their implementation; it allows an assessment of the institutional capacity of cities to integrate biodiversity concerns into their planning frameworks.
- The third parameter is *environmental communication*, which explores the infrastructures, strategies, and repertoires through which cities communicate their environmental agendas and, more specifically, how they frame biodiversity in campaigns, public platforms, and participatory processes; it recognises communication not as a secondary add-on but as a constitutive element of environmental governance.

- Finally, the *climate justice framework* parameter considers whether and how cities incorporate equity into their environmental strategies, whether through distributive criteria, targeted investments in vulnerable neighbourhoods, or initiatives addressing environmental inequalities such as heat exposure or energy poverty.

In parallel, the semi-structured interviews were organised around three thematic dimensions: *governance of urban biodiversity*, *communication strategies*, and *citizen engagement and education*. This focus reflected the project's objective to investigate how biodiversity is managed institutionally, how it is narrated and promoted in the public sphere, and how citizens are involved in its stewardship. The interview guide Included open questions designed to elicit both factual accounts (e.g. existing plans, campaigns, participatory projects) and interpretive reflections (e.g. perceived challenges, opportunities for innovation, views on public responsiveness).

By integrating the parameters for city profiling with the thematic axes of the interviews, the research design makes it possible to connect two scales of inquiry: the broader institutional and communicative positioning of cities, and the lived experiences, practices, and perceptions articulated by experts and practitioners directly involved in biodiversity governance.

The interview data were analysed using thematic analysis, a qualitative approach well suited for identifying recurring patterns within complex material (Braun & Clarke, 2006). Coding was concentrated on the three main dimensions of the study, governance, communication, and citizen engagement, and was conducted in line with the research questions. ATLAS.ti software was employed to support the systematic organisation of the transcripts and codes, facilitating cross-case comparisons and the integration of document-based findings.

As already noted, the interviews were complemented by a systematic examination of documentary sources, which provided additional context for the interpretation of findings and ensured data triangulation (Denzin, 2012). This integration between interview-based narratives and document-based evidence enhanced the robustness of the analysis and reinforced the consistency of the city profiles.

Ethical standards were rigorously applied: participants received detailed information about the study's aims and procedures, provided informed consent, and were assured of confidentiality. Participants were provided with detailed information about the study's objectives and procedures and signed informed consent forms before participating. Data was anonymized to protect participants' identities and stored securely.

Part II

Frameworks for Urban Biodiversity Action

Chapter 3

Governing Urban Biodiversity

Monica Bernardi

Governing urban biodiversity today entails addressing one of the most complex and urgent challenges of the twenty-first century: reconciling urban expansion with the safeguarding of species and habitats, public health, and environmental justice. Biodiversity is not merely an ecological component but can be understood as a "relational" infrastructure, where nature, culture, society, and politics are Interwoven. Its governance can no longer be confined to top-down regulatory instruments or technocratic visions of planning; it instead requires hybrid, multi-scalar and participatory forms, able to acknowledge biodiversity as an urban common and as a collective right to ecological well-being (Mahmoud et al., 2025).

3.1 From green to life

Over the past two decades, theoretical and political debate on urban biodiversity has undergone a profound repositioning, directly questioning the forms of governance and the modalities through which contemporary cities negotiate cohabitation between human and non-human. Whereas for a long time "urban green" was conceived as a merely functional or decorative endowment – a neutral backdrop to urban life, to be ordered, measured in square metres per capita, and managed as a technical sector – today a more radical vision prevails, whereby biodiversity is recognised as an infrastructure that is not only ecological but also *relational*, capable of unsettling the very foundations of urban design (Andersson et al., 2014; Hinchliffe & Whatmore, 2006).

This transformation is not only lexical but signals a paradigm shift affecting the epistemic, normative and symbolic assumptions through which cities have historically related to nature. The modern-functionalist model, grounded in a sharp separation between built and natural space, generated a form of "ecology

of control," as Swyngedouw's works have shown (Swyngedouw, 1996, 2004, 2011). In this framework, nature has been domesticated, marginalised, transformed into an ornament or into an instrument of social regulation. It is a technocratic approach aimed at neutralising unpredictability and subordinating vital cycles to the needs of urban order and social reproduction. As Kaika (Kaika, 2004) argues, modern cities have concealed the ecological relations that sustain them, constructing a narrative in which nature only appears as an object to be designed, contained or aestheticised.

Within this conceptual void emerged the approach of *urban political ecology* (UPE), which has deconstructed urban nature as a given entity, showing it instead to be the product of power relations, socio-ecological conflicts, institutional arrangements and dynamics of accumulation (Heynen et al., 2006). Urban green, in this perspective, is never neutral: its forms, uses, and locations reflect and reproduce socio-spatial hierarchies, as the many cases of contemporary *green gentrification* illustrate (Anguelovski et al., 2019; Checker, 2011). From this critical standpoint, to speak of urban biodiversity entails a change of scale and register: it is no longer a matter of counting species or classifying habitats, but of interrogating the ecological and political relations that structure urban space. Biodiversity thus becomes a *device of signification*, capable of exposing asymmetries in access to ecological commons, trajectories of urban exclusion, and modes of multispecies marginalisation. In other words, an indicator of the democratic quality of cities.

Adopting this perspective implies rethinking urban governance in relational and transformative terms, recognising that biodiversity is not merely a technical or environmental issue but also a field of conflict and possibility, activating claims for justice, recognition and redistribution. Designing more greenery is not enough: the questions are which forms of nature are made visible and accessible, which actors are legitimised to care for it, who benefits and who is excluded from its presence. As Haraway (Haraway, 2016) insists, facing the ecological, social and political collapse of our time requires "making kin," that is, constructing multispecies relations that go beyond traditional family ties, imagining forms of coexistence and solidarity that include humans, animals, plants, technologies and environments.

This rethinking has led to the proposal of urban biodiversity as a *common good*, entrusted to forms of shared governance based on co-responsibility, care and co-production (Foster & Iaione, 2016; Ostrom, 1990). In this vision, biodiversity is no longer a parameter to be quantified or a constraint to be mitigated, but a

generative ground for relationships, belonging, and collective agency, through which the city can be reinterpreted not as a mere built space but as *a relational environment of the living*.

The notion of "green justice" and of the city that is *just green enough* (Wolch, Byrne & Newell, 2014) effectively synthesises this reconceptualisation, putting forward an integrated vision where public health, environmental equity and interspecific inclusion converge in a political project that restores to urban biodiversity its ontological and civic centrality. Houston et al. (2018), echoing Haraway's call to make kin, translate it into the urban context, calling for the design of cities that include other living beings as part of socio-ecological relations. They challenge the anthropocentrism implicit in traditional planning and advocate for an ethic and a "city of cohabitation" between humans and non-humans (animals, plants, fungi, microorganisms); what they explicitly call *more-than-human urbanism,* emphasising the need to create spaces conceived not only for humans but also for other living beings, reimagining cities as *multispecies entanglements.*

In this sense, the governance of urban biodiversity becomes an eminently political matter, touching the very core of urban sociology: what forms of coexistence do we want to foster in the spaces we inhabit? How should power over urban transformation be redistributed? Which instruments can we deploy to promote fairer and more sustainable relations among species, territories and institutions?

Rethinking urban governance "from green to living" therefore means overcoming the idea of nature as a frame or a service, and instead recognising it as a *collective subject*, an active component of the urban fabric, a criterion for assessing the institutional and democratic quality of the city. In a time marked by ecological instability and political delegitimation, urban biodiversity may thus represent not only a policy domain but also an epistemic frontier for the reinvention of the urban condition.

3.2 Genealogy of models of governing nature in cities

If today we can conceive urban biodiversity as a political and relational criterion of the city's democratic quality, this is also because, over time, albeit amid contradictions and resistances, how it has been governed has changed. Retracing the genealogy of models for governing nature in cities makes it possible to understand the transitions, inertias and hybridisations that have marked the

evolution of regulatory approaches to living in urban settings. Four principal phases can be identified in particular: normative incorporation, multi-level institutionalization, hybrid experimentation and transformative innovation.

In its initial phase, up to the 1970s, urban planning was underpinned by a binary ontology that sharply separated the built environment from the natural world, translating this dualist epistemology into technical and regulatory instruments. Within this framework, biodiversity governance largely revolved around the designation and protection of residual natural areas (such as parks and reserves), reflecting a conservationist paradigm that remained largely external to, and disengaged from, the urban fabric (Elmqvist et al., 2013; Visseren-Hamakers & Kok, 2022). However, as early as the pioneering studies of the 'Chicago School', the possibility of an urban nature, made up of local ecologies coexisting within built spaces, began to be recognised, although without yet interrogating in depth the active role of urban institutions in governing the living (Bulkeley et al., 2022a).

From the 1980s onwards, with the decline of the "interventionist/planning State" and the rise of the neoliberal paradigm, urban – including environmental – policies underwent a first reconfiguration, shifting from centralised, regulatory and sectoral models to forms of governance informed by principles of administrative efficiency and public–private partnership (Pierre, 2011; Rhodes, 1996). In response to environmental crisis and disorderly urban growth, the environment, previously peripheral to planning, was progressively integrated as a transversal dimension of urban policies, through the adoption of technical and programmatic instruments of ecological planning (green plans, integrated environmental plans), often oriented towards risk mitigation and the passive protection of residual habitats. Nature in the city was thereby framed within quantitative standards, vegetation-cover indices and functional zoning grids which, although representing a first step towards recognising the ecological importance of urban space, struggled to grasp its relational, political and symbolic dimensions.

In the 1990s, with the first United Nations Convention on Biological Diversity (Rio de Janeiro, 1992), we have a turning point, because for the first time, the term *urban biodiversity* appeared in the academic literature (Ossola & Niemelä, 2018), and a new institutional grammar took shape, one that recognised biodiversity as a planetary common good requiring coordinated responses across multiple scales of governance.

This laid the foundations for multi-level governance, theorised by scholars such as (Bulkeley & Betsill, 2005; Hooghe & Marks, 2001), in which power and competences are distributed among international, national, regional and local institutions; in this polyarchic approach the city acquires a central role in the territorial translation of international policies (Stehle et al., 2022). Environmental decisions no longer depend exclusively on the nation state; supranational (EU, CBD), regional and local authorities come into play, generating what Hooghe and Marks define as a 'dispersion of authority', that is, not merely decentralisation, but a relational network in which each level intervenes according to specific prerogatives (Hooghe & Marks, 2001). Moreover, the strategic framework of reference becomes increasingly centred not only on green and infrastructures but on species, habitats, ecosystem services and multispecies relations, marking the shift from a more general ecological governance to a more specific form attentive to biodiversity.

The first *Local Biodiversity Strategy and Action Plans* (LBSAP), emerged, inspired by Local Agenda 21 initiatives and the principles of participatory sustainability, through which cities became actors in their own right (not merely recipients) of planetary policies, integrating ecological mapping, conservation objectives and operational tools into urban planning. Among the earliest examples of LBSAPs is that of Cape Town, in South Africa. Initially adopted in 2009 and subsequently updated in 2019 for the period 2019–2029, the plan includes a long-term strategy and a detailed action plan, co-ordinated by the City's Biodiversity Management Branch; it entails the strengthening of institutional instruments (including dedicated units, integration with the Municipal Spatial Development Framework and the Integrated Development Plan), the protection of priority areas through the BioNet (Critical Biodiversity Areas and Ecological Support Areas), the control of invasive species and the enhancement of environmental education, with the aim of consolidating biodiversity as urban infrastructure and a generator of 'green jobs'[3].

Furthermore, cities began to exchange good practices and enter into dialogue with one another, creating networks such as ICLEI (Local Governments for Sustainability), which assists local authorities in formulating policies aligned with international objectives, facilitates knowledge and experience sharing among cities, and seeks to influence global biodiversity policy in fora such as the CBD or UN- Habitat (Frantzeskaki, Buchel, et al., 2019). They also launched

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[3] See the document LOCAL BIODIVERSITY STRATEGY AND ACTION PLAN of Cape Town (2019) here https://shorturl.at/qvA52

partnerships such as the CitiesWithNature platform, in which ICLEI, the IUCN Urban Alliance and The Nature Conservancy serve as a point of reference for urban action towards the post-2020 biodiversity agenda; or they coalesced into networks such as C40 Cities, a coalition of major world cities committed to combating climate change through concrete, shared actions.

Cities also began to interface with NGOs, universities and the market. International networks feed shared international standards, such as the Singapore Index, or the Urban Nature Indexes, both of which will be discussed later, and promote benchmarking and financing, supporting the implementation of urban strategies (Xie & Bulkeley, 2020). These networks function as epistemic and infrastructural intermediaries between global and local levels of governance (Acuto & Rayner, 2016).

Since the 2000s, moreover, in an attempt to translate the ambitions of global strategies into practice, hybrid devices and technical tools have spread, such as the *Green Space Factor*, the *Green Plot Ratio*, the *Urban Greening Factor* and, more recently, *Nature-based Solutions and Nature Prescriptions*, which aim to integrate biodiversity into urban functions and to generate environmental, social and health co-benefits (Frantzeskaki et al., 2017).

These metrics introduce a logic of measurability and comparability of urban ecological performance, useful not only for international benchmarking but also for attracting public and private funding. However, according to some authors (Colding & Barthel, 2013; Pauleit et al., 2017), this approach risks reducing biodiversity to a set of coefficients, overlooking its political, social and multispecies complexity. The result is that the balance of biodiversity governance becomes more unstable, suspended between operational simplification and political weakening. This tension is also manifested in growing institutional fragmentation, competition for resources, and pressures towards the standardisation and homogenisation of local responses, which often ignore ecological and socio-cultural specificities, amplifying inequalities especially between the Global North and South (Driessen et al., 2012; Dushkova & Haase, 2020).

Although cities are increasingly expected to play a pivotal role in safeguarding biodiversity, they frequently lack the requisite legal competences, fiscal resources, or regulatory authority to intervene effectively. This generates what may be termed an "expectations without capacity" effect, whereby the ambitions of local governance collide with the structural limitations of the public apparatus (Ansell et al., 2017). It is for this reason that Local Biodiversity Strategies and Action

Plans (LBSAPs) often remain largely programmatic documents, rather than transformative instruments.

The most recent phase of this genealogy, currently unfolding, is marked by the emergence of the concept of 'transformative governance'. As we shall see, this refers to the capacity of urban institutions to activate collective processes of learning, innovation and ecological justice (Frantzeskaki, McPhearson, et al., 2019; Wolfram et al., 2019). Such processes are advanced through light institutional devices, such as collaboration pacts for the care and management of green spaces, deliberative instruments such as participatory environmental budgets, participatory afforestation initiatives, and civic-tech platforms (for example, Spain's *Decidim*). These instruments demonstrate how biodiversity can become a driver of institutional innovation and democratic inclusion (Torfing & Ansell, 2015), fostering forms of distributed agency, redistributing decision-making capacities, valorising local knowledge, and building multi-scalar alliances.

This brief genealogy illustrates that the governance of urban biodiversity is an evolutionary process, reflecting tensions between standardisation and adaptation, normative verticality and relational horizontality, functionalist visions and transformative perspectives. We now turn to examine the architecture upon which it is built.

3.3 Institutional Architecture for the Governance of Urban Biodiversity

3.3.1 The actors involved

As highlighted in the literature on multilevel environmental governance, urban biodiversity constitutes a policy arena in which vertical dynamics (EU, state, regions, municipalities) intersect with horizontal ones (city networks, local partnerships), frequently in the absence of a hierarchically dominant authority (Betsill & Bulkeley, 2006). This implies an evident pluralisation and heterogeneity of actors involved, and entails an increasing relevance of mechanisms of co-ordination, negotiation and learning across levels, particularly in the phases of implementation and monitoring.

At the centre of this composite, multilevel and multi-actor institutional field are *local public authorities* (municipalities, metropolitan cities, technical offices…) formally responsible for spatial planning, the management of green spaces, and

building regulation. Yet their capacity for action is often constrained by regulatory frameworks imposed by higher tiers of government, by the scarcity of financial and human resources, and by the internal fragmentation of competences (Ansell et al., 2017; Bulkeley & Betsill, 2005). To this must be added a widespread weakness of ecological expertise within administrative apparatuses, which limits the ability to elaborate systemic and integrated strategies. At the regional and national levels, institutions play a central role in defining the normative framework, programming financial resources and adopting general plans. Yet they rarely engage in effective dialogue with local levels. The result is a fragmented, mosaic-like governance architecture, in which environmental policies unfold according to sectoral and disarticulated logics, thereby making it difficult to integrate biodiversity into the ordinary processes of urban governance.

Alongside public actors, the *private sector* participates in increasingly significant, though also ambivalent, ways. On the one hand, there is growing attention to sustainability as a competitive lever, with investments in green infrastructures, environmental certifications, and start-ups focused on urban regeneration. On the other hand, the risk persists that urban nature becomes a tool of territorial marketing, feeding speculative pressures, property valorisation or greenwashing. Projects for "green districts", eco-districts, or urban parks designed as economic attractors often conceal dynamics of exclusion and gentrification (Anguelovski et al., 2019).

At a deeper level, the economic sector has come to occupy an increasingly structural role in the urban governance of biodiversity, not only as an investor but also as a co-decision-maker within networks, plans and territorial instruments. Businesses – ranging from environmental utilities to real-estate companies and urban logistics operators – directly influence decisions on land use, the design of public spaces, and the distribution of green infrastructures. In some contexts, the introduction of green corporate governance criteria or ESG (Environmental, Social, Governance) indicators has stimulated new forms of environmental accountability, directing investment towards NbS and regenerative models (Long et al., 2023). In others, instruments such as urban biodiversity offsetting (ecological compensation mechanisms for urban transformation projects) have opened up spaces of negotiation between public authorities, private actors and local communities, while at the same time raising critical questions about the monetisation of nature and the ecological justice of such exchanges (Apostolopoulou, 2020).

Public–private partnerships can likewise be reimagined in transformative terms through forms of multi-actor co-governance, as already experimented in some cities.

- In Singapore, a city at the forefront of green urban design experimentation, an emblematic example of its ecological vision is the Gardens by the Bay project, which was developed through a partnership between public agencies and private companies collaborating on design, maintenance and management. At the core of the project stand the iconic Supertrees, vertical structures up to 50 metres tall functioning as multifunctional vertical gardens that host over 150,000 plants from more than 200 species and integrate photovoltaic panels for energy supply. Since 2008, a regulation has required that every new urban development compensate fully for green areas removed, fostering the adoption of NbS. In Marina Bay, a 100% greenery replacement policy has been implemented, stimulating private investment in ecological technologies and advanced green infrastructures.
- In Montréal, the Montréal Declaration on Metropolitan Areas[4], establishes a model of multi-level co-governance based on partnerships among governments, businesses, trade unions and communities, aimed at strengthening urban sustainability through integrated planning – including sustainable mobility, land-use management, natural resource protection and renewable energy. Moreover, the city has committed to "zero net artificialisation" and zero net biodiversity loss by 2030, through a partnership involving public authorities, civil society and private enterprises.

These are only two examples illustrating how economic actors can be involved not merely in the provision of environmental services, but also in the co-design of long-term urban ecological visions. However, for such partnerships to be genuinely oriented towards the common good rather than rent-seeking, a strong regulatory framework, mechanisms for democratic oversight, and transparent governance of data, impacts, and biodiversity targets are required.

Among the actors involved, organised *civil society* is assuming an increasingly prominent role. Environmental associations, neighbourhood committees, and informal citizen groups contribute to a diverse range of practices, including community gardening initiatives, urban horticulture, participatory mapping,

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[4] The text can be read here: Montreal-Declaration.pdf.

monitoring activities, and micro-design projects. These practices weave everyday ecological relationships that often escape the purview of institutional planning, yet are essential for the socio-ecological resilience of urban territories. A noteworthy example is provided by the collaboration pacts – initially experimented in Bologna and now widespread in many Italian cities such as Turin, Milan, and Naples – which constitute hybrid forms of co-governance capable of institutionalising the shared care of green spaces and urban habitats (Foster & Iaione, 2016; Iaione, 2016). It should, however, be emphasised that their effectiveness depends on the quality of public support, the availability of stable resources, and the presence of civic infrastructure for coordination and training; in the absence of these conditions, the rhetoric of participation risks masking a de facto delegation of ecological responsibility to communities that are often already vulnerable and overburdened.

Another fundamental actor is the *scientific community*, which, through universities, research institutes and think tanks, contributes to the production of ecological knowledge, the definition of indicators, the evaluation of impacts and the co-design of interventions (Fischer, 2000). The relevance of these actors has grown with the development of transdisciplinary approaches and the spread of citizen science practices, which render data production part of a public and collective process. This can transform science into an ally of institutional transformation, supporting the shift from "science for policy" to "science with society". In Italy this transformation is exemplified by the **National Biodiversity Future Center** which, with its transdisciplinary community of research and practice, promotes an operational model of open and collaborative science and acts as a digital–physical ecosystem that connects laboratories, territories and citizens, transforming scientific production into an educational resource, an instrument of participation and a lever for institutional transformation (Bernardi, 2025a).

Finally, as introduced in the previous section, an increasingly important role is played by international city networks (ICLEI, C40, Eurocities…), by platforms promoted by UN agencies (CBD, UN-Habitat), and by transnational initiatives such as CitiesWithNature or the Urban Nature Indexes programme. These actors serve as epistemic and infrastructural intermediaries, promoting the transfer of practices and the construction of legitimacy for institutional innovations and urban experiments (Elmqvist et al., 2013; Xie & Bulkeley, 2020).

3.3.2 Enabling conditions

If the variety of actors and their interactions constitute the lifeblood of urban biodiversity governance, their actual capacity to shape territories depends on a set of enabling conditions (political, institutional, and relational) that determine the effectiveness, coherence and transformative orientation of the actions undertaken. As systematised by van der Heijden (van der Heijden, 2019) on the basis of an extensive review of the international literature on urban environmental governance, the implementation of local ecological policies depends upon a series of enabling factors that are necessary, though not in themselves sufficient, to guarantee transformative outcomes. Although these factors have been developed primarily within the field of climate and environmental governance, they are highly pertinent to the governance of urban biodiversity, as they condition its capacity for implementation, co-ordination and learning. The most significant include:

- a supportive political and legal context (Boswell & Mason, 2018; Jordan et al., 2005);
- an adequate degree of local decision-making autonomy (Bulkeley & Betsill, 2013; Hein & Pelletier, 2006; Johnson, 2017);
- access to dedicated financial resources (Clarke, 2017; Hughes, 2017; Sanchez-Rodriguez, 2009);
- vertical co-ordination across administrative levels (Kern & Mol, 2013; Knieling, 2016);
- horizontal co-ordination between departments, agencies and functional groups (Coaffee & Lee, 2016);
- participation in international networks and city alliances (Bansard et al., 2017; Barber, 2013);
- the active involvement of public and private stakeholders within a co-governance perspective (Knieling, 2016; T. Scott, 2015; Sprain, 2016);
- the presence of political and administrative leadership capable of catalysing change (Gupta et al., 2015; Haus & Erling Klausen, 2011).

Taken together, these elements constitute an enabling ecosystem which, alongside actors and instruments, can either reinforce, or if absent obstruct, the transformative ambitions of urban biodiversity policies. In fact, without such enabling conditions, even the most advanced instruments risk remaining ineffective, while the objectives of protecting and integrating urban biodiversity are reduced to mere declaratory statements devoid of territorial impact.

3.3.3 Operational Instruments

The transition towards an urban governance of biodiversity cannot be disentangled from a complex repertoire of operational instruments, capable of translating political and regulatory orientations into effective territorial practices. Alongside the multiplicity of actors and the institutional conditions that facilitate their action, it is precisely these devices (legal, economic, contractual, participatory, and informational) that provide concreteness and directionality to the objectives of protecting and enhancing the living fabric of the city. In recent years, we have witnessed their growing pluralisation, and at least five principal categories can be identified. In addition to *traditional regulatory tools*, there is an increasing prominence of *incentive-based, contractual, participatory and informational instruments*, able to mobilise resources, coalitions and transformative learning processes.

As regards the first category, *regulatory* instruments, the so-called *command and control* mechanisms, establish binding legal constraints and obligations. These include, for example, building codes that impose minimum percentages of vegetative cover, municipal regulations on urban green, landscape or environmental restrictions, and the provisions of general and detailed urban plans. They are grounded in a multilevel legal-normative infrastructure encompassing international, national and local regulations. In Italy, this category is embodied in a series of consolidated devices, though often weakly implemented, foremost among them the *Piani del verde urbano* (Urban Green Plans). Historically conceived with a descriptive and managerial function, often limited to tree inventories or maintenance programming, they can today be reinterpreted in transformative terms and integrated into intersectoral ecological governance strategies, thereby acquiring renewed potential. On their own, however, they are insufficient: without connections to deliberative processes, mainstreaming strategies and monitoring systems, they risk remaining merely symbolic. By contrast, if well designed, they can become procedural infrastructures for the co-management of the urban living, civic monitoring and ecological justice, serving as a bridge between regulation and relationality in the shared construction of the city.

Other examples include the *CAM-Criteri Ambientali Minimi* (Minimum Environmental Criteria), Law 10/2013, or the ISPRA Guidelines (Lapenna, 2025). Their effectiveness, however, remains constrained by structural shortcomings. Much like Urban Green Plans, which frequently lack binding force, the *CAM,* innovative though they are in promoting ecological

sustainability in public procurement, struggle to influence the structural organisation of urban green due to the limited technical capacity and weak ecological culture of local authorities. Similarly, Law 10/2013, which obliges municipalities with more than 15,000 inhabitants to inventory trees and plant one for every newborn, has thus far had marginal impact, owing to the absence of sanctions, the insufficiency of controls and the lack of integration into municipal budgets (ISPRA, 2022).

To these must be added *economic and fiscal incentives*, such as green building credits, subsidies for renaturalisation initiatives, grants for green roofs, or ecological taxation on impermeable surfaces. *Contractual and voluntary instruments* are also widespread, based on agreements between public and private actors: examples include collaboration pacts, river or urban forest contracts, and public–private partnerships for the joint management of green areas. In some cases, specific calls or funds are established for projects of afforestation, urban agriculture or NbS. Increasingly, cities are also adopting *participatory and deliberative instruments*, such as green participatory budgets, neighbourhood laboratories, ecological co-design processes, citizens' assemblies or biodiversity forums. All of these processes' orient governance in an increasingly transformative direction, strengthening the democratic dimension of ecological governance and integrating local and scientific knowledge.

Equally relevant, finally, are informational instruments, which include guidelines, technical standards, codes of conduct, ecological quality labels, data platforms, indices and indicators, such as the Singapore Index (City Biodiversity Index), ICLEI's Urban Nature Index, or the IUCN classification of urban habitats. The spread of digital technologies, including monitoring apps, participatory maps, and open-source environmental sensors, further enables forms of distributed monitoring and citizen engagement (Gabrys, 2017; Goodchild, 2007). These instruments, often of the *soft law* variety, perform an important cultural and technical orientation function, contributing to the standardisation and adoption of ecological practices, even though they present the risk of excessive technicisation and the depoliticisation of decision-making.

3.3.4 Policies and strategies for Urban Biodiversity

Urban biodiversity now stands at the centre of a dense web of strategic and regulatory frameworks that redefine the roles and responsibilities of cities within the ecological transition. The *Kunming–Montreal Global Biodiversity Framework*, the *EU Biodiversity Strategy for 2030*, the *European Green Deal* and the

Sustainable Development Goals (particularly SDGs 11, 13 and 15) constitute the multilevel political reference system within which urban administrations are called not only to safeguard ecosystems, but also to innovate planning practices, ecological regeneration, and the management of urban spaces.

In response to these imperatives, many cities are elaborating strategies and policy mixes that integrate biodiversity into urban planning, ecological regeneration, green and blue infrastructures, as well as into climate adaptation, public health, mobility and social cohesion policies (through *mainstreaming*). The most advanced experiences show how biodiversity can become a transversal guiding principle, capable of orienting urban design and sectoral choices towards an ecological and relational vision of the city.

Providing a comprehensive overview of these policies is nonetheless complex, given the breadth of the environmental policy domain. Here we draw upon Coletti's (Coletti, 2024) systematisation of European public environmental policies, which distinguishes between preventive policies, mitigation and adaptation policies, natural resource protection policies, and reparative policies. Although originally conceived for environmental issues in a broad sense and given that policies rarely operate in "watertight compartments", often overlapping, this framework can also serve as a useful guide in relation to biodiversity.

(I) *Preventive policies* aim at the proactive protection of ecosystems and natural commons for the benefit of future generations. The Convention on Biological Diversity falls within this category. In Europe, for instance, the European Commission adopted in 2006 a communication and action plan entitled *Halting the Loss of Biodiversity by 2010 and Beyond: Sustaining Ecosystem Services for Human Well-being*, followed in 2011 by a new strategy to achieve six objectives by 2020: full implementation of environmental legislation, strengthening of green infrastructure, sustainable agriculture and forestry, improved fisheries management, action against invasive species, and enhanced global co-operation. Also included here are international efforts to preserve marine biodiversity, such as the Marine Strategy Framework Directive, one of the pillars of EU integrated environmental policy, and the Habitats Directive, which, while recognising economic, social, cultural and regional needs, established the Natura 2000 network: the world's largest protected area system, covering more than 850,000 km². Measures aimed at reducing sources of pollution, such as air quality directives or noise pollution controls, can also be indirectly placed in this preventive category.

(II) *Mitigation and adaptation policies* unfold along two interlinked paths. Mitigation seeks to address the structural drivers of biodiversity loss, such as land consumption, pollution, soil sealing and ecological fragmentation. Adaptation, by contrast, seeks to adjust natural and social systems to the ongoing impacts of climate change and biodiversity erosion, strengthening their socio-ecological resilience, for example, reducing vulnerability to extreme events such as landslides, cyclones, floods, droughts or wildfires. In urban contexts, mitigation is pursued through ecologically oriented urban plans, multifunctional zoning, environmental restrictions, and the integration of ecological criteria into planning, such as green roofs, living walls, permeable pavements, urban forestry, incentives for de-sealing, or renaturalisation of marginal and degraded areas (former industrial zones or landfills). Through ecological restoration, these areas can be transformed into multifunctional green spaces, fostering the return of native biodiversity and the reconstruction of functional habitats, while simultaneously reducing hydrogeological risk and improving landscape quality (Aronson et al., 2017). Such measures not only enhance ecological connectivity but also deliver multiple co-benefits for human well-being, air quality and heat island mitigation (Benedict & McMahon, 2006). Sustainable mobility policies, including active transport promotion, reduction of motorised traffic, and investment in low-impact infrastructure, also fall within mitigation, as they indirectly safeguard biodiversity by reducing atmospheric and noise pollution, as well as anthropogenic pressure on habitats (Tzoulas et al., 2007).

Adaptation policies increasingly rely on ecosystem-based approaches, which promote the conservation and sustainable use of ecosystems as an integral part of urban design, thereby contributing to multiple sustainability goals (Elmqvist et al., 2015). A concrete example is provided by the already mentioned *NbS*, defined by the IUCN as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits". By harnessing the ecosystem services of healthy ecosystems, such as carbon sequestration, water regulation, and pollutant mitigation, and integrating them with ecological engineering and digital technologies (sensors, green infrastructures), NbS can optimise territorial outcomes. They may take natural forms (wetland restoration, reforestation) or urban green infrastructures (green roofs, rain gardens, ecological corridors) (Kabisch, 2015). In this sense, urban biodiversity

becomes a strategic resource for climate adaptation, enhancing rainwater absorption, mitigating heatwaves and increasing socio-ecological resilience (IPBES Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019). Yet, as the European Commission stresses, scaling NbS requires not merely substituting existing practices but a profound transformation in governance, mindsets, and financial models (Commissione Europea et al., 2020).

Urban water management also plays a crucial role. Sustainable Urban Drainage Systems (SUDS), permeable surfaces, green roofs and blue-green infrastructures simultaneously reduce pollutant loads, increase urban resilience, and create new habitats for aquatic and terrestrial biodiversity (EEA, 2020).

In governance terms, mitigation and adaptation are increasingly integrated, as acting on biodiversity entails both avoiding further damage and reinforcing socio-ecological resilience.

(III) *Natural resource conservation and management policies* focus on preserving ecosystems and species over time, placing at the centre of governance the active and integrated conservation of the urban natural heritage. Here, the common-pool character of biodiversity becomes particularly evident (Ostrom, 1990). Given the degradation and impoverishment of territories resulting from human exploitation, it is essential to rethink development models and promote transitions towards more circular, sustainable and respectful forms of production and consumption. In this respect, the EU introduced in 2018 four Directives (849, 850, 851, 852) to strengthen objectives on recycling municipal and packaging waste, reducing landfilling, promoting reuse and industrial symbiosis, and introducing greener products into the market.

This category also encompasses the creation and management of protected areas within urban settings, nature parks, ecological reserves, urban forests, which provide wildlife refuges and green lungs in cities (Ives et al., 2016; Niemelä, 2014). Their effectiveness depends on management quality, stakeholder participation, and the integration of ecological principles in territorial planning (Niemelä, 2014). Equally, urban green space management, public and private, is vital for maintaining ecological connectivity and promoting floristic and faunal diversity (Gómez-Baggethun et al., 2013). Ecological corridors and green infrastructures represent a further step, connecting fragmented habitats and facilitating species mobility. Such interventions, including tree-lined streets, linear parks and

riparian buffer zones, simultaneously improve quality of life by reducing pollution and providing spaces of well-being (Ahern, 2013).

Among the instruments already implemented in numerous cities are *Strategic Environmental Assessments* (*Valutazioni Ambientali Strategiche* - VAS), *the Green Public Procurement*, and *GIS tools* for mapping ecological connectivity. Additionally, ecologically oriented master plans – such as the Metropolitan Territorial Plan of Milan – and multifunctional ecological zoning schemes, which operate preventively while also contributing to conservation and management objectives, play a significant role. Notable examples include the experiences of Utrecht (NL), Bonn (DE), Barcelona (ES), and Tartu (EE), which employ integrated urban planning frameworks oriented towards ecosystem services, combining sectoral policies with cross-cutting ecological goals.

This approach enables a move beyond "decorative green space" towards a holistic vision of biodiversity as strategic infrastructure for urban well-being and resilience.

3.3.5 New orientations: rights of nature and multispecies governance

The mere pluralisation of actors and instruments does not in itself guarantee equity or democratisation. Urban governance dynamics remain deeply shaped by asymmetries of power, tensions between technocratic and participatory logics, and persistent forms of exclusion, particularly in marginalised contexts and in cities of the Global South. Indigenous, migrant and marginalised communities often see their ecological knowledge and territorial practices disregarded. In response to such systemic inequalities, and to the urgency of authentic ecological democratisation, profoundly innovative legal and political approaches have begun to emerge in recent years, challenging the anthropocentric paradigm underpinning modern environmental institutions. Among these, the recognition of the *rights of nature* constitutes a paradigmatic shift: it attributes legal subjectivity to natural entities (rivers, ecosystems, mountains, urban forests…) formally endowing them with rights, duties and legal representation. This move entails a profound reconfiguration of the relationship between law, the living, and the city, and opens the way towards forms of *multispecies governance*, in which non-human entities are recognised as co-constitutive of the urban political and juridical fabric (Burdon, 2014a; Latour, 2004)

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Although still marginal within international law and European legislation, such experiments are multiplying across the globe, from New Zealand to Latin America, from the United States to several European cities, recasting urban biodiversity not merely as an object of protection, but as a *collective subject bearing interests, rights and forms of ecological agency*

An emblematic case is that of the Whanganui River in New Zealand, recognised in 2017 as a legal person with "rights, duties and responsibilities" and entrusted to two guardians, one representing the state and one the Māori. This institutional solution embodies a relational vision of the living, founded on the principle that "*I am the river and the river is me*", granting the river an ontological and legal status not subordinated to the human[5].

In Latin America, the juridification of nature has assumed constitutional significance. Ecuador's 2008 Constitution was the first in the world explicitly to recognise nature (*Pachamama*) as a subject of rights, including the right to exist, persist, maintain and regenerate its vital cycles[6]. In Quito, an International Tribunal for the Rights of Nature has also been established. In Colombia, in 2016 the Atrato River was recognised as a legal subject bearing right, and in 2018 the same principle was extended to the Colombian Amazon[7]. Bolivia's 2009 Constitution likewise established the legal subjectivity of *Madre Tierra*, subsequently elaborated in the *Ley de Derechos de la Madre Tierra* (2010), which defines ecological rights such as the right to biodiversity, to balance, and to clean air and water[8].

In the United States, municipal ordinances recognising legal rights for local natural entities are also multiplying, such as the groundwater aquifers in Santa Monica (California)[9] or Lake Erie in Toledo (Ohio)[10], often with the aim of halting extractive projects or processes of irreversible environmental degradation (Borràs, 2017; Burdon, 2014b). Although still marginal within mainstream legal frameworks, these approaches raise fundamental questions regarding the redefinition of the relationship between law, territory, and ecological communities.

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[5] See: The personhood status of the Whanganui River: Wellbeing Economy Alliance

[6] Official text of the Constitution of the Republic of Ecuador (2008), Chapter 7: Rights of Nature: Ecuador 2008 Constitution - Constitute

[7] See: Colombia court case on the rights of the Amazon - Eco Jurisprudence Monitor

[8] See the Ley de Derechos de la Madre Tierra here: Ley 071 21 de diciembre 2010

[9] Ordinance of Santa Monica: Santa Monica Sustainability Rights Ordinance | Adaptation Clearinghouse

[10] Bill of Rights of Erie Lake: CHAPTER XVII LAKE ERIE BILL OF RIGHTS

In Europe, the debate remains more embryonic but is nonetheless evolving. There have been initiatives to recognise legal personhood for rivers (as in the protests concerning the Loire in France), for forests, or for urban ecosystems; meanwhile, administrative and constitutional appeals invoking the notion of diffuse ecological damage are becoming more frequent. In Italy, although there is as yet no explicit normative framework recognising the rights of nature, some local authorities have adopted symbolic motions—for example, Naples in 2022, with a resolution recognising the rights of nature, or Bologna in 2021, with a City Council resolution on the "rights of ecosystems". Moreover, recent constitutional jurisprudence has strengthened environmental protection as a fundamental principle (Constitutional Law no. 1/2022)[11].

The idea of urban biodiversity, not merely as a sum of species, but as a multispecies living network, that may enjoy legal representation and ecological citizenship subverts anthropocentric logics of protection. It opens the way to forms of co-decision between humans and non-humans, and ultimately to a genuinely **multispecies or post-human governance** (Latour, 2004). These experiments configure cities and territories as laboratories of juridical and democratic innovation, where biodiversity is reimagined as a collective subject contributing to the construction of urban futures. Yet, as Kauffman observes (Kauffman, 2023), the legal recognition of nature risks remaining merely symbolic if not accompanied by adequate institutional capacities. For such rights to be effective, operational instruments, dedicated resources, and above all a widespread culture of ecological responsibility, also at the local level, are indispensable.

3.4 Towards transformative governance

The previous sections have outlined the institutional architecture, actors, instruments and strategies of urban biodiversity governance. Yet today, the accelerating climate crisis, the systematic erosion of biodiversity, and widening environmental inequalities challenge the very capacity of institutions, calling for an approach no longer centred on technical efficiency or symbolic solutions, but on *transformative governance* (Frantzeskaki, McPhearson, et al., 2019; Wolfram et al., 2019). This is not simply an incremental evolution of environmental

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[11] The Constitutional Law of 11 February 2022, No. 1, can be accessed here: LEGGE COSTITUZIONALE 11 febbraio 2022, n. 1 - Normattiva

governance, but a genuine shift in perspective, transcending anthropocentric and sectoral approaches.

In this context, urban biodiversity can no longer be regarded merely as an "environmental issue", a governance problem to be addressed through regulations, incentives or awareness campaigns. It becomes instead a genuine agent of transformation, since the way in which the living is treated within urban areas may redefine political priorities, metrics of success and institutional languages, either fostering or impeding the emergence of a culture of interdependence and ecological coexistence (Bulkeley et al., 2022b).

According to Patterson and colleagues (Patterson et al., 2017), transformative governance can be understood across three key dimensions: (1) *governance of transformations*, namely the capacity of institutions to steer and regulate systemic change processes; (2) *governance for transformations*, understood as the enabling of conditions for change (capacities, resources, visions); and (3) *transformations in governance*, that is, the transformation of governance modes themselves, involving new institutional, participatory and cognitive configurations. These dimensions, strongly interdependent and often overlapping, provide a useful framework for interpreting the experiments emerging in the field of urban biodiversity, and highlight how transformative governance calls into question the very processes through which public decisions are made (who decides, how decisions are taken, and on the basis of which values) (Meadowcroft, 2009; O'Brien, 2011).

Complementing these dimensions is an operational framework that facilitates their implementation, the so-called *capacity model* described by Hölscher (2020), which identifies four core "governance capacities" (Hölscher, 2020):

- *Stewarding:* anticipating, protecting and managing uncertainty and risk, while ensuring continuity in volatile contexts
- *Unlocking:* removing institutional obstacles, path dependencies, and the factors that sustain unsustainable or rigid practices, thereby creating space for ecological innovation
- *Transforming:* conceiving and integrating novel solutions (e.g. pollinator parks, multispecies corridors), securing codes, funding and practices that shift everyday functioning
- *Orchestrating:* coordinating actors, resources, objectives and timelines, as in ecological PPP partnerships or Living Labs, generating synergies across sectors and scales.

These capacities do not operate in isolation but reinforce one another. *Stewarding*, for instance, creates trust and space for *unlocking*, without which innovations remain isolated, while without *orchestrating* solutions struggle to scale up and become systemic. Integrating this framework helps structure capacity-building trajectories, guiding training, interdepartmental governance, adaptive monitoring and experimental arenas. A notable case is Rotterdam, where the creation of informal networks and collaborative spaces has supported not only ecological experimentation but also institutional mainstreaming and the emergence of new regulatory instruments (Hölscher et al., 2019; Molenaar et al., 2020).

Other cities are increasingly inspired by these principles and dimensions. The establishment of community gardens designed for pollinators and native species (*pollinator parks*), the creation of ecological corridors linking neighbourhoods, or the adaptation of urban infrastructure to facilitate wildlife passage (such as green bridges) are all examples of how multispecies and connective public spaces can be designed. In parallel, urban co-design laboratories involving experts, local communities and unconventional knowledge foster more reflexive and inclusive decision-making processes. Integrated strategies, such as the aforementioned LBSAPs, or the use of civic technologies to map and monitor urban greenery, express adaptive and shared forms of governance.

These practical experiences illustrate how stewarding, unlocking, transforming and orchestrating take shape in urban contexts. Yet for such practices to deliver real transformations, there must be a deliberate construction of collaborative capacity: the intentional design and reinforcement of processes, norms and relational infrastructures to sustain collective action (Emerson & Nabatchi, 2015); such capacity is not given, but must be actively cultivated over time through cycles of learning, trust and adaptation.

Examples of transformations in governance can be observed in lightweight co-governance regimes such as ecological participatory budgeting (Brignone et al., 2022), collaborative green regulations (the aforementioned Italian *patti di collaborazione*) (de Nictolis & Iaione, 2021; Iaione, 2016), urban ecological transition laboratories (*Living Labs*) (Voytenko et al., 2016), or participatory afforestation projects such as *ForestaMI* in Milan (Pastore, 2025). Other examples emerge in structured interdepartmental strategies where different municipal departments have collaborated actively to address ecological and climatic challenges. In Melbourne[12], the *Urban Forest Strategy* Plan engaged environment,

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[12] More info: Urban Forest Strategy | City of Melbourne

planning, participation and mobility departments to increase tree canopy cover; in Barcelona the *Pla Clima*[13] and the *Pla Natura*[14] work synergistically to integrate resilience, health and green infrastructure across administrative domains; in Cape Town, the *Climate Change Strategy*[15] connects water management, energy, planning and social development for coordinated climate action; and in Rio de Janeiro, the *Cidade pelo Clima/City for Climate*[16] programme aligned sustainable development and climate planning, creating interdepartmental governance for urban decarbonisation. These are clear examples of mainstreaming strategies that some cities are gradually adopting, situated firmly within the sphere of transformative governance.

It is nevertheless crucial to recognise that co-creation is not in itself a guarantee of transformation. Without redistributive mechanisms, it risks being co-opted as a low-cost inclusive narrative, compensating for deficits in urban welfare through logics of voluntarism and public de-responsibilisation (A. J. Scott & Storper, 2015; Swyngedouw, 2005). The rhetoric of participation can easily degenerate into *green tokenism*, where involvement does not genuinely alter priorities, budgets or the rules of the game (Simon, 2016). For this reason, transformative governance of biodiversity must embed ecological justice as a constitutive principle, working towards the redistribution of decision-making power, resources and access to the living. Studies on *green gentrification* (Anguelovski et al., 2019; Gould & Lewis, 2016) reveal how even participatory ecological interventions may have regressive effects, displacing the most vulnerable in the name of a "requalified" yet exclusionary nature. The fundamental questions thus remain: *who decides? who participates? who benefits?*

The essence of transformative governance lies not merely in participatory methods but in institutional capacity to learn and to transform. This requires stable deliberative architectures, flexible regulatory instruments, protected spaces for experimentation, and an administrative culture open to dialogue, cross-

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[13] A climatic strategy with more than 1.800 M€ to reduce emissions and favour the city adaptation to the climate change: See here: Pla Clima | Barcelona City Hall

[14] Participatory plan to expand green infrastructure and biodiversity through 100 projects and a dedicated Observatory; see here Plan Natura Barcelona 2021-2030 - decidim.barcelona

[15] The strategy can be consulted here: Cape Town's New Climate Change Strategy Aims to Make City Stronger - Destination Cape Town

[16] Climate Governance Programme, established in 2011 to develop integrated mitigation and adaptation actions, can be consulted here: Cities100: Rio de Janeiro has aligned sustainable development and climate action

fertilisation of knowledge, exchange and the management of uncertainty (Torfing et al., 2019).

As Frantzeskaki & Loorbach (2010) argue, collaborative innovations do not emerge spontaneously but must be supported through shared visions, distributed leadership, narrative capacity and structural funding. Urban biodiversity, in this light, may become a generative lever for reorienting public action, reconnecting habitats and institutions.

 Finally, it is important to emphasise that transformative governance is neither a rigid model nor a set of replicable procedures; it is instead a situated practice, taking shape within specific contexts where actors, institutions and communities operate. Its effectiveness depends on actual room for manoeuvre, available resources, organisational capacities and relational continuity. Thus, the point is not to replace technical rationality with participatory rationality, but to articulate them coherently, adapting instruments and languages to contemporary ecological and social challenges. The value of transformative governance lies in its capacity to render decision-making mechanisms more inclusive, reflexive and adaptive, while strengthening the ability of institutions to learn, correct themselves and transform over time.

3.5 Measuring for transformation

One of the most delicate aspects in governing urban biodiversity is the issue of *measurement*. On the one hand, the complexity of urban ecological phenomena requires sophisticated and comparable analytical tools; on the other, the use of indicators risks reducing biodiversity to a technical object, readily computable but difficult to translate into social and political transformation. It is within this tension that a crucial challenge now lies: how to move from governance *informed* by biodiversity to governance *oriented* by its systemic impact.

As noted earlier, recent years have witnessed a proliferation of indicators, frameworks and monitoring systems promoted by international organisations, city networks and environmental agencies. Among the most prominent is the Singapore Index on Cities' Biodiversity, but also the OECD Green City Indicators and, more recently, the Urban Nature Indexes (UNI) developed by the IUCN (Pierce et al., 2024). The latter are structured into six thematic areas, each comprising five indicators, for a total of thirty sub-indicators. These areas include: urban consumption factors (such as food, energy, water), anthropogenic pressures on the environment (such as noise and water pollution), the state of

habitats (protection, connectivity, restoration), the state of species (extinction risk, presence of key species), the benefits provided by nature (health, culture, employment), and governance responses (strategies, regulations, participation). The aim is to align local actions with global targets and render the ecological performance of cities assessable.

Complex indicators such as the UNI demand not only technical capacity but also institutional commitment and horizontal coordination across sectors and departments. As Püchel and colleagues (Püchel et al., 2024) emphasise, the effective integration of ecological data into urban decision-making processes depends on factors such as administrative leadership, trust between organisations and political continuity – all crucial for translating environmental monitoring into transformative action.

Box 2 *The Re-Nature Index*

The Re-Nature Index: an NBFC contribution to transformative measurement

Developed within the National Biodiversity Future Center, the *Re-Nature Index* is a composite tool designed to capture the multidimensional character of urban biodiversity at the metropolitan scale (Bernardi et al., 2025; Terenzi et al., 2025). Unlike conventional indices that focus primarily on ecological or infrastructural dimensions, the Re-Nature Index integrates five analytical clusters: *Planet, Climate Justice, Environmental Prosperity, Governance,* and *People Engagement*.

This structure allows the index to combine ecological metrics with indicators of social equity, governance capacity and civic participation, thereby revealing not only environmental performance but also systemic vulnerabilities and socio-ecological inequalities. The Re-Nature Index has been conceived as both a diagnostic and a generative instrument, since it provides a comparative overview of resilience and sustainability across urban areas, while at the same time supporting policymakers, practitioners and citizens in identifying priorities for action and opportunities for collaborative governance.

In this way, the Re-Nature Index contributes to bridging the persistent gap between technical monitoring and transformative practice, showing how measurement can evolve from a narrow tool of compliance into a framework for equity-oriented, participatory and adaptive urban governance.

Moreover, measurement is never a neutral operation, since every selected indicator reflects specific properties and visions. To measure is to decide what counts, and therefore to produce a particular type of governable reality. Urban biodiversity thus risks being 'reified' into percentages of permeable soil, numbers of native species, or square metres of accessible green space (Turnhout et al., 2014)

It must also be noted that many measurement tools developed internationally risk being used locally in a purely formalistic manner, without generating substantive changes in policy or practice. Such instrumental use leads to reporting that serves primarily to demonstrate compliance but fails to deliver concrete transformation. As a result, the gap between global strategies and local action often produces reports that are largely symbolic or superficial, more useful for justifying existing practices than for stimulating genuine pathways of change (ibid.).

For this reason, genuinely transformative governance cannot be confined to "measuring for compliance" but must rather "measure for transformation": that is, using indicators as generative devices for institutional learning, collective reflexivity and civic engagement, rather than as mere instruments of vertical control. It is the integration of measurement within decision-making processes that ultimately determines its effectiveness (Dushkova & Haase, 2020).

Indicators can in fact be employed in very different ways, with markedly different impacts. They may be used merely to check conformity ("accounting use"), confined to technical reporting without change; they may serve for benchmarking or to attract funding ("performative use"), enhancing image rather than substantive action; if employed critically, they may stimulate institutional learning ("reflexive use"); or, when embedded in dialogue and co-design processes, they may foster civic participation and collaboration across political and social actors ("deliberative use"). This categorisation, grounded in the literature on *dialogic accounting*, underscores that it is not the instrument itself that makes the difference, but rather how, why and by whom it is used.

When measurement is not isolated within a technical–administrative circuit but becomes part of open and reflexive deliberative processes, its function and meaning change, shifting from a sanctioning practice to a generative one. In such a context, indicators are not deployed to judge or rank cities as "virtuous" or "lagging behind", but to construct common languages, render ecological

priorities transparent and debatable, and enable distributed learning among heterogeneous actors (Bebbington et al., 2007).

A further development that profoundly reshapes this landscape is the recent adoption of the *EU Nature Restoration Regulation* (see chapter 1). By establishing two binding indicators (urban green space and urban tree canopy cover) the Regulation alters the very conditions under which cities operate (European Union, 2024). Unlike voluntary frameworks promoted by international organisations or city networks, these indicators are now part of a legal cycle of monitoring and reporting. Their introduction compels municipalities to harmonise baselines, integrate ecological data into official planning instruments, and connect local monitoring with national and European accountability structures. While there is a risk that such obligations reinforce a compliance-oriented culture, they can also be mobilised as levers for more participatory and deliberative forms of governance, using mandatory data collection as a foundation for broader civic engagement and institutional learning.

Some European cities are already experimenting with hybrid forms of participatory monitoring that put this transformative approach into practice.

- In Barcelona[17], environmental indicators have been linked to ecological participatory budgeting processes, translated into funded actions. Between 2020 and 2023 the city allocated €30 million of its municipal budget to 76 projects directly proposed by citizens through the Decidim platform, assessed in terms of impact on urban greenery, ecological connectivity and community well-being; at least 21 of these are already being implemented, involving residents and municipal staff in a circular process from proposal to evaluation, execution and monitoring.

- In Montréal, biodiversity monitoring has been accompanied by neighbourhood deliberative laboratories, with public discussions of the data. More than 80 initiatives across the metropolitan area have focused on natural space conservation, biodiversity and socio-ecological transition. In addition, urban citizen science laboratories have emerged where residents, researchers and administrators collaborate to monitor habitats, species and ecosystem services ("Ecosystem Management Program") in major urban parks, balancing conservation with public accessibility[18].

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[17] The 2020 Green and Biodiversity Plan of Barcelona can be consulted here: PlanVerde_2020.pdf
[18] See also: https://www.cbd.int/article/action-agenda-city-of-montreal

- In Bruxelles, the *Biodiv.Brussels* platform[19] integrates quantitative data (green cover, species present) with participatory assessments of perceived quality, enabling citizens to identify natural spaces that are "invisible" to official metrics. The outcome is a hybrid system that combines technical metrics with community perceptions, enhancing transparency, contestability of environmental choices, and more informed participation.

However, the capacity to embed measurement in deliberative processes depends largely on local institutional capacity, analytical expertise, resource availability, administrative culture and continuity of structures. Without these prerequisites, even the best indicator systems risk fuelling nominal governance that produces reporting without real transformation (Turnhout et al., 2014).

These experiences nevertheless demonstrate that ecological assessment can be not only more accurate but also more equitable when it is shared, transparent and deliberative. They highlight the pedagogical and transformative potential of measurement, showing that accountability is not solely an instrument of control, but also a lever for *civic empowerment and environmental justice.*

At the same time, there has been a significant expansion of economic and financial instruments designed to promote and support urban ecological policies. Among these, particular attention should be paid to payments for ecosystem services (PES), which valorise the role of green infrastructures in producing collective benefits (such as climate regulation or air purification) through direct incentives to private owners or local communities. Similarly, the use of green bonds is spreading, enabling cities to raise capital for environmental projects and link financial investment to ecological reporting. These instruments, if properly regulated, can become strategic levers for urban ecological transition, but they also raise critical questions about the governance of green finance, the distribution of risks, and the criteria for assessing impact. Who decides what is deemed "green" or "ecological"? Who benefits from the incentive? How can we prevent biodiversity from being absorbed into extractive or speculative logics?

Finally, one of the most promising dimensions of transformative governance is represented by the aforementioned **citizen science**, which enables citizens, activists, schools, associations and communities to contribute to the collection and interpretation of ecological data within a process of knowledge democratisation that values local knowledges and redefines the very objects of governance (Haklay, 2015; Irwin, 2002). Today, countless biodiversity citizen

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[19] For further information: https://www.biodiv.be/links/brussels-environment-green-spaces-and-biodiversity

science projects exist across European and North American cities – from participatory species mapping, collective tree censuses and acoustic bird monitoring to studies of light pollution and soil quality. Platforms such as iNaturalist, eBird or Globe at Night have produced datasets of unprecedented scale, increasingly used by researchers and institutions (Sullivan et al., 2014; Kyba et al., 2023). These initiatives demonstrate not only the scientific value of citizen science, but also its pedagogical role in cultivating ecological literacy and environmental citizenship (Bonney et al., 2015; Hadjichambis et al., 2020).

If integrated within a continuous cycle of data collection, reflection and decision-making, citizen science can be understood as an instrument of *adaptive collaborative governance*, capable of institutionalised learning (Emerson & Nabatchi, 2015). For it to be genuinely transformative, however, it must transcend the extractive logic of mere "data collection" and instead foster a dialogical process among citizens, experts and institutions, through which ecological subjectivities, a sense of belonging and critical capacities may be cultivated. In this perspective, measurement becomes a political practice – a means of developing participatory ecological citizenship and strengthening collective intelligence. Citizens become genuine *environmental agents of change*, acquiring skills, awareness and tools to act locally in concrete and responsible ways (Hadjichambis et al., 2024). Moreover, some authors argue that the potential of citizen science extends beyond instrumental utility, carrying relational and epistemological value, becoming a form of *ecological kin-making*, that is, building affective bonds between people and environments (Dunkley, 2023).

Box 3 *Citizen Science within NBFC*

NBFC and Citizen Science as transformative measurements

In Italy, thanks to the National Biodiversity Future Center, citizen science has begun to evolve from scattered initiatives into a genuine civic infrastructure. Key milestones include the creation in 2024 of the *National Citizen Science Table*, involving around 150 researchers; the development of a *national open-source platform* linked to the EU-Citizen.Science framework; and, in May 2025, the launch of the *Biodiversity Sampling Week*, which mobilised over 120 projects and hundreds of citizens in monitoring urban and peri-urban biodiversity (Bernardi, 2025b). These initiatives illustrate how citizen science can be scaled up to the national level, linking local engagement to continental strategies and anchoring participatory monitoring within the governance of biodiversity.

In conclusion, employing measurement in a genuinely transformative way presupposes at least three conditions. First, governance must be adaptive, able to learn from indicators and to revise its strategies accordingly. Second, data need to be interpreted critically, with attention to the ecological disparities and power imbalances that shape the urban Ie. Third, public administration should cultivate a culture that goes beyond mere compliance or reporting, fostering instead the collective construction of meaning and value.

3.6 Conclusions

The trajectory traced in this chapter has demonstrated that urban biodiversity is not merely an ecological or technical–administrative concern, but an *eminently political arena*, intersecting with conflicts, socio-spatial inequalities, urban imaginaries and multispecies rights. Within this framework, a *transformative governance* of urban biodiversity cannot be reduced to the incremental improvement of existing policies; it must instead envisage a *structural reconfiguration* of how cities produce, manage and distribute nature. This is all the more urgent as it represents the only genuine option available in the face of accelerating climate change.

Three elements emerge as critical nodes.

(I) The first concerns the recognition of eco-political conflicts. Biodiversity lies at the centre of tensions between competing land uses, divergent visions of urban green, economic interests and social claims. An effective transformative governance cannot elide these tensions but must take them as a terrain for democratic construction, interrogating *who decides what, for whom, and with which ecological and social consequences.*

(II) the need to widen the range of actors involved in governance, extending beyond formal institutions to include local and Indigenous communities, diverse forms of *situated knowledge*, and even *more-than-human* entities. This should not be regarded as a supplementary exercise but as a foundational requirement, calling for the design of co-governance arrangements that recognize the multiplicity of interests at play, give weight to grassroots practices, and incorporate multispecies perspectives into the very fabric of decision-making.

(III) Finally, governance practices must be able to weave together planning, experimentation, collective learning and ecological justice. In this respect, approaches such as *mainstreaming*, *nature-based solutions*, *adaptive management* and *rights of nature* should not be appropriated in a technocratic manner but critically reinterpreted within the broader framework of the urban commons.

In the Italian context, where urban biodiversity remains marginal within the institutional agenda, these orientations represent both a challenge and an opportunity to reconceive cities as eco-political spaces capable of sustaining interspecies alliances, generating forms of environmental justice, and fostering shared care of territories. The work of the National Biodiversity Future Center marks a turning point in this direction; by promoting transdisciplinary knowledge, supporting innovative territorial practices and facilitating new alliances between research institutions, administrations and civil society, it can contribute to consolidating pathways of governance that are more effective, just, transformative and regenerative.

Ultimately, if understood through a *transformative lens*, the governance of urban biodiversity can become a collective practice of care and ecological emancipation, and an opportunity to reimagine cities as *more-than-human spaces of coexistence*, capable of generating new forms of environmental justice**,** interspecific solidarity and the right to life.

Chapter 4

Communicating Urban Biodiversity. Concepts and Contexts

Pablo Gómez-Iniesta

Cities have become epicenters of contemporary environmental challenges and opportunities. Housing more than half of the world's population and consuming approximately 75% of global resources, urban areas exert disproportionate pressure on ecosystems while simultaneously serving as laboratories for innovative sustainability solutions (Elmqvist et al., 2013). Within this complex urban metabolism, biodiversity plays a fundamental role in supporting human well-being, regulating climate, purifying air and water, and enhancing quality of life.

Yet biodiversity remains largely invisible to urban residents, perceived as distant from daily concerns or relegated to rural and wilderness contexts. This "psychological distance" (Spence et al., 2012) poses a formidable barrier to conservation action, making the communication of urban biodiversity not merely an informational task but a strategic imperative for environmental governance. How cities frame, disseminate, and dialogue about biodiversity determines whether citizens perceive themselves as passive observers or active stewards of their local ecosystems.

This chapter explores the multifaceted landscape of urban biodiversity communication, examining its historical evolution, strategic dimensions, practical applications, and persistent challenges. It situates communication within broader debates about environmental governance, city diplomacy, and participatory democracy, arguing that effective communication is essential for translating scientific knowledge into meaningful action and for positioning cities as influential actors on the global environmental stage.

4.1 From Environmental Awareness to Biodiversity Communication

The foundations of environmental communication were laid during the early 1970s, a period marked by growing recognition of planetary limits and ecological degradation. The United Nations Conference on the Human Environment, held in Stockholm in 1972, represented a watershed moment, bringing environmental concerns into international political discourse and establishing the principle that environmental protection requires coordinated global action (Meadows et al., 1972). This conference catalyzed the first wave of environmental communication, primarily focused on raising awareness about pollution, resource depletion, and the fragility of natural systems.

During this initial phase, communication strategies were largely didactic and top-down, emphasizing scientific evidence and catastrophic scenarios to mobilize public concern. Environmental NGOs emerged as key communicators, employing dramatic imagery and advocacy campaigns to pressure governments and corporations. However, these early efforts often struggled to translate awareness into sustained behavioral change, revealing the limitations of fear-based messaging and one-way information transmission.

The 1980s witnessed a conceptual shift with the publication of the Brundtland Report, Our Common Future (1987), which introduced the now-ubiquitous definition of sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" This framing proved transformative for communication, as it connected environmental protection to social equity and economic prosperity, making sustainability relevant to diverse stakeholders beyond the environmental movement. The concept of intergenerational equity provided a moral foundation that resonated across cultures and political systems, facilitating broader public engagement.

The 1992 United Nations Conference on Environment and Development in Rio de Janeiro – commonly known as the Rio Earth Summit – marked another critical juncture. This gathering produced Agenda 21, a comprehensive action plan for sustainable development that explicitly recognized the importance of public participation and access to information. The summit's emphasis on the "triple bottom line" – integrating environmental, social, and economic dimensions (Planet, People, Profit) – expanded the scope of sustainability communication beyond purely ecological concerns (UN-Habitat, 2010). Governments and corporations began adopting sustainability reporting practices,

establishing transparency mechanisms that would later become standard in public and private sector communication.

While sustainability communication gained momentum throughout the 1980s and 1990s, biodiversity as a distinct communication focus emerged more explicitly following the 1992 Convention on Biological Diversity (CBD). This landmark treaty, signed by 196 parties, established three primary objectives: 1) the conservation of biological diversity, 2) the sustainable use of its components, and 3) the fair and equitable sharing of benefits arising from genetic resources. Importantly, the CBD recognized that biodiversity conservation requires not only protected areas but also the integration of conservation principles into all sectors of society.

The early years of biodiversity communication faced significant challenges. Biodiversity as a concept proved more abstract and difficult to communicate than climate change or pollution, lacking the immediacy and tangibility of visible environmental degradation. The term itself – contraction of "biological diversity" – remained technical and distant from everyday experience, particularly for urban populations whose contact with nature was often limited to parks and gardens.

The Millennium Ecosystem Assessment (MEA), published in 2005, represented a crucial advance in making biodiversity communication more accessible and relevant. By framing biodiversity through the lens of ecosystem services – the benefits that humans derive from nature, including provisioning services (food, water), regulating services (climate regulation, flood control), cultural services (recreation, spiritual value), and supporting services (nutrient cycling, soil formation) – the MEA connected biodiversity to human well-being in concrete, understandable terms (MEA, 2005). This framing proved particularly effective in urban contexts, where residents could readily appreciate how green spaces regulate temperature, filter air pollution, provide recreational opportunities, and enhance mental health.

The 2010 adoption of the Aichi Biodiversity Targets under the CBD framework provided specific, measurable goals that facilitated more structured communication strategies. These 20 targets, ranging from raising awareness (Target 1) to protecting at least 17% of terrestrial areas (Target 11), gave cities and nations concrete benchmarks to communicate progress and galvanize action. International campaigns such as the International Day for Biological Diversity and initiatives by organizations like the International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) helped mainstream

biodiversity discussions, gradually moving the topic from specialized scientific and policy circles into broader public discourse.

The most recent phase of biodiversity communication has been shaped by the European Union's Biodiversity Strategy for 2030, which explicitly integrates urban biodiversity into planning and governance frameworks. This strategy sets ambitious targets, including bringing nature back to cities, increasing urban green spaces, and establishing urban green corridors that connect fragmented habitats (European Commission, 2020). By positioning urban biodiversity as central to climate adaptation, public health, and quality of life, the EU strategy has elevated biodiversity from a niche environmental concern to a core element of urban policy, demanding sophisticated communication approaches that engage diverse urban stakeholders.

4.2 Strategic Communication: Building Legitimacy and Trust in Urban Biodiversity

Strategic communication, as applied to public sector organizations and urban governance, encompasses the deliberate and coordinated efforts to create, maintain, and strengthen relationships between institutions and their publics (Canel & Luoma-aho, 2020). Unlike simple information dissemination, strategic communication involves careful audience analysis, message framing, channel selection, and feedback mechanisms designed to achieve specific organizational and societal goals. In the context of urban biodiversity, strategic communication serves multiple functions: building institutional legitimacy, fostering public trust, mobilizing citizen participation, and positioning cities as credible actors in environmental governance.

Research on public sector communication emphasizes that legitimacy (the perception that an institution has the right to govern and that its actions are appropriate and justified) depends fundamentally on effective communication (Canel & Luoma-aho, 2020). Cities seeking to implement ambitious biodiversity policies must cultivate legitimacy by demonstrating competence, transparency, and responsiveness to citizen concerns. This requires moving beyond one-way information transmission toward dialogue-based approaches that acknowledge diverse perspectives and incorporate public input into decision-making processes.

The concept of "symmetrical two-way communication," articulated by public relations scholars and recently revisited by Zabala, Díaz-Campo, and Sánchez-Calero (2022), provides a normative framework for biodiversity communication.

This model emphasizes mutual understanding and balanced exchange between organizations and publics, rather than persuasion or manipulation. In practice, symmetrical communication involves creating opportunities for citizens to voice concerns, ask questions, and contribute knowledge, recognizing that urban residents possess valuable experiential knowledge about local ecosystems that can inform policy and management decisions.

One of the most persistent challenges in biodiversity communication is the "psychological distance" that separates abstract global issues from personal experience and immediate concern (Spence et al., 2012). Biodiversity loss often occurs gradually and invisibly, lacking the dramatic events that characterize natural disasters or acute pollution incidents. Moreover, the consequences of biodiversity decline may not manifest for years or decades, creating temporal distance that undermines urgency. For urban residents, biodiversity can seem spatially distant, associated with rainforests or coral reefs rather than city streets and neighborhoods.

Effective communication strategies must therefore work to reduce psychological distance by making biodiversity tangible, local, and personally relevant. This involves highlighting the biodiversity that exists within cities (the birds nesting in urban parks, the pollinators visiting community gardens, the microorganisms enriching urban soils) and connecting these organisms to services that residents value. For example, communicating how urban trees reduce energy costs by providing shade, or how green roofs mitigate flooding and reduce stormwater management expenses, frames biodiversity in terms of direct economic and safety benefits.

Framing (the selection and emphasis of certain aspects of an issue to promote particular interpretations) plays a crucial role in shaping public engagement with biodiversity (Nisbet, 2009). Research demonstrates that different frames resonate with different audiences and contexts. Health frames, emphasizing how urban nature improves physical and mental well-being, prove particularly effective in engaging residents concerned with quality of life. Economic frames, highlighting the financial value of ecosystem services or the costs of biodiversity loss, appeal to business communities and fiscally-minded policymakers. Social equity frames, drawing attention to disparities in access to urban nature and the concentration of environmental burdens in marginalized communities, resonate with social justice advocates and can build broader coalitions for biodiversity action.

Contemporary research on urban biodiversity communication emphasizes the importance of framing co-benefits, the multiple positive outcomes that flow from

biodiversity conservation (Mumaw et al., 2023). Rather than presenting biodiversity as competing with other urban priorities such as housing or economic development, effective communication demonstrates how biodiversity contributes to achieving multiple goals simultaneously: improving public health, enhancing climate resilience, creating green jobs, and strengthening community cohesion. This integrative framing helps mainstream biodiversity across policy domains and builds support among diverse stakeholder groups.

Beyond information provision and framing, strategic communication can draw on behavioral science to design interventions that facilitate pro-biodiversity behaviors. The concept of "nudging," popularized by Thaler and Sunstein (2008), refers to subtle changes in choice architecture that make desired behaviors easier or more attractive without restricting freedom of choice. In urban biodiversity contexts, nudges might include making native plants the default option at municipal nurseries, designing parks with clearly marked wildlife-friendly zones, or using social norms messaging to encourage sustainable gardening practices.

Research demonstrates that behavioral interventions are most effective when combined with clear communication about why behaviors matter and how they contribute to collective goals (Moser & Dilling, 2011). For example, a campaign encouraging residents to reduce lawn mowing frequency is more successful when it explains how longer grass supports pollinators and reduces water consumption, provides specific guidance on implementation, and showcases neighbors who have adopted the practice. This combination of information, practical guidance, and social proof addresses multiple barriers to behaviour change.

Strategic communication for urban biodiversity must also recognize and address the gap between attitudes and behaviours, the well-documented phenomenon whereby people express concern for environmental issues but fail to translate this concern into consistent action. This "value-action gap" reflects multiple barriers including lack of knowledge about effective actions, perceived inconvenience, social norms that discourage pro-environmental behaviors, and structural constraints that make sustainable choices difficult or expensive. Effective communication strategies acknowledge these barriers and work to reduce them through clear guidance, social support, and advocacy for policy changes that make sustainable behaviors easier and more attractive.

4.3 Communication Channels in the Digital Age

4.3.1 The Expansion of Communication Platforms

The communication landscape for urban biodiversity has been fundamentally transformed by digital technologies, which have multiplied the channels through which information flows and created new opportunities for engagement and participation. Social media platforms, including Facebook, Twitter, Instagram, TikTok, and YouTube, have become central venues for biodiversity communication, enabling cities, NGOs, scientists, and citizens to share information, mobilize support, and document urban nature in real time (Moss et al., 2021). Each platform offers distinct affordances and reaches different demographic groups, requiring tailored communication strategies. Instagram's visual emphasis makes it ideal for showcasing the beauty and diversity of urban nature through photographs and short videos, while Twitter facilitates rapid information sharing and dialogue among activists, policymakers, and experts. TikTok has emerged as a powerful platform for reaching younger audiences through creative, entertaining content that can make biodiversity accessible and engaging. YouTube supports longer-form educational content, including documentary-style videos, expert interviews, and how-to guides for urban conservation actions.

Beyond social media, cities and organizations employ diverse digital tools including dedicated websites, mobile applications, email newsletters, podcasts, and webinars. Each channel serves different communication functions: websites provide comprehensive information repositories; apps facilitate specific actions like species identification or reporting wildlife sightings; podcasts enable in-depth exploration of complex topics; webinars create opportunities for interactive learning and dialogue. The proliferation of channels demands sophisticated communication strategies that integrate multiple platforms while maintaining consistent messaging and branding. The rise of environmental influencers, that is individuals with large social media followings who focus on sustainability and conservation topics, represents another significant development, since these influencers can amplify biodiversity messages to audiences that might not engage with traditional institutional communication, translating scientific information into accessible, relatable content. Cities and conservation organizations increasingly partner with influencers to extend their reach and credibility, particularly among younger demographics.

4.3.2 Citizen Science: Democratizing Knowledge Production

Citizen science, that is the involvement of non-professional scientists in data collection, analysis, and interpretation, has anticipated in chapter 3, has emerged as a particularly powerful form of biodiversity communication that simultaneously generates scientific knowledge, educates participants, and fosters environmental stewardship (Bonney et al., 2014). Digital platforms like iNaturalist, eBird, and iSpot enable urban residents to document and share observations of plants, animals, and fungi in their neighborhoods, contributing to databases that scientists use to track biodiversity patterns, monitor species distributions, and assess ecosystem health.

The communicative power of citizen science extends beyond data collection. By actively observing and documenting urban nature, participants develop deeper knowledge of local biodiversity, cultivate observational skills, and form emotional connections to the species they encounter. This experiential learning proves far more impactful than passive information consumption, transforming participants from abstract supporters of biodiversity into engaged stewards with personal investment in conservation outcomes. Research demonstrates that citizen science participants develop increased ecological literacy, stronger pro-environmental attitudes, and greater willingness to engage in conservation behaviors (Bonney et al., 2014). Moreover, citizen science creates communities of practice, that is networks of individuals who share knowledge, support each other's learning, and collectively advocate for biodiversity conservation. These communities often extend beyond digital platforms to include in-person events such as bioblitzes (intensive species documentation efforts), guided nature walks, and data analysis workshops. The social dimensions of citizen science strengthen its communicative impact, as participants not only learn about biodiversity but also experience the collective power of community action.

Cities increasingly recognize citizen science as a valuable tool for both monitoring biodiversity and engaging residents. Municipal governments support citizen science by providing training, promoting platforms, organizing events, and incorporating citizen-generated data into planning and management decisions. This integration of citizen science into formal governance processes validates participants' contributions and demonstrates that their observations matter for policy, further strengthening engagement and trust.

4.3.3 Transparency and the Perception of Being Informed

A crucial yet often overlooked dimension of biodiversity communication is the perception of being informed, namely the subjective sense that adequate information is available and accessible. Research indicates that citizens' trust in institutions and willingness to support policies depend not only on the quantity and quality of information provided but also on their perception that institutions are communicating transparently and responsively (Cheng et al., 2019).

In the field of biodiversity communication, transparency involves multiple elements: making information readily accessible through multiple channels; communicating both successes and challenges honestly; explaining the rationale behind decisions; acknowledging uncertainty and limitations in knowledge; and providing opportunities for questions and feedback. Cities that communicate transparently about biodiversity, by sharing monitoring data, explaining trade-offs in management decisions, admitting when initiatives fall short of goals, build credibility and trust even when outcomes are imperfect.

The perception of being informed also relates to the relevance and usability of information. Technical reports filled with scientific jargon may satisfy formal transparency requirements while leaving citizens feeling uninformed and excluded. Effective communication requires instead translating complex information into accessible formats, using visualizations, infographics, and narratives that make data meaningful and actionable for non-specialist audiences. This emphasis on accessibility reflects a shift from transparency as mere information disclosure to transparency as genuine comprehensibility and usability.

Contemporary research emphasizes that effective urban biodiversity communication links messages to concrete plans and indicators, ensuring that communication aligns with measurable targets and demonstrates progress over time (Pierce et al., 2020). When cities communicate biodiversity goals alongside specific indicators, such as increases in tree canopy cover, numbers of green roofs installed, or improvements in species diversity, residents can track progress and hold institutions accountable. This measurement-based communication strengthens both transparency and credibility, transforming abstract commitments into tangible outcomes.

4.4 Biodiversity Communication as Public Diplomacy: The European Context and Global City Networks

4.4.1 The European Union's Leadership in Biodiversity Communication

The European Union has emerged as a global leader in urban biodiversity governance and communication, establishing ambitious policy frameworks and supporting innovative communication initiatives that serve as models for cities worldwide. The EU Biodiversity Strategy for 2030 represents the most comprehensive regional biodiversity policy, setting targets that include protecting at least 30% of land and sea areas, restoring degraded ecosystems, reducing pesticide use, and bringing nature back to cities (European Commission, 2020). Crucially, the strategy recognizes that achieving these targets requires not only policy instruments but also effective communication to build public support and mobilize action.

EU Green Week, an annual event organized by the European Commission, exemplifies the Union's approach to biodiversity communication. This week-long series of conferences, workshops, exhibitions, and public events brings together policymakers, businesses, NGOs, and citizens to discuss environmental challenges and showcase solutions. By creating a high-profile platform for dialogue and knowledge exchange, EU Green Week amplifies biodiversity messages, facilitates networking among stakeholders, and generates media coverage that extends the reach of conservation messages far beyond event participants.

The Green Cities Europe initiative represents another key communication platform, supporting cities in implementing NbS and sharing best practices. Through this network, municipalities exchange experiences with green infrastructure, urban forestry, biodiversity-friendly planning, and citizen engagement strategies. The initiative's communication activities, including case studies, webinars, site visits, and publications, help cities learn from each other's successes and failures, accelerating the diffusion of effective practices and building a collective identity among European cities committed to urban nature.

The European Climate Pact, launched as part of the European Green Deal, extends communication efforts beyond institutional actors to engage citizens directly in climate and biodiversity action (European Climate Pact, 2022). The Pact invites individuals, communities, and organizations to pledge specific actions (from creating pollinator gardens to organizing educational events) and provides resources, recognition, and networking opportunities to support these

commitments. By framing climate and biodiversity action as collective endeavors that require contributions from all societal actors, the Climate Pact cultivates a sense of shared responsibility and empowerment

4.4.2 City Diplomacy and Transnational Networks

Beyond national and regional frameworks, cities increasingly engage in direct international cooperation and advocacy through city diplomacy, that is the strategic projection of urban identity and interests on the global stage (Acuto, 2013). City diplomacy encompasses diverse activities including bilateral partnerships, participation in transnational networks, hosting international events, and advocacy at global forums. In the environmental domain, city diplomacy has become particularly prominent as municipalities recognize that many sustainability challenges transcend national boundaries and require coordinated urban action.

The C40 Cities Climate Leadership Group exemplifies the power of transnational city networks in shaping environmental governance and communication. Founded in 2005 and now comprising nearly 100 of the world's largest cities, C40 facilitates knowledge exchange, coordinates joint action, and amplifies urban voices in international climate negotiations. While C40's primary focus is climate change, its activities increasingly address biodiversity, recognizing the interconnections between climate action and nature conservation. The network's communication strategies, including high-profile reports, media campaigns, and mayoral summits, position cities as leaders in environmental governance and create pressure on national governments to adopt more ambitious policies (Acuto & Rayner, 2016). Scholars like Juan Luis Manfredi (2020) have analyzed how cities leverage diplomacy to establish themselves as independent actors in international relations, capable of forming partnerships and influencing policy debates independently of national governments. This urban agency proves particularly significant for biodiversity governance, where cities often implement more progressive policies than their national counterparts and serve as laboratories for innovative approaches. By communicating their achievements and commitments through diplomatic channels, cities not only share knowledge but also build normative pressure for higher environmental standards globally.

City-to-city partnerships, such as sister city relationships and bilateral cooperation agreements, provide additional venues for biodiversity communication and knowledge transfer. These partnerships enable cities to learn

from each other's experiences with specific challenges, such as managing urban wetlands, controlling invasive species, or engaging marginalized communities in conservation, through direct exchange of technical expertise, study visits, and joint projects. The communication that flows through these partnerships is often more detailed and context-specific than what occurs through larger networks, allowing for deeper learning and adaptation.

4.4.3 Positioning Cities as Biodiversity Leaders

Strategic communication about urban biodiversity serves not only to inform and engage local residents but also to position cities as credible, innovative leaders on the global stage. Cities compete to attract investment, skilled workers, tourists, and international recognition, and a strong reputation for environmental leadership can provide significant competitive advantages. Copenhagen's success in branding itself as a carbon-neutral city, for example, has enhanced its international profile, attracted green businesses and conferences, and strengthened civic pride (Van der Pluijm & Melissen, 2007).

Effective positioning requires consistent, evidence-based communication about achievements, challenges, and commitments. Cities that transparently report biodiversity indicators, showcase innovative projects, and honestly acknowledge ongoing challenges, build credibility with international audiences. This transparency distinguishes genuine leadership from "greenwashing", the superficial claims of environmental commitment unsupported by substantive action. International audiences, particularly investors and partner cities, increasingly scrutinize environmental claims and reward authenticity while penalizing exaggeration or deception.

The communication of urban biodiversity also intersects with broader narratives about urban quality of life, innovation, and resilience. Cities that successfully integrate biodiversity into comprehensive sustainability narratives, demonstrating how NbS address multiple challenges including climate adaptation, public health, social equity, and economic development, create more compelling and credible messages than those that treat biodiversity as an isolated concern. This integrated communication reflects the reality that biodiversity conservation in cities is inseparable from broader urban development trajectories and governance capacities.

4.5 Challenges and Opportunities in Urban Biodiversity Communication

4.5.1 Navigating Complexity and Avoiding Oversimplification

Biodiversity represents an inherently complex concept, encompassing genetic diversity, species diversity, and ecosystem diversity across multiple spatial and temporal scales. Communicating this complexity to non-specialist audiences without oversimplifying or distorting scientific understanding poses a persistent challenge. Overly technical communication alienates audiences and fails to motivate action, while excessive simplification risks conveying misleading messages that undermine long-term understanding and support.

Research on science communication emphasizes the importance of finding appropriate levels of complexity that respect both scientific accuracy and audience comprehension (Moser & Dilling, 2011). Effective strategies include using concrete examples and case studies to illustrate abstract concepts, employing analogies and metaphors that connect unfamiliar ideas to familiar experiences, and using visual representations such as infographics and data visualizations that make patterns and relationships more accessible. For instance, explaining biodiversity through the metaphor of an insurance policy (where greater diversity provides resilience against environmental changes) can make the concept more relatable while preserving its essential meaning.

The challenge of complexity extends beyond scientific concepts to encompass the socio-political dimensions of biodiversity governance. Urban biodiversity conservation involves navigating trade-offs between competing land uses, balancing diverse stakeholder interests, addressing historical inequities in access to nature, and coordinating across fragmented governance structures. Communicating these complexities honestly while maintaining public engagement requires sophisticated messaging that acknowledges tensions and uncertainties without inducing paralysis or cynicism.

4.5.2 Combating Misinformation and Cultivating Media Literacy

The digital information environment, while offering unprecedented opportunities for biodiversity communication, also facilitates the rapid spread of misinformation and disinformation. False or misleading claims about environmental issues, from conspiracy theories about climate change to exaggerated reports of species extinctions to unfounded criticisms of conservation

policies, circulate widely on social media, potentially undermining public understanding and support for biodiversity action (Moss et al., 2021).

Addressing misinformation requires multi-pronged strategies that combine proactive communication, rapid response to false claims, and long-term investment in media literacy. Proactive communication involves consistently providing accurate, accessible information through trusted channels, establishing credibility before misinformation takes hold. Rapid response mechanisms enable cities and conservation organizations to quickly identify and counter false claims, preventing them from becoming entrenched. However, research suggests that simple fact-checking is often insufficient, as corrections may reinforce the original misinformation through repetition or trigger defensive reactions among those who have accepted false claims.

More fundamentally, addressing misinformation requires cultivating media literacy, that is the ability to critically evaluate information sources, recognize manipulation techniques, and distinguish credible evidence from speculation or propaganda. Cities and educational institutions can support media literacy through formal education programs, public workshops, and partnerships with libraries and community organizations. By empowering citizens to navigate the information environment critically, these initiatives build long-term resilience against misinformation.

4.5.3 Overcoming Apathy and Competition with Other Priorities

Even when information about biodiversity is accurate, accessible, and well-communicated, cities face the challenge of competing for public attention and political priority against numerous pressing concerns including housing affordability, public safety, transportation, and economic development. In resource-constrained environments where budgets are limited and political capital is finite, biodiversity conservation may be perceived as a luxury rather than a necessity, vulnerable to being deprioritized when other crises emerge.

Overcoming this challenge requires embedding biodiversity within broader urban agendas rather than presenting it as a separate, competing priority. When biodiversity conservation is framed as integral to public health, climate resilience, economic vitality, and social equity, rather than as an isolated environmental concern, it becomes more difficult to dismiss and easier to justify politically and fiscally. This mainstreaming approach aligns with contemporary research emphasizing that effective urban biodiversity governance requires integration

across sectors and scales rather than siloed conservation efforts (Mahmoud et al., 2024).

Communication strategies that highlight co-benefits and synergies prove particularly effective in building support across diverse constituencies. For example, communicating how green infrastructure simultaneously manages stormwater, reduces urban heat, sequesters carbon, provides recreational space, and supports biodiversity appeals to public works departments, public health officials, climate activists, community groups, and conservation advocates. This multi-benefit framing creates broader coalitions and more robust political support than single-issue advocacy.

4.5.4 Opportunities: Success Stories and Nature-Based Solutions

Despite these challenges, urban biodiversity communication benefits from compelling success stories that demonstrate the feasibility and benefits of conservation action. The already mentioned Singapore's transformation into a "City in a Garden" exemplifies how long-term vision, sustained investment, and strategic communication can fundamentally reshape urban form and identity (Tan et al., 2013). Over decades, Singapore has integrated nature throughout the city through extensive tree planting, green roofs and walls, park connectors, and innovative designs like the Gardens by the Bay. This transformation has been accompanied by sophisticated communication that positions urban nature as central to Singapore's competitive advantage, quality of life, and national identity.

Similarly, cities like Barcelona, Hamburg, and Copenhagen have become international references for urban biodiversity and sustainability, attracting study visits, media attention, and replication efforts. These cities' communication strategies emphasize not only their achievements but also their ongoing challenges and learning processes, creating narratives of continuous improvement rather than perfection. By sharing both successes and failures, they build credibility and provide realistic models for other cities to adapt.

NbS, as described in chapter 3, have emerged as a particularly powerful frame for biodiversity communication (Ramaswami et al., 2016). This concept resonates with diverse audiences by emphasizing functionality and problem-solving rather than abstract conservation values. Examples include constructed wetlands that treat wastewater while providing habitat, urban forests that reduce heat island effects while supporting biodiversity, and green corridors that facilitate species movement while offering recreational paths. By demonstrating how working

with nature can be more effective and cost-efficient than conventional gray infrastructure, nature-based solutions communication builds support for biodiversity conservation among audiences that might not respond to traditional conservation messaging.

4.5.5 Leveraging Technology and Sustainable Finance

Emerging technologies create new opportunities for biodiversity communication and engagement. Augmented reality applications can overlay information about species and ecosystems onto physical spaces, enabling users to "see" invisible ecological processes or historical landscapes. Virtual reality experiences can transport urban residents to nearby natural areas or distant ecosystems, fostering emotional connections and understanding. Artificial intelligence and machine learning facilitate automated species identification, making citizen science more accessible and accurate.

The rise of sustainable finance mechanisms, including green bonds, biodiversity credits, and impact investing, provides cities with new resources for biodiversity projects while creating communication opportunities. When cities issue green bonds to finance urban forest expansion or wetland restoration, transparent communication about project outcomes and environmental benefits builds investor confidence and public trust (Van der Pluijm & Melissen, 2007). Regular reporting on how funds are used and what results are achieved demonstrates accountability and can attract additional investment.

Participatory budgeting processes, where residents directly decide how to allocate portions of municipal budgets, offer another opportunity to engage citizens in biodiversity governance while building support for conservation investments. Cities that have implemented participatory budgeting for environmental projects report increased civic engagement, greater satisfaction with local government, and more equitable distribution of green infrastructure. The deliberative processes involved in participatory budgeting also serve educational functions, as residents learn about biodiversity issues, trade-offs, and possibilities through structured dialogue.

4.6 Looking Forward: Communication, Empowerment, and Urban Resilience

The communication of urban biodiversity stands at a critical juncture. Scientific evidence increasingly demonstrates that thriving urban ecosystems are not amenities but necessities, essential for climate adaptation, public health, social cohesion, and long-term urban resilience. Yet translating this evidence into widespread understanding and sustained action requires communication strategies that are sophisticated, adaptive, and genuinely participatory.

The future of biodiversity communication lies in moving beyond information transmission toward genuine co-creation of knowledge and governance. Recent research on urban biodiversity governance emphasizes the transformative potential of systemic co-inquiry and social learning processes, where citizens and institutions jointly investigate problems, develop solutions, and reshape governance arrangements (Mumaw et al., 2023). These approaches recognize that effective biodiversity conservation in cities requires not only scientific expertise but also the experiential knowledge, values, and creativity of diverse urban residents. Communication becomes not a tool for persuading citizens to accept predetermined policies but a medium through which collective intelligence emerges and democratic governance is strengthened.

This shift toward participatory communication aligns with broader trends in urban governance toward greater transparency, accountability, and citizen empowerment. As cities face increasingly complex, interconnected challenges, from climate change to social inequality to public health crises, traditional top-down governance models prove insufficient. Biodiversity communication that fosters dialogue, acknowledges uncertainty, respects diverse knowledge systems, and creates space for experimentation can contribute to more adaptive, resilient governance capable of navigating uncertainty and change.

The role of cities as actors in biodiversity diplomacy will likely continue to expand. As national governments struggle to reach consensus on ambitious environmental policies, cities demonstrate that meaningful action is possible at the urban scale. Transnational city networks provide platforms for sharing innovations, coordinating advocacy, and building normative pressure for higher environmental standards. The communication that flows through these networks, combining technical knowledge exchange with political messaging, positions cities not as subordinate implementers of national policy but as independent actors shaping global environmental governance.

Looking ahead, several priorities emerge for advancing urban biodiversity communication.

I) First, greater investment in communication capacity within municipal governments is essential. Many cities lack staff with expertise in strategic communication, relying instead on ad hoc efforts that fail to reach diverse audiences or sustain engagement over time. Building professional communication teams, providing training, and allocating adequate budgets would strengthen cities' capacity to design and implement effective campaigns.

II) Second, more systematic evaluation of communication interventions is needed. While the field has generated numerous case studies and best practice guides, rigorous evidence about what communication strategies work, for whom, and under what conditions remains limited. Cities should partner with researchers to design evaluation frameworks that assess not only reach and engagement metrics but also deeper outcomes including knowledge change, attitude shifts, behavioral adoption, and governance transformation.

III) Third, communication strategies must address persistent inequities in access to urban nature and participation in environmental governance. Low-income communities and communities of color often experience both lower access to quality green space and greater exposure to environmental hazards, yet they are frequently excluded from biodiversity planning and decision-making processes. Communication that actively reaches marginalized communities, employs culturally appropriate methods, addresses language barriers, and creates genuine opportunities for influence can help redress these inequities while enriching biodiversity governance with diverse perspectives and knowledge.

IV) Fourth, biodiversity communication must strengthen connections between local action and global challenges. While making biodiversity locally relevant is essential, effective communication also helps residents understand how their actions contribute to broader ecological systems and global conservation goals. This scalar connectivity, linking individual behaviors to neighborhood ecosystems to regional landscapes

to planetary processes, can foster both empowerment (by demonstrating that individual actions matter) and humility (by revealing human dependence on vast, interconnected natural systems).

V) Finally, biodiversity communication must grapple honestly with the profound transformations required to achieve sustainability. While positive messaging and success stories play important roles in building engagement, communication that glosses over the magnitude of environmental challenges or suggests that incremental changes are sufficient risks fostering complacency. Effective communication balances hope and urgency, celebrating progress while acknowledging how far cities must still travel to achieve truly sustainable, biodiverse urban futures.

4.7 Conclusion

Communicating urban biodiversity is far more than a technical exercise in information dissemination. It is a strategic practice that shapes how cities govern themselves, how citizens relate to nature and each other, and how urban areas position themselves in an interconnected world. From the early environmental awareness campaigns of the 1970s to today's sophisticated digital engagement strategies, biodiversity communication has evolved in scope, sophistication, and strategic importance.

Effective communication helps build the legitimacy and trust that cities need to carry out ambitious conservation policies. It also brings global environmental issues closer to people's daily lives, making them feel less distant and abstract. Good communication creates space for residents to share knowledge, take part in decision-making, and experience what it means to care for their environment together. It can even strengthen a city's role on the international stage, enabling local governments to form partnerships and influence broader policy debates. Yet significant challenges remain. The complexity of biodiversity concepts, the proliferation of misinformation, the competition with other urban priorities, and persistent inequities in access and participation all constrain communication effectiveness. Addressing these challenges requires sustained investment, continuous learning, honest acknowledgment of limitations, and genuine commitment to participatory governance.

The cities that will thrive in an era of environmental change are those that recognize urban nature not as a constraint on development but as fundamental infrastructure supporting health, resilience, and prosperity. Communicating this recognition, namely translating it into accessible narratives, engaging dialogues, and concrete actions, is essential for building the broad-based support that ambitious biodiversity conservation requires. As cities continue to grow and environmental pressures intensify, the quality of biodiversity communication may prove as consequential as the quality of biodiversity policy itself.

Ultimately, urban biodiversity communication is about empowerment: empowering citizens with knowledge and agency, empowering communities to shape their environments, and empowering cities to lead global environmental governance. By fostering transparent, participatory, and strategically sophisticated communication, cities can cultivate the collective intelligence and commitment needed to build truly sustainable, nature-rich urban futures.

Chapter 5

Engagement and Education in Urban Biodiversity

Pablo Gómez-Iniesta and Monica Bernardi

Urban areas now house over half of humanity, and by 2050, nearly 70% of the global population will live in cities (UN DESA, 2018). This rapid urbanization poses profound challenges for biodiversity, as habitat fragmentation, pollution, and climate change threaten species survival in urban landscapes. Yet cities also present unique opportunities: urban green spaces, community gardens, street trees, and even small patches of habitat can support remarkable biodiversity and provide essential ecosystem services, from air purification and temperature regulation to mental health benefits and social cohesion (Aronson et al., 2017; Kabisch et al., 2016).

Bringing nature back to cities requires more than technical interventions or policy mandates. It demands a fundamental shift in how urban residents perceive, value, and interact with the living world around them. Engagement and education are central to this transformation. When communities participate in biodiversity monitoring, restoration, and stewardship, they develop deeper ecological understanding, foster environmental citizenship, and co-create knowledge that informs more effective, equitable urban planning (Palma et al., 2024; Peltola & Arpin, 2018).

This chapter explores precisely the multifaceted role of engagement and education in urban biodiversity conservation. It considers formal education systems (schools, universities, and institutional partnerships) alongside informal and experiential learning through community gardens, citizen science, and participatory design processes. The discussion brings together theoretical perspectives on transformative learning, environmental citizenship, and communities of practice, while also addressing the cultural, ethical, and social dimensions of reconnecting people with urban nature. Particular attention is given to inclusive and equitable approaches, drawing on diverse global examples

from Latin America, Asia, Africa, and beyond, not limited to European or Mediterranean contexts.

While communication – through awareness campaigns, storytelling, and dialogue – plays a supporting role in enhancing participation and learning, it is treated here as an enabling element rather than a central theme, as another chapter in this volume addresses communication in depth. Our focus remains on the pedagogical, participatory, and policy dimensions of urban biodiversity engagement.

5.1 Transformative & Collective Learning

The *transformative learning* theory, developed by Jack Mezirow and expanded by others, posits that deep, lasting change in perspectives occurs when learners critically reflect on their assumptions and experiences (Mezirow, 1997; Taylor & Cranton, 2012). In urban biodiversity contexts, transformative learning happens when residents move beyond passive awareness to active stewardship, shifting from viewing nature as distant or decorative to recognizing themselves as participants in urban ecosystems.

Recent studies demonstrate that frequent, tactile engagement with biodiversity catalyzes transformative learning. Gerits et al. (2023) in this regard found that participants in agrobiodiversity citizen science projects using small-scale observatories (square-meter gardens) reported significant shifts in perspectives and behaviors: over 50% changed their views on agrobiodiversity, and approximately one-third altered their practices. The authors identified tactile tools, repeated engagement, and reflective communication as key mediators of transformation. Similarly, garden-based education programs in diverse settings – from Turkey's ODTÜ Bostan community garden to campus gardens in the United States – have fostered transformative learning by providing hands-on, repeated, and socially embedded experiences that challenge participants' assumptions about food systems, ecology, and their roles as urban dwellers (Çolak & Yılmaz, 2024; Krasny & Tidball, 2009).

Transformative learning in urban biodiversity is not merely cognitive; it is affective and relational. Encounters with urban wildlife, participation in habitat restoration, and shared experiences in community gardens generate emotional connections that motivate sustained engagement (Tidball & Krasny, 2011). These affective dimensions are particularly important for broadening participation beyond traditional environmental constituencies, as discussed in Chapter 3.

5.1.1. Environmental Citizenship and Civic Ecology

Environmental citizenship extends beyond individual behaviour change to encompass rights, responsibilities, and active participation in environmental governance (Dobson, 2007; Hadjichambis et al., 2020). In urban contexts, environmental citizenship manifests through civic ecology practices, community-led stewardship activities such as tree planting, habitat restoration, and community gardening that enhance both social and ecological resilience (Krasny & Tidball, 2015).

Urban biodiversity education that fosters environmental citizenship links personal learning to collective action and policy engagement. For example, the Missouri Botanical Garden's BiodiverseCity St. Louis[20] initiative integrates public education, professional training, and citizen science to build regional networks of informed stewards who influence municipal landscaping practices, school curricula, and local policy (Ponzi et al., 2024). Similarly, the Conservation Trust of Puerto Rico's[21] mentored citizen science program progressed participants from contributory data collection to co-created research projects, empowering communities to generate knowledge that informed local conservation decisions (Krasny & Bonney, 2005).

Environmental citizenship also requires attention to equity and justice. Peltola and Arpin (2018) at this regard argue that participatory biodiversity monitoring can reproduce socioeconomic inequalities if programs fail to address barriers to participation, as can be time constraints, lack of access to green spaces, and cultural alienation from mainstream environmental discourse. Inclusive environmental citizenship, therefore, must be intentionally designed to engage marginalized communities, recognize diverse knowledge systems, and address structural inequities in urban environments.

5.1.2. Communities of Practice and Social Learning

Communities of practice, in brief groups of people who share a concern or passion and learn collectively through sustained interaction, provide a valuable framework for understanding how urban biodiversity engagement scales and deepens (Wenger, 1998) or has the potential to. In urban contexts, communities

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[20] For the Missouri Botanical Garden. BiodiverseCity St. Louis initiative see here: https://www.missouribotanicalgarden.org/sustainability/sustainability/biodiversecity-st-louis
[21] More information about the Conservation Trust of Puerto Rico here: https://archivo.paralanaturaleza.org/en/about-the-trust-ctpr/

of practice emerge around shared stewardship activities, such as community gardeners exchanging seeds and techniques, citizen scientists collaborating on biodiversity surveys, or neighborhood groups co-designing green infrastructure.

Social learning, a closely related concept, emphasizes collective learning processes that occur through dialogue, collaboration, and shared problem-solving (Reed et al., 2010). Urban Living Labs (ULLs) exemplify this approach: multi-stakeholder platforms where residents, municipal staff, researchers, and NGOs co-create and test biodiversity interventions. For instance, the BiodiverCities project in Valongo, Portugal[22], established micro-laboratories where citizens, municipal actors, and academics collaboratively designed and evaluated participatory biodiversity actions, fostering shared ownership and iterative learning (Isidoro et al., 2022). Similarly, the Biodiversity Urban Living Lab (BULL) framework integrates human-computer interaction (HCI) design and "more-than-human" perspectives to enable community co-creation of biodiversity solutions, recognizing that urban ecosystems involve diverse actors, human and non-human (Slingerland & Overdiek, 2023).

These theoretical frameworks converge on a central insight: effective urban biodiversity engagement is not merely about transferring knowledge from experts to publics, but about creating conditions for transformative, participatory, and equitable learning that empowers diverse communities to become active stewards of urban nature.

5.2 Contexts and Settings for Urban Biodiversity Education

5.2.1 Formal education

Formal education systems play a critical role in shaping how young people understand and value urban biodiversity. Integrating biodiversity into school curricula, through science, geography, and social studies, provides students with foundational ecological knowledge and opportunities for place-based learning (Schweitzer & Gionfra, 2018). However, effective biodiversity education goes beyond classroom instruction to include outdoor, experiential learning that connects students directly with urban ecosystems. Several innovative school-

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[22] Câmara Municipal de Valongo. Projeto BiodiverCities Valongo. https://www.cm-valongo.pt/pages/1162.

based programs illustrate this approach. For instance, the "Celebrando la Naturaleza Urbana" project in Quito, Ecuador, engaged two schools in citizen science activities that linked classroom learning to local urban biodiversity. Students used iNaturalist to document species in their neighborhoods, generating valuable biodiversity data while developing scientific inquiry and observation skills (Peñaherrera Romero et al., 2022). Similarly, the Arboriza mobile app in Brazil enabled school students to map and document urban trees, contributing to municipal tree inventories while learning about urban forestry and ecosystem services (Frank et al., 2025). For school-based citizen science to succeed, careful design is essential. Soanes et al. (2020) provide practical guidance for wildlife research with children, emphasizing clear protocols, achievable tasks, appropriate supervision, and ethical considerations. They note that logistical constraints, such as scheduling, resource availability, and safety concerns, can limit participation and data reliability, but these challenges can be mitigated through strong teacher training, institutional support, and partnerships with universities or NGOs.

Also, universities, botanical gardens, museums and eco-museums, as well as research institutions, bring scientific expertise, infrastructure, and credibility to urban biodiversity education (Bell et al., 2021; Borrelli, 2024). These institutions can serve as knowledge brokers, connecting researchers, educators, practitioners, and communities. The Missouri Botanical Garden's BiodiverseCity St. Louis initiative exemplifies this model. Launched to promote regional biodiversity through horticulture, education, and citizen science, the initiative partners with schools, businesses, municipalities, and conservation organizations to advance ecological landscaping and biodiversity-friendly practices. It offers professional training for landscapers and educators, coordinates citizen science projects, and provides resources for schools and community groups. By leveraging its institutional strengths (taxonomic expertise, living collections, and public outreach capacity) the Garden has built a regional network that integrates biodiversity into urban planning, education, and practice (Ponzi et al., 2024).

Similarly, universities can anchor urban biodiversity education through campus-based initiatives that serve as living laboratories for students and surrounding communities. Campus gardens, green roofs, and restored habitats provide hands-on learning opportunities and demonstrate sustainable practices. For example, community gardens on university campuses in Turkey and the United States have fostered interdisciplinary learning, agency, and solidarity among students, while

serving as sites for research and public engagement (Çolak & Yılmaz, 2024; Krasny & Tidball, 2009).

Institutional partnerships are particularly valuable for addressing capacity gaps in under-resourced schools and communities. By providing training, materials, and scientific mentorship, universities and botanical gardens can democratize access to high-quality biodiversity education and support long-term engagement.

5.2.2 Community-Based Education

Community-based education encompasses grassroots practices such as community gardens and civic ecology initiatives, where residents learn together through hands-on stewardship, shared experimentation, and everyday engagement with urban nature.

Community gardens for instance are among the most powerful sites for informal urban biodiversity education, providing place-based learning opportunities where participants cultivate not only plants but also ecological knowledge, social connections, and stewardship values (Krasny & Tidball, 2009; Okvat & Zautra, 2011). Research consistently shows that they foster transformative learning; indeed, participants in garden-based programs report increased understanding of biodiversity, ecosystem services, and sustainable practices, as well as shifts in attitudes and behaviors (Gerits et al., 2023). In this way gardens act as contexts for science learning (observing pollination, soil ecology, and plant-insect interactions), civic ecology (habitat creation and restoration), and social learning (exchanging knowledge and building community networks).

To bring an example, the ODTÜ Bostan community garden in Ankara, Turkey, clearly illustrates these dynamics. Established as a grassroots initiative, the garden became an informal transformative learning environment where participants engaged in collective decision-making, experimented with agroecological practices, and developed solidarity and agency. The garden thus fostered interdisciplinary learning, connecting agriculture, ecology, social justice, and urban planning, and served as a space for critical reflection on urban food systems and environmental governance (Çolak & Yılmaz, 2024).

Community gardens also support intergenerational learning and cultural exchange. In diverse urban neighborhoods, gardens become spaces where immigrant communities maintain cultural food traditions, elders share agricultural knowledge, and children learn about plant life cycles and seasonal rhythms. This cultural dimension enriches biodiversity education, recognizing

that urban nature is not only an ecological but also a social and cultural phenomenon.

While community gardens are collective spaces, private gardens and yards also offer significant opportunities for urban biodiversity conservation and education. Wildlife gardening programs encourage homeowners to create habitat for pollinators, birds, and other urban wildlife through native plantings, water features, and pesticide reduction. Diduck et al. (2020) examined learning pathways in private urban gardens, finding that gardeners' biodiversity practices were shaped by diverse factors including personal values, social networks, resource access, and prior knowledge. Effective wildlife gardening programs provide accessible information, social support, and visible endorsement from trusted institutions. For example, the Knox Gardens for Wildlife program in Australia combined municipal endorsement, garden assessments, local advice hubs, and volunteer networks to scale household wildlife gardening. This partnership model, linking community groups, local councils, and horticultural experts, produced measurable biodiversity and social benefits while reframing citizens as land stewards (Mumaw & Bekessy, 2017).

Beyond gardens and community stewardship, many learning experiences also unfold outdoors, through activities that bring people into direct contact with urban ecosystems, such as field trips, nature walks, and wilderness experiences, that have long been recognized as valuable for environmental learning. In urban contexts, outdoor education takes diverse forms: school excursions to urban parks, guided biodiversity surveys, unstructured play in green spaces.

Nature-based education for resilient cities emphasizes experiential, place-based learning that connects children and adults with local ecosystems. Schweitzer and Gionfra (2018) argue that nature-based education fosters ecological literacy, emotional connection to nature, and resilience, both individual (coping skills, well-being) and collective (community cohesion, adaptive capacity). They highlight examples from European cities where nature-based education is integrated into urban planning, including schoolyard greening, forest kindergartens, and urban nature centers. Experiential learning is particularly effective when combined with reflection and action. Programs that engage participants in habitat restoration, tree planting, or invasive species removal provide tangible contributions to biodiversity while fostering stewardship values and self-efficacy (Tidball & Krasny, 2011).

5.3 Citizen Science. Participation, Data, and Stewardship

Citizen science, as already anticipated, has become a cornerstone of urban biodiversity monitoring and engagement. Enabled by digital technologies, particularly mobile apps like iNaturalist, citizen science projects generate vast quantities of biodiversity data while engaging diverse publics in scientific inquiry and stewardship (Bonney et al., 2014; Dickinson et al., 2012).

The City Nature Challenge (CNC), an annual global bioblitz, exemplifies the scale and impact of urban citizen science; launched in 2016 as a friendly competition between Los Angeles and San Francisco, the CNC has grown to include hundreds of cities worldwide. In 2022, participants made over 1.6 million observations of more than 57,000 species in four days. Palma et al. (2024) document how the CNC contributes to biodiversity knowledge, informs local government practices, and fosters public engagement. Municipal staff report using CNC data to identify biodiversity hotspots, prioritize conservation actions, inform educational programming, and build cross-departmental collaboration. Regional implementations of the CNC demonstrate diverse approaches. In La Paz, Bolivia, the *Reto Ciudad Naturaleza*[23] mobilized thousands of participants through partnerships between the Wildlife Conservation Society, Universidad Mayor de San Andrés, and the Museo Nacional de Historia Natural. The initiative provided training in iNaturalist use, conducted outreach in schools and communities, and generated over 137,000 observations in 2022, strengthening urban-nature connections in a rapidly growing Andean city (Prado et al., 2023). In Puebla, Mexico, the *Reto Naturalista Urbano* engaged 66 volunteers who produced 2,724 records across 680 species, demonstrating how targeted campaigns with taxonomic support can generate valuable biodiversity data in medium-sized cities (Ramírez Bravo et al., 2022).

Beyond large-scale initiatives like the CNC, citizen science takes many different forms, each offering distinct ways for participants to engage. Projects vary along a continuum from contributory (participants primarily collect data designed by scientists) to collaborative (participants contribute to project design and data analysis) to co-created (community members and scientists jointly design and implement research) (Bonney et al., 2009). Each model offers distinct learning

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[23] Wildlife Conservation Society Bolivia. *Reto Ciudad Naturaleza:* https://cienciaciudadanabolivia.org/iniciativa/reto-ciudad-naturaleza/.

and empowerment opportunities. The already mentioned Conservation Trust of Puerto Rico's parks program for instance well illustrates progression along this continuum. The program began with contributory citizen science but evolved through mentorship to co-created projects where community members identified research questions, designed studies, and interpreted findings. This approach built scientific capacity, fostered long-term engagement, and produced locally relevant knowledge that informed conservation decisions (Krasny & Bonney, 2005).

School-based citizen science also demonstrates diverse models. The URBAN biomonitoring program in Hamilton, Ontario, used a nine-step framework adapted from the Cornell Lab of Ornithology to engage volunteers in monitoring urban biodiversity[24]. The program emphasized species identification skills, data quality, and stewardship outcomes, demonstrating that well-designed protocols and training can produce reliable data while fostering environmental learning (Cartwright et al., 2015).

These models create valuable opportunities for learning and stewardship, but they also raise important considerations particularly in relation to equity, data quality, and sustained participation. Indeed, if from one side citizen science offers multiple benefits, such as cost-effective biodiversity monitoring, public engagement, scientific literacy, and stewardship (Dickinson et al., 2012), on the other side, there are challenges and equity concerns must be addressed.

(I)   First, citizen science data can be spatially and taxonomically biased, reflecting who participates and where they observe. Crowdsourced bird observations, for example, are disproportionately contributed by White, relatively affluent participants, and reporting patterns follow the spatial structuring of race and wealth in cities (Callaghan et al., 2021). These biases can skew biodiversity knowledge and conservation priorities if not recognized and properly addressed.

(II)   Another issue relates to inclusivity and access: Peltola and Arpin (2018) argue that participatory biodiversity monitoring can reproduce socioeconomic inequalities unless programs intentionally address barriers to participation. Time constraints, lack of access to technology or green spaces, limited prior knowledge, and cultural alienation from mainstream science can exclude marginalized communities. Affective, participant-centered approaches that treat people as individuals with

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[24] See the official site here: https://urbanmonitoring.ca/

diverse abilities and backgrounds can increase inclusion and foster ownership of learning processes.

(III)   The third issue concerns mentorship and sustained engagement; indeed, long-term engagement requires more than technology; it requires relationships. Scientist-community mentorship, as demonstrated in Puerto Rico's program, builds trust, capacity, and sustained participation (Krasny & Bonney, 2005). Without ongoing support, initial enthusiasm can wane, and participants may feel disconnected from the scientific process.

(IV)   The last element has an ethical nature: citizen science in urban areas raises ethical questions about data privacy, intellectual property, and the potential for surveillance. Programs must ensure informed consent, transparent data use, and equitable benefit-sharing, particularly when working with vulnerable communities.

5.4 Participatory Design and Co-Creation

A growing body of research highlights the role of participatory design and co-creation in advancing urban biodiversity governance, providing structured ways for stakeholders to collectively shape interventions and policies

Participatory design approaches recognize that effective urban biodiversity conservation requires collaboration among diverse stakeholders, from residents, to municipal staff, planners, NGOs and civil society, researchers, and businesses. One prominent example is Urban Living Labs (ULLs), which provide structured platforms for collaboration and enable iterative experimentation, co-learning, and the co-creation of biodiversity interventions (Bulkeley et al., 2016; Voytenko et al., 2016).

The already mentioned BiodiverCities project in Valongo, Portugal, exemplifies this approach since it is based on micro-laboratories where citizens, municipal actors, and academics collaboratively designed and tested participatory actions to promote urban biodiversity. These micro-labs fostered shared decision-making, local experimentation, and mutual learning, while addressing context-specific challenges such as limited green space and community awareness. The project demonstrated that co-created interventions generate greater community ownership and are more likely to be sustained than top-down initiatives (Isidoro et al., 2022).

The Biodiversity Urban Living Lab (BULL) framework extends participatory design to include "more-than-human" perspectives, recognizing that urban biodiversity involves diverse actors, human and non-human. Slingerland and Overdiek (2023) propose integrating human-computer interaction (HCI) co-design with citizen sensing to enable communities to monitor and respond to biodiversity in real time. This approach emphasizes experimentation, adaptability, and inclusive participation, challenging traditional expert-driven conservation models.

While ULLs offer experimental spaces, similar participatory dynamics are now increasingly shaping municipal urban planning and policy frameworks. Municipal biodiversity strategies, green infrastructure plans, and climate adaptation frameworks now often include provisions for community engagement, co-design, and citizen science (European Commission, 2021; ICLEI, 2021). For example, the City Nature Challenge has been used by municipalities to inform biodiversity planning. Palma et al. (2024) report that local government staff use CNC data to identify priority conservation areas, develop educational materials, and foster cross-departmental collaboration. In some cities, CNC results have influenced green infrastructure investments and habitat restoration projects, demonstrating how citizen-generated data can inform policy.

However, genuine participatory governance requires more than consultation; it requires power-sharing, transparency, and accountability. Communities must have meaningful influence over decisions, not merely provide input that is ignored or tokenized. This demands institutional change, shifting from technocratic, expert-led planning to collaborative, adaptive governance that values diverse knowledge systems and centers community priorities (Ernstson et al., 2008).

Alongside municipal efforts, Non-governmental organizations (NGOs) and civil society groups play a pivotal intermediary role in urban biodiversity engagement, bridging communities, institutions, and governments. NGOs often possess the trust, cultural competence, and local knowledge needed to engage marginalized communities, while also having the technical capacity and networks to collaborate with researchers and policymakers.

The Wildlife Conservation Society's coordination of the La Paz City Nature Challenge illustrates this role[25]. WCS partnered with universities, museums, and

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[25] See more info here: https://programs.wcs.org/newsroom/News-Releases/articleType/ArticleView/articleId/22709/Bolivia-Shines-in-the-City-Nature-Challenge-2024-La-Paz-Achieves-Third-Consecutive-Victory.aspx

community groups to provide training, outreach, and logistical support, enabling large-scale participation and generating valuable biodiversity data (Prado et al., 2023). Similarly, the Conservation Trust of Puerto Rico facilitated long-term citizen science through mentorship and community partnerships, building local capacity and empowering communities to lead conservation initiatives (Krasny & Bonney, 2005).

Effective NGO intermediation requires careful attention to power dynamics, ensuring that NGOs amplify rather than displace community voices, and that partnerships are equitable and mutually beneficial.

These governance actors operate within broader cultural landscapes that shape how communities perceive and interact with biodiversity. Indeed, urban populations are culturally diverse, and effective biodiversity engagement must recognize and respect this diversity. Different cultural groups have distinct relationships with nature, shaped by histories, traditions, values, and lived experiences (Buijs et al., 2009; Gómez-Baggethun et al., 2013). For example, immigrant communities often maintain cultural food traditions through urban agriculture, growing crops that connect them to homelands and provide culturally significant foods not available in mainstream markets. These practices contribute to urban agrobiodiversity while serving as sites for cultural preservation and intergenerational knowledge transmission (Barthel et al., 2015).

Culturally responsive education approaches recognize and value diverse knowledge systems, including indigenous and traditional ecological knowledge. While the urban biodiversity literature reviewed here provides limited examples of integrating indigenous knowledge in cities, there is growing recognition that indigenous perspectives on reciprocity, relationality, and stewardship offer valuable insights for urban sustainability (Whyte, 2018). In cities with indigenous populations, such as urban centers in Australia, Canada, and New Zealand, there are opportunities to integrate indigenous land management practices, languages, and worldviews into biodiversity education and governance.

5.5 Environmental Justice, Equity and Ethical Considerations

Urban biodiversity engagement must address environmental justice, that is the *fair distribution of environmental benefits and burdens* across different social

groups, ensuring that no community disproportionately bears environmental risks or is excluded from accessing environmental good. Unfortunatly, in many cities, green space and biodiversity are unevenly distributed, with wealthier, predominantly White neighborhoods enjoying more and higher-quality green infrastructure than low-income communities and communities of color (Wolch et al., 2014). Such spatial inequality shapes who can meaningfully participate in biodiversity engagement. Residents of under-greened neighborhoods may have less access to nature, fewer opportunities for outdoor recreation, and less exposure to environmental education. Moreover, participatory programs that fail to address these structural inequities can reproduce existing disparities, concentrating resources and attention in already privileged areas (Peltola & Arpin, 2018).

Addressing equity in urban biodiversity therefore requires proactive strategies that prioritize marginalized communities, reduce participation barriers, and ensure that environmental benefits, such as cooling, cleaner air, shade, and recreational opportunities, are fairly shared and distriubuted. This requires intentional outreach, culturally competent programming, investment in under-resourced neighborhoods, and community leadership.

Beyond questions of justice among human groups, urban biodiversity engagement also raises ethical considerations concerning coexistence, rights, interests, and relationships between humans and non-human species. Traditional conservation approaches often frame nature as separate from humans, something to be protected from human impact. In contrast, urban ecology recognizes that cities are hybrid socio-ecological systems where humans and non-humans coexist, often in close proximity (Grimm et al., 2008). This coexistence is not always harmonious. Urban wildlife in particular, from rats and pigeons to coyotes and wild boars, can generate conflicts, particularly when animals are perceived as pests, threats, or nuisances. Environmental education can play a crucial role in reframing precisely these perceptions and relationships, fostering coexistence ethics that recognize the agency and value of urban wildlife (Falcão & Dias, 2025). For example, education programs that highlight the ecological roles of "pest" species (such as scavengers' contributions to nutrient cycling) can reduce stigma and promote more tolerant attitudes.

More-than-human perspectives, as discussed in chapter 4, increasingly influential in environmental humanities and urban ecology, challenge anthropocentric

frameworks by recognizing the agency, interests, and inherent value of non-human beings (Haraway, 2016). In urban biodiversity contexts, this perspective encourages designing cities that accommodate diverse species' needs, not merely human preferences, and involving "more-than-human" considerations in planning and governance (Slingerland & Overdiek, 2023).

5.6 Insights, barriers and strategic directions

Drawing on the research and diverse examples discussed throughout this chapter, several key success factors emerge for fostering effective engagement and education in urban biodiversity.

First, hands-on, place-based learning remains one of the most powerful tools for cultivating environmental understanding. Tactile, experiential activities—such as gardening, field observation, and habitat restoration—offer opportunities for deeper connection and transformative learning that classroom instruction alone cannot replicate (Gerits et al., 2023; Tidball & Krasny, 2011). Direct contact with living systems enables participants to perceive ecological processes in action, reinforcing both cognitive and emotional engagement.

A second critical factor is sustained engagement and repeated interaction. While single events or short-term campaigns may spark interest, their long-term impact is often limited. Meaningful change arises from continuity, repeated participation over time that builds ecological literacy, interpersonal relationships, and stewardship values (Cartwright et al., 2015). Programs that offer recurring opportunities, mentorship, and feedback loops are far more likely to foster lasting commitment.

Equally important are strong partnerships and institutional support. Collaborations among schools, universities, NGOs, botanical gardens, and municipal authorities combine complementary strengths: scientific expertise, pedagogical capacity, public legitimacy, and logistical resources. These partnerships not only enable programs to scale but also provide the stability needed to endure beyond individual initiatives (Ponzi et al., 2024).

Linked to this is the role of mentorship and social support, which can significantly enhance engagement outcomes. Relationships between scientists and community members, peer-to-peer networks, and facilitated learning

communities help to build capacity, trust, and long-term participation (Krasny & Bonney, 2005). Social structures of learning ensure that knowledge is shared horizontally as well as vertically, strengthening the resilience of engagement ecosystems.

Attention to equity and inclusion emerges as another defining feature of successful initiatives. Programs that intentionally reduce barriers, whether through affective learning approaches, targeted outreach, or culturally responsive design, consistently engage more diverse participants and achieve more equitable outcomes (Peltola & Arpin, 2018). Addressing social diversity is not merely a moral imperative but a practical necessity for ensuring that urban biodiversity reflects and benefits all communities.

A further lesson lies in the integration of engagement with policy and practice. Citizen science and participatory design gain significance when their findings inform municipal decision-making, planning, and management. Tangible policy impact, such as influencing conservation priorities or shaping green infrastructure, reinforces participants' sense of contribution and secures institutional backing for future initiatives (Palma et al., 2024).

Finally, reflective practice and rigorous evaluation underpin continuous improvement. Programs that incorporate structured reflection, stakeholder feedback, and systematic assessment can adapt to changing contexts, demonstrate effectiveness, and contribute to the evidence base for what works in biodiversity engagement and education (Gerits et al., 2023). Evaluation, when coupled with learning, becomes itself a form of engagement, encouraging reflexivity among both practitioners and participants.

Despite these advances, several enduring challenges continue to limit the reach and effectiveness of urban biodiversity engagement and education initiatives.

A persistent issue involves data biases and representativeness. Citizen science may open the door to broader participation, but it still tends to reflect who actually has the time, access, and confidence to take part. This means that observations often cluster in well-resourced neighborhoods and around participants who already enjoy reliable internet, safe green spaces, and spare time. Marginalized communities and ecologically neglected areas are, unsurprisingly, less visible in the resulting datasets. Addressing these biases requires deliberate strategies for inclusion, careful data interpretation, and attention to the social geography of participation (Callaghan et al., 2021; Peltola & Arpin, 2018).

Resource constraints remain another major barrier, particularly in under-resourced communities and cities of the Global South. Limited funding, limited staff capacity, and inadequate infrastructure often restrict the scope, continuity, and sustainability of programs. Even where enthusiasm is high, lack of institutional and financial support can undermine long-term viability.

Other barriers are more mundane but no less consequential. School-based initiatives may face curriculum pressures, time constraints, or safety concerns that limit outdoor learning. Community projects often encounter difficulties in securing land access, managing liability, or navigating bureaucratic procedures. Such obstacles can dampen motivation and erode the momentum necessary for ongoing engagement.

Scaling up successful projects is also more complicated than it might seem. Projects that work well in one neighborhood or city do not automatically travel to another; social dynamics, ecological conditions, and governance arrangements vary widely, and what counts as a promising model in one context may require significant adaptation elsewhere. This makes shared learning platforms useful, but it also reminds us that scaling is as much a political and cultural process as a technical one.

Lastly, measuring impact remains methodologically demanding. Tracking changes in behaviour, ecological conditions or policy influence over time requires longitudinal data, stable partnerships and sufficient resources. In reality, these elements rarely come together. Many programs operate on short funding cycles, rely on volunteer labour, or lack the capacity to monitor outcomes beyond the immediate project period. As a result, it is often hard to show what their long-term contributions actually are, and this makes it even more challenging to secure renewed or expanded support.

Taken together, these challenges point to the need for continued experimentation and a willingness to question assumptions about what participation can achieve. They also underline the importance of collaboration across sectors, since no single actor can address these issues alone. The future of urban biodiversity will depend not only on technical innovations, but also on the ability of institutions and communities to cultivate inclusive, adaptive and evidence-informed cultures of engagement and learning.

Against this backdrop, several practical directions emerge for strengthening how cities can design and support engagement and education

(I)   A first strategic direction concerns policy integration. One essential step is to integrate citizen science into biodiversity monitoring and planning, ensuring that community-generated data, such as those produced through initiatives like the City Nature Challenge, inform habitat management, conservation priorities and educational programming. Formal mechanisms should be established to incorporate this knowledge into planning cycles, bridging local experience and institutional decision-making (Palma et al., 2024).

(II)   A second direction relates to participatory design and innovation. Cities should fund and support Urban Living Labs and participatory design processes that allow residents, planners and scientists to co-create biodiversity interventions. Sustained facilitation, adequate resources and clear institutional commitments are critical to transform such initiatives from short-term experiments into long-term practices (Isidoro et al., 2022; Slingerland & Overdiek, 2023).

(III)   Equity and justice form a third, essential dimension. Municipalities are encouraged to target biodiversity investments and green infrastructure in under-resourced neighborhoods, addressing social and spatial inequalities in access to nature. This entails culturally competent outreach, accessible programming and leadership opportunities for local communities (Peltola & Arpin, 2018). Partnerships with botanical gardens, universities, museums and NGOs can offer technical expertise, training and coordination networks that enhance municipal biodiversity programs. In parallel, governments should support community-led stewardship by providing resources, training and recognition for local projects such as community gardens, habitat restoration or volunteering initiatives, while simplifying permitting and land access procedures.

(IV)   Within the educational sphere, a further direction involves strengthening the role of schools. Integrating local biodiversity into curricula helps students connect learning to their immediate environment. Using nearby parks, green corridors, and schoolyards as outdoor classrooms transforms abstract ecological concepts into tangible experiences (Schweitzer & Gionfra, 2018). Schools can also host citizen science projects in collaboration with universities, NGOs, or botanical gardens, provided that protocols, training, and logistics are adapted to

classroom realities (Soanes et al., 2020). Educational programs should go beyond awareness to link learning with concrete action, empowering students to participate in habitat creation, restoration, or local policy advocacy, thereby nurturing agency and stewardship (Krasny & Tidball, 2009).

(V)   Universities and research institutions, for their part, provide another crucial layer. Their expertise in taxonomy, monitoring, and methodology can strengthen community and municipal initiatives, while mentorship and training activities bridge academic and local knowledge (Ponzi et al., 2024). Academia is also urged to conduct participatory and action-oriented research that engages communities as co-researchers, addressing their priorities and producing actionable outcomes that inform urban biodiversity governance.

(VI)   Civil society contributes a complementary set of capacities. NGOs and community-based groups are uniquely positioned to bridge the gap between institutions and citizens. By leveraging trust, cultural competence, and local knowledge, NGOs can engage marginalized populations and facilitate collaborations between communities, researchers, and public authorities (Krasny & Bonney, 2005). They also play a key advocacy role, using citizen science data, community narratives, and participatory research to promote equitable biodiversity policies and investments.

(VII) Finally, several cross-cutting principles apply across all sectors. Effective programs should use communication and storytelling strategically, blending awareness campaigns, dialogue, and narrative to strengthen emotional connection with urban nature, while ensuring that communication is coupled with genuine opportunities for participation and learning. Continuous monitoring and evaluation are vital: both ecological indicators (such as species diversity and habitat quality) and social outcomes (participation rates, learning gains, behavioral change, and policy influence) should be assessed to refine interventions and demonstrate impact (Gerits et al., 2023; Palma et al., 2024). Finally, all initiatives must embrace cultural responsiveness and pluralism, recognizing that relationships with nature are shaped by diverse cultural and ecological worldviews. Integrating indigenous and traditional

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ecological knowledge, when appropriate, and designing accessible, inclusive programs can ensure that engagement and education truly reflect the diversity of urban communities.

5.7. Conclusion

Bringing nature back to cities is not solely a technical or ecological challenge; it is fundamentally a cultural and educational endeavor. Urban biodiversity thrives when residents understand, value, and actively steward and take care of the living systems around them. Engagement and education, through formal schooling, informal community activities, citizen science, participatory design, living labs… are essential for cultivating this urban ecological culture.

The examples reviewed in this chapter demonstrate that effective urban biodiversity engagement is transformative, participatory, and equitable. It moves beyond passive awareness to active stewardship, beyond expert-led conservation to co-created knowledge, and beyond privileged constituencies to inclusive, justice-oriented practice. It recognizes that urban ecosystems are hybrid socio-ecological systems where humans and non-humans coexist, and that sustainable urban futures require reconnecting people with nature in ways that are culturally responsive, socially just, and ecologically sound.

Cities worldwide are experimenting with innovative approaches, from global bioblitzes and urban living labs to community gardens and school-based citizen science; all initiatives that generate valuable biodiversity data, foster environmental citizenship, and inform more effective, equitable urban planning. However, realizing the full potential of engagement and education requires sustained institutional commitment, adequate resources, strong partnerships, and explicit attention to equity and inclusion. As urbanization accelerates and biodiversity loss intensifies, the imperative to build an urban ecological culture becomes ever more urgent. By embedding engagement and education into biodiversity planning, cities can empower residents to become informed, active stewards of urban nature, co-creating resilient, biodiverse, and just urban futures.

Chapter 6

What experts think about Urban Biodiversity

Monica Bernardi and Pablo Gómez-Iniesta

6.1. Preliminary considerations

Understanding how experts interpret the state of urban biodiversity is essential for grasping the broader political and institutional landscape within which cities are attempting to govern ecological change. Experts, by virtue of their trajectories across research, practice and policy arenas, weave together perspectives that local actors alone cannot always access. Their accounts illuminate structural tensions, governance blind spots and emerging opportunities, and help situate city-specific experiences within a wider regional and international conversation. In this chapter, their voices serve precisely this function, not to offer a definitive verdict on what cities "are doing", but to probe how urban biodiversity is imagined, prioritised and problematised by those who work at its frontiers.

The interviews, in the form of semi-structured conversations, allow to explore a common set of themes (the ones of interest in our research, that is governance, communication, education/engagement) without constraining participants into predetermined categories. The six experts included were selected through purposive sampling within the broader research design, considering three criteria: recognised competence in biodiversity research or practice; direct experience with urban ecological initiatives; and the ability to situate Mediterranean trajectories within wider transnational frameworks. This produced a deliberately heterogeneous group spanning ecological science, urban planning, forestry, consultancy, activism, and municipal support functions. The goal was not representativeness but epistemic richness, that is engaging people capable of stepping across institutional boundaries and articulating how urban biodiversity policies take shape on the ground. To ensure confidentiality, all interviewees have been anonymised and are identified as E.1, E.2, E.3, and so forth.

- E.1: Architect and designer of an annual city making festival.
- E.2: Professor of Urban and Community Forestry.

- E.3: Researcher, environmental scientist, and activist.
- E.4: Social scientist in Urban Planning and city on nature.
- E.5: City support officer.
- E.6: Researcher and project manager in urban planning.

These profiles, working across scales (between local planning instruments, national regulations and European agendas) are well positioned to interpret how fragmented competences, policy misalignments or competing urban priorities can undermine ecological ambitions. Their proximity to international networks offers an additional lens, indeed comparisons with Northern and Western European cities, or with globally recognised practices, help identify both the specific constraints of Mediterranean governance and the opportunities that could be mobilised. At the same time, their familiarity with administrative routines and political negotiations allows them to detect blind spots that tend to disappear in official narratives, such as missing regulatory frameworks, absence of binding standards, contradictions between climate action and biodiversity protection, uneven capacities across municipal departments.

We can see that expert interpretations echo themes that recur across the book (such as governance complexity, communicative framings, socio-spatial inequalities) and contribute to making visible the socio-political fabric in which biodiversity is embedded. They help read local actions not as isolated steps but as part of a longer trajectory shaped by institutional inertia, public expectations, or shifting policy horizons.

The thematic analysis identified a constellation of recurring concerns, including the persistent fragmentation of governance arrangements (vertically between levels of government and horizontally across municipal departments), often identified as a key obstacle to effective action; the difficulty of integrating biodiversity into planning instruments and regulatory frameworks; the tensions between ecological goals and the pressures of rapid urban development; and the uneven role of communication and education in shaping public understanding and political prioritisation. These themes do not appear in isolation, but instead they form the backdrop against which experts reflect on what it means for cities to take biodiversity seriously, and why the transition towards more ecologically just urban futures remains so complex.

In what follows, we unpack these themes to provide a situated interpretation of how biodiversity is governed and imagined today. The aim is to understand how

those deeply immersed in biodiversity work read the institutional, political and cultural conditions of the Mediterranean context, and how these readings help illuminate the broader dynamics explored throughout the volume.

6.2. Thematic Constellation Emerging from the Expert Interviews

The thematic analysis of the expert interviews revealed a dense constellation of issues that converge around six broad areas. While each participant approached urban biodiversity from a different disciplinary angle, ranging from urban forestry to ecological activism, spatial planning and consultancy, their reflections converge on a set of interrelated challenges that shape urban biodiversity in cities. What emerges is a set of interdependent dynamics that collectively define the possibilities and limits of biodiversity action in urban contexts. The six categories identified include: (1) Governance and policy frameworks, (2) Challenges and barriers, (3) Integration of biodiversity into urban planning, (4) Communication and public awareness, (5) Education and capacity building, and (6) Collaborative approaches and international networks.

6.2.1 Governance and policy frameworks

A first cluster of reflection concerns *multilevel governance* and *policy frameworks* for urban biodiversity. Experts consistently highlight institutional fragmentation and a lack of coordination, both vertically (across national, regional and municipal levels) and horizontally (between municipal departments). This fragmentation is perceived as one of the main obstacles to the effective implementation of biodiversity strategies in cities because it generates a governance environment in which responsibilities are dispersed, priorities conflict, and no single actor is able to assemble the coherence that ecological action requires. Experts described situations in which biodiversity initiatives are undermined not by political resistance or public contestation, but by the simple impossibility of aligning different administrative mandates. When environmental, planning, education, and maintenance units operate with separate logics, biodiversity tends to fall into the "interstitial spaces" of governance, too cross-cutting to be owned by a single department, and too complex to be coordinated informally. In the words of one of the experts:

"*I have known cities that have paralyzed revegetation projects... due to lack of cooperation within the administration itself... It is not possible for the administration itself to sabotage projects due to lack of collaboration*" (E.6).

This quote illustrates how administrative silos, conflicts and disconnection between municipal departments (e.g., between the areas of education and urban maintenance) can even produce active friction and lead to the cancellation of environmental initiatives. Similarly, another expert stressed that the city "*is only one entity among many*", insisting that without alliances and coordination among all the governmental actors involved (from regional authorities, heritage agencies, water utilities, and transport bodies to bring some examples), local biodiversity policies will struggle to prosper. Together, three of the six experts emphasised the need to improve inter-institutional coordination to prevent the internal administrative structure from becoming a factor that hinders actions in favour of biodiversity. The dispersion of authority becomes especially problematic given the cross-scalar nature of biodiversity, since ecological processes do not respect administrative boundaries, while political jurisdictions do. As a result, projects must navigate a labyrinth of approvals, negotiations and informal adjustments, diluting ambition and prolonging timelines. Moreover, fragmentation amplifies vulnerability to political turnover: without institutionalised coordination mechanisms or dedicated biodiversity units, ecological agendas depend heavily on "champions" within the administration, making progress fragile and reversible. Experts therefore emphasise that strengthening biodiversity governance requires not merely new policies, but a reconfiguration of organisational architectures and a cultural shift towards recognising biodiversity as a foundational urban dimension.

Indeed, a second sub-theme within this category is precisely the integration of biodiversity into urban planning and local policies. The interviewees agree that cities should incorporate biodiversity objectives into their urban plans in a cross-cutting manner. They highlighted the need for local biodiversity strategies to be integrated into existing planning instruments (urban development plans, municipal ordinances, etc.). For example, a Spanish expert pointed out that

"*it is essential to integrate the protection and promotion of biodiversity in urban agendas and in general urban development plans, and for this to be translated into mandatory norms so that actions are effective*" (E.6).

This observation highlights two key points. First, it underscores the need to integrate biodiversity criteria in the strategic vision of the city, including urban agendas and master plans. Second, it emphasises that such guidelines should not

remain merely voluntary recommendations but should be translated into concrete and enforceable regulations. In many cases, the absence of a clear regulatory framework has meant that considerations related to nature have been pushed into the background in the face of conventional urban development pressures. Several experts mentioned examples where, in the absence of regulatory provisions, urbanisation continued "as usual" with little regard for emerging ecological criteria.

Finally, regarding governance, experts note the lack of continuity in municipal environmental policies when political administrations change. Biodiversity strategies require a long-term perspective, yet they often suffer from interruptions or policy reversals associated with electoral cycles and administrative changes. Two interviewees (an Italian expert from the private sector and a public sector expert) highlighted this problem, stressing the importance of institutionally safeguarding initiatives so that they transcend individual administrations. For example, they described the creation of dedicated structures, such as "task forces" or transition teams, designed to ensure the continuity of projects regardless of who is in power. As one of them explained, referring to a practical case:

"*[So] political changes – such as new elections – do not affect the process... This is one of the great difficulties: how to align climate objectives with changes in government*" (E.5).

This concern reflects the broader challenge of reconciling long-term environmental objectives with short-term political dynamics, and it highlights the need for governance mechanisms, such as permanent technical teams or multiparty agreements, that can ensure the stability of biodiversity policies beyond the electoral cycle.

In summary, within the governance category, the experts advocate greater inter-institutional coordination, the integration of biodiversity into urban planning, and policy stability as essential conditions for empowering cities in biodiversity management.

6.2.2 Challenges and barriers

The second thematic category encompasses the main *obstacles* that hinder the practical implementation of urban biodiversity initiatives. These include resource limitations as well as bureaucratic and technical barriers.

(I) A key obstacle repeatedly mentioned is the *lack of stable funding* and resources to support biodiversity initiatives. Multiple experts agree that while

there is strong interest in developing biodiversity projects, municipal budgets are often limited and/or dependent on external funding (such as subsidies from higher levels of government, international financing, etc.). One interviewee, with experience in local public administration, emphasised that the viability of these strategies is directly linked to budget allocation:

"*One of the key aspects is that vertical coordination is tied to the budget: in our experience, we managed to secure more funding by continuously presenting our progress to councillors and the mayor until they saw results and agreed to increase our budget*" (E.2)

This testimony highlights two important aspects. Firstly, it illustrates a concrete successful case – the development of Melbourne's Urban Forest Strategy – sustained, transparent communication about ongoing work gradually convinced political leaders that biodiversity was not a marginal add-on but a domain deserving structural investment. The increase in the city's biodiversity budget did not emerge overnight; it was the cumulative effect of repeated briefings, accessible progress updates, and an ability to translate technical achievements into politically meaningful outcomes. The Melbourne case shows that narrative continuity, rather than rhetorical urgency, is often what shifts political will.

Secondly, it suggests that proactively managing vertical relationships within the municipal ecosystem – particularly between technical staff and elected officials – can be a strategic tool for unlocking financial resources. When these relationships are cultivated with care, technical expertise can travel upward more effectively, making biodiversity legible and actionable to those who control budgetary levers. This is why the question of funding cannot be separated from broader governance dynamics; it is not merely about "finding money", but about ensuring that biodiversity gains a stable political constituency within the city.

Nevertheless, most cities lack dedicated budget lines for biodiversity or rely on one-off project funds, creating uncertainty regarding the continuity of biodiversity initiatives. This further underscore the importance of institutionalising multi-year environmental budgets to ensure long-term stability.

(II) Another significant challenge highlighted is *bureaucracy* and the slow pace of administrative processes. Two experts explained that even when political will and financial resources are available, internal procedures can hinder execution. Issues such as excessive fragmentation of responsibilities, cumbersome administrative procedures, and delays in decision-making were frequently mentioned. One interviewee observed that urban projects often require the

involvement of multiple offices (urban planning, environmental affairs, public participation, etc.), which

"*makes everything very granular and… nothing actually gets off the ground*" (E.1).

This last quote effectively captures the idea that a highly fragmented administrative structure complicates the ability to respond swiftly to cross-cutting issues such as biodiversity. Bureaucratic fragmentation, already discussed within the governance category, has an additional dimension here: the lack of operational coordination mechanisms and the absence of centralised one-stop offices for integrated environmental projects. Some experts suggested the creation of specialised units or interdepartmental "windows" to accompany biodiversity project implementation, precisely to overcome these administrative bottlenecks.

(III) Finally, within this category, the difficulty of *measuring and monitoring* progress in urban biodiversity emerges as a barrier. Quantifying the impact of biodiversity policies is complex due to the multidimensional nature of the issue and the absence of standardised indicators. Two of the experts (a researcher and a municipal manager) pointed out methodological challenges in this regard: lack of baseline data, indicators that are not well adapted to the urban context, and the overall need to develop better monitoring tools. One of them acknowledged that

"*Monitoring the effects of our actions is a very complex issue. A lot of work is being done to develop robust indicators, but it is difficult for cities to use such complex indicators to track results*" (E.2).

Here, the tension is evident between the technical sophistication of certain biodiversity indicators (often developed in academic settings) and the practical capacity of local governments to apply them. According to this expert, "*we still have a long way to go*", both in defining what should be monitored and how to monitor it.

During the interviews, the Cities Biodiversity Index (Singapore CBI) was mentioned as a potential tool, though its application was deemed complex in Western contexts. Additionally, experts noted the lack of socio-ecological indicators that capture the benefits of biodiversity for the urban population (e.g., in health and well-being), making it more difficult to communicate and justify interventions to citizens.

In summary, experts identified three main barriers:

→ insufficient financial resources,

→ internal bureaucratic hurdles, and

→ technical challenges in monitoring results.

These barriers are interrelated and highlight the need to strengthen the institutional capacities of cities, in financial, administrative, and technical terms, to be able to effectively implement biodiversity policies.

6.2.3 Integration of biodiversity into urban planning

A third category of findings concerns how to effectively incorporate biodiversity into the design and physical management of the city. Here, discussions revolved around urban strategies, regulations, and concrete interventions in the urban fabric.

A central sub-theme was the use of green infrastructure (parks, ecological corridors, linear greenways, riparian buffers, green roofs and façades, etc.) in enabling biodiversity to persist and regenerate within heavily urbanised settings. While all experts converged on the need to expand green spaces, they were equally insistent that the challenge cannot be reduced to a simple metric of surface area. What matters, they argued, is how these spaces function ecologically: their habitat heterogeneity, their capacity to support native species, and, above all, their degree of connectivity within the wider urban landscape. Several interviewees warned that isolated green areas, even when carefully designed, tend to remain ecological "islands" that limit species movement and undermine long-term ecosystem resilience. From this perspective, the conversation often returned to the idea of ecological networks. The ambition is not to accumulate a collection of green patches, but to weave them into a coherent system capable of sustaining biodiversity flows across neighbourhoods, through the urban core, and into the surrounding peri-urban landscape. This vision encourages cities to think in terms of continuity rather than fragmentation. Street trees can link pocket parks; riverside restoration can anchor larger ecological corridors; and infrastructural surfaces such as roofs, bridges or railways can serve as stepping stones that connect otherwise disjointed habitats.

One expert described this approach in a very graphic manner, suggesting the connection of the periphery with the urban centre:

"*We must increase green areas and create ecological corridors that connect the periphery with the interior of the city, while addressing the problem of land consumption, because we are living a deep 'cementification' that generates many problems*" (E.3).

This remark weaves together two ideas that appear consistently across the interviews. On the one hand, planning for green infrastructure requires attention to territorial structure. Remnant natural areas in peri-urban zones need to be

linked to the inner city through ecological corridors that counteract the fragmentation produced by decades of urban expansion. On the other hand, the reference to "deep cementification" signals a wider concern about the extent of soil sealing and construction that characterises many cities today. Interviewees stressed that reversing this tendency – or at least mitigating it – involves reintroducing green elements at multiple scales, from small patches to larger ecological axes.

Several interviewees provided examples of initiatives aligned with this approach, ranging from restored river corridors to networks of small, interconnected parks, indicating that the incorporation of green infrastructure is one of the areas where the most progress has been made in certain pilot cities.

Despite these advances, experts also pointed to the absence of specific urban planning regulations to ensure the integration of biodiversity into all new developments. In many cities, land use and building regulations still do not incorporate biodiversity standards (e.g., green area requirements per inhabitant, protection of certain urban habitats, etc.), meaning that consideration for nature is left to the discretion of each project or administration. "*If this does not translate into mandatory regulations, urban planning will continue as usual,*" warned one of the experts when comparing different cities. In fact, in the Spanish experience shared by this interviewee, it has been necessary to reform urbanisation and building ordinances to introduce revegetation criteria. In her words:

"*It is necessary to integrate these strategies in all strategic plans, and then there must be a regulatory adoption so that they can be effective*" (E.6).

This statement underlines that having green plans and strategies in planning documents is not enough; they need to be incorporated into the regulatory framework (zoning plans, building codes) to truly guide practice. Another Italian expert agreed that traditional planning instruments need updating: many cities lack "specific regulation" and rely on good will, while others have begun to include environmental goals in their General Regulatory Plans, which is seen as a step in the right direction.

As an optimistic counterpoint, interviewees also highlighted successful cases of urban ecological restoration that serve as replicable examples. They mentioned opportunities to restore degraded ecosystems within cities, such as urban rivers, peri-urban wetlands, or abandoned lots converted into natural spaces, that have provided both ecological and social benefits. Two experts (from Latin America and Europe) offered perspectives in this regard. One noted the richness of

community-based restoration initiatives that already exist globally, emphasising the importance of recognising and incorporating them into urban management.

"*I have seen many examples where local and indigenous communities work with nature and integrate that work into the city, for example in wetland restoration; the community collaborates with local institutions to undertake restoration drawing on their knowledge*" (E.2).

This testimony highlights the value of community-based initiatives in urban restoration, drawing on local knowledge (e.g., indigenous knowledge) in collaboration with authorities. The mention of restored wetlands within the city is illustrative of how lost ecosystem services can be recovered, improving urban resilience (flood control, recreation, species habitat) while actively engaging citizens.

Another expert provided local examples, indicating that European cities such as London, Barcelona, and Milan are undertaking projects for the "renaturalisation" of urban spaces, ranging from extensive green roofs to linear parks on former railways. In short, within urban planning, experts advocate greener urban designs, featuring interconnected green infrastructure, supported by clear regulations, and drawing lessons from successful restoration projects to inspire action in other urban contexts.

In short, experts argue

→ for greener and more ecologically connected urban forms,

→ for planning instruments that move from voluntary guidance to binding regulation, and

→ for restoration practices that draw inspiration from successful projects and from community-based knowledge.

These elements outline a pathway in which ecological continuity, regulatory clarity and socially rooted restoration become the cornerstones for embedding biodiversity more solidly within urban planning.

6.2.4 Communication and public awareness

The fourth thematic category encompasses experts' reflections on the *social and communicative dimension* of urban biodiversity. A clear consensus emerged that urban biodiversity remains a poorly understood concept among the public, making it difficult to prioritise on the public agenda. This communication challenge was mentioned by at least two experts, who noted that terms such

as "biodiversity" can sound abstract or unfamiliar to ordinary citizens, particularly in urban contexts where nature is less immediately visible.

An Italian expert from the outreach sector described how, at present, only a very small audience engages in urban nature-related activities: "*Most people don't understand it clearly... when some activity is organised, only a few hundred people participate and understand something. We are talking about niches of niches: only a tiny minority learns about it*" (E.1).

This observation highlights that interest in and understanding of urban environmental issues are largely confined to small groups, while the majority remains disengaged. The expert attributed this to a general lack of awareness of major environmental issues affecting everyday urban life (such as energy, water, and green spaces), advocating for greater "awareness" through accessible language and participatory experiences.

Similarly, another expert remarked that traditional official channels (such as municipal bulletins or city council websites) often have a very limited reach: "*nobody reads them, and those who do read them don't...*", she noted graphically suggesting that innovative approaches are needed to effectively communicate with the wider public.

In short, experts perceive a lack of public understanding of urban biodiversity, which constitutes a barrier; if society does not value or demand action in this area, decision-makers are less likely to prioritise it.

Faced with this challenge, the interviews revealed various communication and awareness-raising strategies that were considered effective in bringing the issue of biodiversity closer to the public. A key point reiterated was the need to adapt both the message and the medium to the target audience. As one of the experts explained, there is no single channel that can reach all segments of the population, making it essential to diversify communication approaches:

"*The choice of channel depends on who you want to reach. For example, if we are talking about older people, social networks would not work; you would have to use the newspaper or the radio. If it's for young people, maybe TikTok; for young adults, Instagram. You have to use different media depending on the target audience*" (E.2).

This practical advice highlights the importance of segmenting communication strategies based on age or other demographic factors. While social media and digital content can be effective in reaching younger populations, for other groups, it is more appropriate to rely on traditional media (local newspapers, radio) or community spaces. Indeed, leveraging local opinion leaders and community-based channels emerged as a key recommendation.

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Another expert emphasised:

"*The key is to involve respected leaders who can speak to the community. If the important thing in a place is the local newspaper, you must go to the local newspaper. It's about reaching out to different audiences by looking for leaders who already have a voice and giving them prominence, for example by recognising them as 'nature ambassadors' in the city*" (E.4).

This proposal suggests identifying trusted voices, not necessarily traditional environmentalists, who already hold influence among specific groups (such as cultural or educational figures, or even youth leaders) and incorporating them as spokespersons for biodiversity. Some cities have already institutionalised 'environmental ambassador' programmes or formed partnerships with schools and museums along these lines.

Additionally, interviewees suggested linking the biodiversity message to values that resonate with people: quality of life, cultural heritage, local pride, and so forth. For example, rather than focusing solely on technical aspects such as species or biodiversity indices, it may be more effective to highlight how urban nature, even something as modest as 'weeds' in a vacant lot, contributes to neighbourhood identity and well-being.

Ultimately, communication strategies should "*show and demonstrate our connections to nature and how important it is*" (E.4) in ways that are tangible and relatable for different audiences.

A related sub-theme is citizen participation in biodiversity projects, understood both as a means of active communication (people learn by doing) and as an end (community empowerment). Experts provided examples of successful initiatives, including ecological volunteering and community-based environmental education. For instance, in Bologna, citizen science projects have been promoted to engage residents in monitoring urban flora and fauna. According to one interviewee, this has increased local interest and knowledge about biodiversity. More generally, experts agreed that directly involving the population in restoration actions, urban gardens, tree-planting days, bioblitzes, and similar initiatives is a powerful tool for raising public awareness and support.

One expert summarised this point as follows:

"*The participation of all actors is fundamental; otherwise, we are not going anywhere. It is key to collaborate to create shared knowledge that is not only in the hands of the city council or researchers, but that translates into collective awareness*" (E.3).

Underlying this is the idea of co-creation of knowledge: when citizens participate alongside scientists and policymakers in biodiversity projects, a common understanding is generated, and the gap between technical and popular knowledge is reduced.

Two experts emphasised that these participatory processes also confer legitimacy on policies, an informed and engaged community will demand continuity in environmental initiatives, creating a virtuous cycle of citizen support for biodiversity.

Thus, communication and participation go hand in hand: effective communication facilitates participation, and active participation, in turn, communicates the value of urban nature through lived experience.

Briefly, the interviews point towards a shared toolkit of solutions:

→ tailoring communication to different publics,

→ engaging credible community voices,

→ linking biodiversity to everyday values, and

→ fostering hands-on participation that builds shared knowledge.

Taken together, these approaches sketch a communicative and participatory strategy capable of bringing biodiversity closer to urban residents while strengthening the social legitimacy of ecological policies.

6.2.5 Education and capacity building

The fifth thematic category focuses on the need to strengthen human and institutional capacities for managing urban biodiversity, both at the level of decision-makers and society in general.

A key sub-theme highlighted is the training and awareness-raising of officials and policymakers on biodiversity issues. According to several experts, one of the current shortcomings is that many municipal officials (mayors, councillors, and technicians in non-environmental areas) lack specific training or deep awareness of biodiversity, making it difficult for them to promote this issue decisively.

"*Municipalities have a lot of work to do because they do not have experts on the subject; they need the support of professionals to combat misinformation*" (E.6),

one expert stated firmly, pointing out that even to communicate effectively (as discussed in the previous section), municipal personnel need training or technical assistance.

Several interviewees recommended implementing training programmes for local government teams to update their knowledge on urban biodiversity, ecosystem services, and NbS. In some cases, partnerships with universities have made it possible to offer short courses or workshops to municipal officials, improving their skills. This training would not only enhance internal understanding of the value of biodiversity but also provide practical tools (e.g., how to integrate ecological criteria into urban projects or how to access environmental funding).

In line with the above, experts emphasised the need for environmental education within both formal education systems and community initiatives. There is a perception of a historical educational deficit: ecology and sustainability topics have been absent or marginal in school curricula, leading to a lack of awareness among citizens from an early age.

"*At the educational level, there is no type of ecological education in the training programmes,*" one expert stated, referring to the Italian context.

This diagnosis is repeated in other cities: biodiversity is barely addressed in school curricula, meaning that new urban generations may complete compulsory education without ever reflecting on the importance of nature.

In response, experts propose integrating environmental education systematically into schools and colleges, rather than through isolated activities. As one interviewee noted:

"*Environmental education is fundamental: if we were to start from the next school year in schools, colleges, and universities, in two or three years this awareness could reorient decisions and would have benefits*" (E.1).

This statement suggests that, even in the short term, introducing biodiversity-related content at all educational levels could shape the attitudes and choices of young people, creating a critical mass more committed to these issues.

In addition to formal education, interviewees also highlighted the importance of informal awareness programmes (public campaigns, environmental education centres, science museums, etc.) to reinforce biodiversity messages among the general population.

Initiatives such as municipal environmental classrooms, biodiversity festivals, or guided urban excursions were cited as good practices for bringing nature closer to citizens and complementing school-based education.

Finally, a cross-cutting sub-theme in the interviews was the importance of collaboration with universities, research centres, and non-governmental organisations to strengthen local capacities.

Several experts described cases in which municipality-university alliances have been "key" to advancing biodiversity strategies, providing scientific evidence and innovative methodologies.

For instance, in Vitoria-Gasteiz (Spain) and in some pilot Italian cities, local universities actively participated in the design of urban biodiversity plans, ensuring technical rigour and effective monitoring.

"*In some cities, it is common to partner with universities, collaborating with researchers who involve their students in these initiatives*" (E.4),

an expert noted, referring to collaborative models where university students carry out applied science projects (such as flora inventories or pollinator studies), generating valuable inputs for municipal authorities.

Similarly, the involvement of environmental NGOs and civil society groups was valued as a catalyst for action and as a bridge to the community. In cities such as Barcelona, for example, local organisations have co-managed neighbourhood biodiversity programmes, ensuring both continuity and citizen engagement.

Interviewees agreed that local government cannot (and should not) act alone but must rely on a broader network of knowledge and action. Such collaboration amplifies available resources (both human and financial) and creates an ecosystem of actors committed to urban biodiversity.

In the end, the interviews point to a shared direction.

→ Cities are encouraged to strengthen the skills of their own staff,

→ rebuild ecological literacy through schools and community programmes, and

→ work closely with universities, research centres and environmental organisations.

Experts consider these forms of capacity building essential for sustaining any long-term commitment to urban biodiversity.

6.2.6 Collaborative approaches and international networks

The final thematic category identified encompasses perspectives on broad collaboration and city-to-city learning. Experts argue that urban biodiversity management requires collaborative approaches not only at the local level (as noted above) but also on larger scales, leveraging national and international networks to share experiences and resources.

A key aspect discussed was cross-sectoral cooperation between the public sector, the private sector, and non-governmental organisations. Three of the experts emphasised that urban biodiversity policies are only truly effective when they transcend the municipal level and actively engage businesses, universities, NGOs, and citizens.

"*The city is only one entity among many; partnerships with other actors (other administrations, businesses, private landowners, etc.) are absolutely critical*" (E.4).

This statement summarises the need for a multi-level, multi-actor governance approach, since no single institution can realistically deliver urban conservation outcomes on its own.

Concrete examples of innovative public-private partnerships were shared. One interviewee described how her municipality successfully expanded urban tree planting through agreements with companies and foundations, leveraging shared financing. Another expert noted:

"*There are collaborative financing approaches: for example, some cities reduce construction taxes if green roofs are installed; others co-finance urban greening projects on a 50/50 basis with businesses*" (E.2).

These strategies – economic incentives and public–private co-financing – have been used in European and American cities to encourage developers and residents to integrate NbS such as green roofs, vertical gardens and permeable courtyards. Experts view these synergies positively, although they warn that clear collaboration frameworks and sustained political commitment from all actors are essential. The interviews revealed that experts look to successful international examples as inspiration for local policies. Pioneering cases from different continents were mentioned – from European cities often described as "biophilic cities" to Latin American metropolises that have developed innovative biodiversity programmes.

Two experts (E.2 and E.4) referenced multiple global examples. For instance, one of them highlighted a mechanism adopted in Brazil to reconcile urbanism with conservation:

"*The first time I saw such a solution was in Curitiba (Brazil), with what they call transfer of development rights: certain areas are designated as environmentally important and any private development that would be done there can be moved to another area*" (E.4).

This management tool, known as Transfer of Development Rights (TDR), has helped to preserve green areas in Curitiba by relocating construction potential to

less ecologically sensitive sites. The mention of this example suggests that similar tools could be explored in European cities facing real estate pressures, fostering conservation without compromising economic viability.

Experts also pointed to North American cities that have developed metropolitan green corridors, such as Green Toronto, or to Asian cities that have introduced mandatory green roofs, as potential sources of inspiration for local adaptation. The exchange of lessons is reciprocal – valuable experiences from within Europe that could be replicated across the continent were also recognised.

Spanish and Scandinavian cities that have taken the lead in specific areas – Vitoria-Gasteiz in green governance and Oslo with its network of urban reserves – were mentioned as models worth following.

Interviewees also emphasised the importance of city networks and international collaborative projects, especially at the European scale, in advancing the urban biodiversity agenda. Participation in European initiatives – including EU Missions, Horizon Europe projects and networks such as ICLEI and Eurocities – has given several cities access to funding, technical expertise and opportunities for knowledge exchange

One of the experts, who coordinates a European project, explained:

"*This 'Net Diversity' initiative allows us to obtain funds directly from the European Union, with 34 participating partners that include banks, the financial sector, and technical universities such as those in Milan and Madrid*" (E.5).

This example demonstrates how consortium projects bring in both resources and expertise from multiple actors. Indeed, thanks to EU-funded projects, medium-sized Italian cities have been able to develop adaptation and biodiversity plans that would otherwise have been impossible with only local resources.

Additionally, membership in international networks facilitates peer-to-peer learning, since cities facing similar challenges such as coastal zone management or invasive species control can work together on shared solutions. Two experts noted the importance of initiatives such as the Urban Biodiversity Hub or the Cities for Biodiversity network in Latin America, which help spread common tools and metrics across municipalities. They also observed that participation in these networks demands time, commitment and administrative capacity, otherwise cities risk engaging only superficially and missing the full benefits of collaboration. As one interviewee pointed out:

"*It is not enough to sign up to a network, you have to translate that commitment into local actions*" (E.3)

In summary, collaborative and international approaches represent both a governance philosophy (multi-stakeholder collaboration), and a set of practical tools (transnational networks and projects) that strengthen urban biodiversity initiatives.

Experts agree that cities must learn from and support one another, as they face common problems in diverse contexts. Being embedded in broader networks brings legitimacy, resources, and knowledge, but their effectiveness depends on local capacity to translate these lessons and collaborations into concrete actions within each city's specific reality.

Overall, the interviews outline a clear direction of travel. Experts call

→ for stronger multi-actor partnerships,

→ for the strategic use of incentives and co-financing arrangements,

→ for systematic engagement in transnational networks, and

→ for the adoption of transferable tools such as development-rights mechanisms or metropolitan green corridors.

These collaborative pathways are seen as essential to embed urban biodiversity within wider governance systems and to ensure that cities can mobilise the resources, knowledge and legitimacy needed to act effectively.

6.3. Discussion on findings

The findings present a complex yet coherent picture of how experts from different sectors perceive urban biodiversity and what they consider necessary to enhance its management. Overall, the interviews reveal a convergence of key concerns – governance, resources, urban integration, awareness, education and cooperation – while also providing specific examples and nuances from each context.

Experts approach urban biodiversity in a multidimensional manner, emphasising that it is not solely an ecological issue but also an institutional, social and economic one. This aligns with recent literature that conceptualises cities as socio-ecosystems, where biological conservation requires simultaneous interventions in policies, infrastructure and citizen behaviour.

A cross-cutting insight is the need to integrate biodiversity into mainstream urban discourse and practices, challenging the notion that nature is merely an accessory or "decorative" element. The experts advocate for biodiversity to be a central

criterion in urban planning, just as economic development or housing currently are. Achieving this requires shifts in the way cities are governed and planned.

The findings also underscore the need to build bridges:

→ between institutions (to overcome fragmentation),

→ between science and policy (to translate knowledge into action), and

→ with citizens (to secure support and participation).

Another important point emerging from the interviews is the impact of governance fragmentation on urban biodiversity efforts. Several experts highlighted that even when biodiversity policies exist, their implementation is hindered by a lack of coordination across municipal departments and between different levels of government. Without structural reforms in governance, biodiversity measures risk being sidelined or only partially implemented. This issue is further complicated by the frequent discontinuity of environmental policies when new political administrations take office. As suggested by one expert, establishing permanent governance structures, such as biodiversity task forces or interdepartmental commissions, could help ensure that biodiversity remains a priority regardless of political cycles.

Financial constraints were also repeatedly mentioned as a key obstacle to biodiversity initiatives. Even in cities with strong environmental agendas, securing stable funding remains a challenge. Several experts suggested that biodiversity policies should be embedded within broader urban development budgets rather than relying on short-term project-based funding. This would require a shift in how biodiversity is framed—as an essential component of urban resilience and public health rather than an optional extra.

Public engagement and communication strategies also emerged as critical elements in the discussion. Experts pointed out that many urban residents are unaware of the value of biodiversity in their cities, making it difficult to generate political and financial support for conservation efforts. Innovative communication campaigns, tailored to different demographic groups, were suggested as a way to bridge this gap. Moreover, involving communities in biodiversity initiatives, through participatory urban gardening, citizen science projects, or local conservation programs, was seen as an effective way to foster both awareness and stewardship.

The interviews also underscored the importance of education and capacity building, not just among citizens but also within municipal institutions. Many decision-makers lack the necessary knowledge and training to integrate

biodiversity considerations into urban planning effectively. Establishing training programs for municipal officials, as well as incorporating biodiversity education into school curricula, was widely supported as a means of addressing this gap.

Another crucial theme in the discussion was the role of international collaboration and knowledge-sharing networks. Experts highlighted that cities facing similar biodiversity challenges could benefit greatly from exchanging experiences and best practices. Participation in global initiatives,

such as the ICLEI Cities Biodiversity Center or the European Green Capital Network, was seen as a way to enhance local efforts through shared expertise and access to funding opportunities.

Looking at the broader picture, the findings suggest that urban biodiversity should not be treated as an isolated policy area but rather as an integral part of sustainable urban development. The interconnectedness between biodiversity, climate resilience, public health, and social well-being needs to be reflected in policy frameworks at all levels. Experts emphasised that shifting to this integrated approach requires a combination of political will, financial investment, and sustained public engagement.

Table 1 *Main findings from the experts*

Challenge identified by experts	Strategic responses suggested
Governance fragmentation	Interdepartmental coordination; stable structures such as task forces; improved vertical alignment
Funding instability	Multi-year budgeting; integration of biodiversity into mainstream development budgets
Limited public awareness	Targeted communication strategies; community engagement; participatory activities
Lack of institutional skills	Training programmes for officials; technical assistance; partnerships with universities

Weak integration in planning	Regulatory updates; binding ecological standards; mainstreaming biodiversity in urban plans
Need for knowledge exchange	Participation in European and global networks; peer-to-peer learning; collaborative projects
Challenge identified by experts	Strategic responses suggested

Overall, the discussion highlights that while significant challenges remain, there are also promising pathways forward. By addressing governance issues, securing long-term funding, enhancing public participation, and strengthening international collaborations, cities can take meaningful steps toward embedding biodiversity into their urban fabric. The perspectives shared by the experts in this study provide a valuable roadmap for policymakers, planners, and community leaders working to make biodiversity a fundamental part of urban life.

In conclusion, the interviews reflect a consensus that urban biodiversity must be addressed with a holistic perspective, integrating:

- → Governance reforms,
- → Investment in capacity-building
- → Innovative ecological planning
- → Active social participation.

Only through this multifaceted approach can cities effectively assume their leading role in biodiversity conservation, contributing not only to human well-being but also to the fulfilment of global environmental commitments.

Part III

Cities In Focus

Chapter 7

Milan: A Metropolitan Model for Urban Biodiversity

Monica Bernardi and Pablo Gómez-Iniesta

7.1. City context

Milan is Italy's second-largest city and the economic capital of the country, located in the Lombardy region on the flat plains of the Po Valley (see Image 1). The municipality counts around 1.37 million residents, while the wider metropolitan area exceeds 3.2 million inhabitants (ISTAT, 2024). The city spans 181 km² and is one of Italy's most densely populated urban areas. Milan experiences a humid subtropical climate, with hot, humid summers and cold, foggy winters that contribute to air-quality challenges in the Po Valley basin. Its urban landscape blends medieval streets, monumental 19th-century boulevards, and cutting-edge districts like Porta Nuova, positioning Milan as both a historical and highly innovative European metropolis.

At the same time, Milan often appears in national and international debates as a city of contradictions. While it consistently performs well in indices of quality of life, innovation and economic competitiveness, environmental indicators reveal a city that continues to struggle with structural ecological pressures that directly influence its biodiversity, air quality and urban liveability. Recent air quality assessments for instance show that Milan remains among the Italian cities with the highest number of days above the daily PM_{10} limit. According to Legambiente's Mal'Aria di città 2025 report, the city registered 68 days above the legal daily threshold in 2024, placing Milan among the worst performing Italian cities on this indicator (Legambiente, 2025; Privitera, 2025). Legambiente's analysis, echoed by international media coverage, also notes that average concentrations of $PM_{2.5}$, PM_{10} and NO_2 in Milan continue to exceed the World Health Organization guideline values (Devdiscourse, 2024). National monitoring by SNPA and ISPRA confirms that the Po Valley remains one of the most critical areas for air pollution in Europe, with meteorological stagnation and

high emissions combining to produce frequent exceedances and chronic exposure for urban populations (ISPRA, 2024; SNPA, 2024). These indicators underscore the intensity of environmental stressors that shape the habitat conditions for urban biodiversity.

Figure 1 *Location of Milan within the Lombardy region and northern Italy. Created by the authors using MapChart[26]*

In addition, land use data further illuminate the spatial constraints on biodiversity. ISPRA's 2023 report on soil consumption shows that a very high proportion of Milan's municipal territory is now sealed or built up, making it one of the most urbanised cities in Italy in percentage terms (ISPRA, 2023). A synthesis of these data by EconomiaCircolare notes that Milan ranks third nationally for soil consumption, with almost 60 percent of its municipal area classified as artificial surfaces, just behind Turin and Naples (EconomiaCircolare, 2024). A quantitative comparison produced by TrueNumbers on the same ISPRA dataset reports similar values, indicating around 58 percent of the municipal area as already built up (TrueNumbers, n.d.). Clearly, the rapid and cumulative conversion of land reduces ecological permeability, fragments habitats and limits the capacity of green infrastructure to support species richness, directly constraining the space available for urban biodiversity to persist and regenerate.

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[26] MapChart is an online tool that allows users to create customizable maps for non-commercial use. Available at: mapchart.net

Nevertheless, despite these pressures, existing monitoring efforts in key urban and peri-urban green areas, including Parco Nord Milano and the Parco Agricolo Sud, document several dozen breeding bird species and a diversified assemblage of mammals and other taxa, indicating a non-trivial level of ecological complexity within Milan's metropolitan green infrastructure (Baietto, 2007; Comune di Milano, 2024). Also, recent biodiversity assessments in newly created urban parks, such as the UpTown district, point to an increasing presence of bird, butterfly and dragonfly species in designed green spaces, suggesting that carefully planned interventions can enhance urban biodiversity even within highly artificialised contexts (Tomasinelli, 2025). In sum, these studies point to a metropolitan green infrastructure that still hosts a non-trivial level of ecological complexity, especially where continuous or semi continuous green corridors have been maintained.

Milan also participates in the regional framework for biodiversity and Natura 2000 management coordinated by Lombardy, in which the LIFE Gestire 2020 integrated project[27] plays a central role in promoting ecological connectivity and coordinated conservation across the region. At the municipal and metropolitan scale, several initiatives explicitly aim to strengthen ecological functions under dense urban conditions. The ForestaMI[28] urban forestry programme, launched by the Metropolitan City and local partners, proposes the planting of 3 million trees by 2030 and had already reached around 600,000 new trees in the Milan metropolitan area by 2024, including interventions along major road corridors and in peri urban areas (ForestaMI, n.d.; ANSA, 2024; MiaNews, 2024).

In parallel, large regeneration schemes such as the redevelopment of the disused railway yards at Scalo Porta Romana and Scalo Farini incorporate new parks, ecological corridors, water sensitive design elements and NbS into their masterplans, signalling an intention to use brownfield reconversion as an opportunity to restore ecological permeability and create new habitats within the urban fabric (FS Sistemi Urbani, n.d.). Yet the city's biodiversity potential remains closely tied to metropolitan governance, given its limited availability of permeable land, the high degree of ecological fragmentation and the structural constraints imposed by air pollution and intensive land take.

Milan therefore appears as a city marked by a dual environmental trajectory. On one hand, it demonstrates strong institutional capacity and dynamic policy experimentation as well as a growing commitment to urban nature and NbS; but

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[27] See the project official website here: https://naturachevale.it/il-progetto/life-gestire-2020.
[28] See the official website: https://forestami.org/

on the other, persistent air pollution, intensive land consumption and limited ecological continuity constrain its ability to fully regenerate biodiversity.

Table 2 *Milan case study – city profile*

City Positioning	• Member of leading urban sustainability networks (C40, Eurocities, Covenant of Mayors), strengthening Milan's climate leadership (C40, 2023). • Award-winning green mobility city, recognised with the C40 Green & Healthy Streets Award for its post-COVID mobility redesign (C40 Awards, 2020). • High international visibility in urban innovation, thanks to the Air & Climate Plan (PAC) and the Strade Aperte mobility programme (Municipality of Milan, 2022). • European reference for green urban regeneration, supported by initiatives like ForestaMI and extensive low-emission zones (ForestaMI, 2021).
Governance	• Strong mayor-council system with nine *Municipi* for local services. • Early member of C40 and the EU Covenant of Mayors. • Climate emergency declared in 2020; Air & Climate Plan approved in 2022. • Dedicated units (Environment & Green Dept., Smart City Lab) coordinate resilience and biodiversity projects. • Participatory tools: open data, local budgeting, and a Permanent Citizens' Climate Assembly.
Climate Justice	• Heat islands strongly affect elderly and low-income districts with limited green space. • Peripheral areas have less tree cover and poorer air quality. • Adaptation strategy maps heat-risk and prioritises vulnerable districts. • Seveso storm-water tunnel reduces flooding in Niguarda and nearby areas. • Programmes support energy-poor households in older, inefficient buildings.
People Engagement	• Participatory budgeting funds local greening and public-space upgrades. • "Milano Partecipa" platform gathers digital input on plans and policies. • Permanent Citizens' Climate Assembly monitors progress on the climate plan.

	• District "town halls" (Piano Quartieri) connect residents with officials.
	• Grassroots participation strongly focused on trees, gardens, and neighbourhood greening.
Planet	• Area C congestion pricing and Area B low-emission zone reduce pollution.
	• Metro expansion and electric buses support cleaner mobility.
	• ForestaMI aims to plant 3 million trees by 2030.
	• Bosco Verticale shows integration of architecture and biodiversity.
	• Railway yards converted into parks (e.g., Biblioteca degli Alberi
Prosperity	• Milan 2030 Plan promotes a circular economy and protects Parco Agricolo Sud.
	• Blue–green infrastructure improves drainage and restores canals.
	• Solar and geothermal pilots expand clean-energy use in public buildings.
	• Strade Aperte awarded by C40 Bloomberg Philanthropies for Green & Healthy Streets (2020) (C40 Cities Bloomberg Philanthropies Awards, 2020).
	• Milan joins the EU Mission for Climate-Neutral and Smart Cities

7.2. Preliminary Considerations

Six interviewees were purposely selected as strategically positioned actors within Milan's biodiversity and climate governance ecosystem. They occupy what can be described as "interfacial" roles, working at the junction between design and regulation, activism and administration, data and policy. Their positionality allows them to observe, and in some cases directly shape, how biodiversity is translated from abstract objective into planning rules, projects, narratives and infrastructural decisions. The sample was constructed to capture the diversity of knowledges and institutional locations that converge around urban nature in a large metropolitan context. It includes professionals embedded in municipal governance processes, consultants who move across public and private sectors, practitioners engaged in climate and environmental activism, and researchers whose work spans urban

planning, public health and cultural production. Together they provide a composite yet coherent view of how biodiversity is problematised, prioritised or marginalised within Milan's ongoing ecological transition; they also enable a fine-grained reading of the tensions between flagship projects and everyday implementation, between climate narratives and biodiversity-specific concerns, between international ambition and local constraints.

To ensure confidentiality, the interviewees are anonymised and referred to as M.1 to M.6. Their backgrounds can be summarised as follows:.

- M.1: Architect and Urban Designer, PhD.
- M.2: Agronomist and Landscape Architect.
- M.3: External municipal consultant specialised in urban metabolism, architect.
- M.4: Researcher, designer, lecturer, author, and advisor on the city and cultural planning.
- M.5: Climate Consultant, Environment and Health Data Analyst, PhD.
- M.6: Designer and director of a climate activism organization.

Through their combined perspectives, these experts allow the Milan case study to be read not only as a local configuration, but as an instance of how urban biodiversity is negotiated in a dense, highly visible European city where climate neutrality, economic competitiveness and environmental justice are increasingly entangled.

7.3. Insights from Milan

Building on these preliminary considerations, the following subsections distil the main insights that emerged from the interviews, translating a diverse set of professional perspectives into a coherent analytical framework for understanding Milan's biodiversity landscape.

7.3.1 Governance and policy implementation

The Milan interviews converge on a shared diagnosis of biodiversity governance that revolves around three intertwined dimensions:

→ institutional fragmentation,
→ the dilution of ambitious plans during implementation, and
→ chronic constraints in financial and human resources.

Although expressed through different professional lenses, the experts' accounts align closely in portraying a governance system that is committed in principle yet structurally hampered in practice.

The first and most widely emphasised issue concerns the dispersion of responsibilities across the municipal ecology. Several interviewees noted how biodiversity competences are distributed among multiple offices and agencies, resulting in siloed efforts and limited coordination. M.1 described Milan's territory as "*extremely fragmented*" both ecologically and institutionally, noting "*a series of actors*" in the municipal structure who work on green space and public space with little integration. M.1 listed the Green Office, Urban Planning (Urban Regeneration), the public company AMAT, and even a little-known "Green and Biodiversity Ombudsman"[29] – a kind of green space commissioner – as stakeholders with overlapping roles. According to him, the absence of an effective coordinating mechanism means the city "*struggles to have a clear vision*" on biodiversity (M.1). M.3 echoes this diagnosis, recalling that it has traditionally been "*really difficult*" to get different departments "*at the same table*", although she observed a recent "*huge effort*" by Milan to adopt more multisectoral governance approaches (such as the inter-departmental collaboration on the energy poverty plan). This success outside the biodiversity sector suggests a model that could be applied to biodiversity governance as well. Indeed, when asked if Milan should have a transversal task force for biodiversity, experts agreed that a more integrated internal structure would help mainstream the issue.

A second recurring concern relates to the relationship between ambition and implementation. Experts noted gaps between biodiversity plans or proclamations and their execution on the ground. M.2 remarked that many ambitious objectives declared in project proposals or tenders "*very rarely then get put into practice*". He cited a recurring "*discrepancy between initial objectives and what later gets delivered*" in projects following innovative competitions, which he sees as "*a big issue to address*" (M.2). This gap is not merely technical but procedural. M.1 gave the concrete example of Milan participation in high-profile international initiatives like C40's *Reinventing Cities*: when a winning project enters the city's approval process, it often "*gets changed, sometimes denatured*", and there is no check to ensure it still meets the original promises. In his view, once external

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[29] The Ombudsman is an independent authority that investigates complaints of maladministration by EU institutions and proposes solutions when appropriate (see EUR-Lex, "The European Ombudsman": https://eur-lex.europa.eu/EN/legal-content/summary/the-european-ombudsman.html).

funding is obtained, implementation often drift from intended outcomes, and biodiversity indicators are not monitored after funding is allocated, leading to a lack of continuity and accountability; but this means that short-term projects may not translate into lasting biodiversity improvements. In addition, several experts suggested that political turnover exacerbates this problem – without long-term strategies insulated from election cycles, initiatives risk losing momentum. No interviewee explicitly mentioned a change of administration in Milan as having influenced biodiversity policy, yet the need for consistent commitment was implicit in their calls for integrated plans and sustained action. M.4 noted that other Italian cities suffer from weak policy execution capacity – "*the policy-making machine… is very tired*" in places like Turin, which hampers implementation. By contrast, Milan's governance culture, although not without issues, may have comparatively better capacity to act, while still being hindered by fragmentation and silos.

Finally, experts converged on the importance of resources, both financial and human, as another prerequisite for effective policy implementation; several experts pointed out that external funding opportunities are the real support for biodiversity actions, even in a wealthy city like Milan. M.1 noted that municipalities respond to incentives: "*there is money – we'll give you funding if you do so many hectares of interventions for biodiversity – then the City of Savona says: 'wow!'*" illustrating how financial carrots from higher levels can spur local action . In Milan, many biodiversity or nature-based projects (e.g., tree planting campaigns) are supported by European or regional funds, which, while helpful, lead to dependence on short-term grants. M.2 celebrated the recent national law mandating restoration of compromised habitats as a "*big victory*" but acknowledged that outcomes will hinge on how it's resourced and enforced at the city level. The human-resource dimension emerged especially through M.6, who noted that even the Green Department "*complains about the lack of personnel*", with overstretched staff unable to handle communication, outreach and ecological management simultaneously. The result is a fragile administrative infrastructure that struggles to sustain biodiversity initiatives beyond the lifespan of individual projects. In sum, governance in Milan faces a dual challenge: improving coordination among fragmented actors and securing the funding and staffing necessary to carry out and sustain biodiversity initiatives. As M.3 noted, achieving even a modest integrated plan has been "*extremely difficult*" and required significant effort, but it represents "*a huge result*" when accomplished.

Across these perspectives, what emerges is not a narrative of failure but a kind of mapping of structural bottlenecks that limit Milan's ability to consolidate

biodiversity as a stable, mainstreamed urban policy field. Read together, the interviews point toward three governance shifts that would significantly enhance implementation capacity:

→ reducing institutional fragmentation through stronger transversal coordination

→ stabilising financial and human resources beyond short-term project cycles, and

→ closing the gap between ambitions and outcomes through more robust monitoring and accountability.

These three dimensions, repeatedly evoked across interviews, constitute the interpretive backbone of the Milan case and illuminate the governance conditions under which urban biodiversity transitions can be advanced or hindered.

7.3.2 Urban green spaces and biodiversity

In the interviews, green spaces emerged as a domain where the tensions between aspiration and ecological reality become most visible. Experts consistently described a city characterised by a patchwork of parks, tree lines and residual green areas that remain ecologically disconnected. M.1 stressed that "*continuity between open and green spaces*" is essential for biodiversity, but in Milan it is lacking – "*the territory is extremely fragmented, with the presence of green spaces… suffering separation*", which leads to poor biodiversity protection. He sees spatial fragmentation as mirroring the institutional fragmentation: ecological networks are broken just as organisational networks are. M.2 amplified this perspective by situating connectivity at a wider territorial scale, emphasising the importance of the new national mandate to restore degraded habitats as an opportunity to re-link ecosystems beyond the municipal boundary. However, within the city, green space expansion often comes through high-profile tree-planting campaigns like ForestaMI, which increase canopy cover but do not necessarily improve ecological relations between sites. Although none of the interviewees mentioned *Bosco in Città* urban forest, preliminary findings suggest it as an example of how biodiversity can recover when areas are managed as ecological systems rather than isolated amenities. Overall, the experts' focus suggests that Milan's challenge is not only the quantity of green (number of trees planted) but how it is placed, connected and made to function ecologically, that is its configuration and interlinkages.

A second narrative thread concerns the ecological quality of green spaces. Simply having green areas is not sufficient – what matters is their ecological functioning

and the way they are managed. As M.1 pointed out, approaches that focus primarily on quantitative targets – such as "*we're thinking of Forestami and planting millions of trees but not why we plant them*" – risk overlooking the underlying ecological rationale. He argued that Milan's recent narrative has been overly fixated on quantitative targets rather than on biodiversity outcomes, implying a lack of strategic ecological planning. An example he gave was that guideline for public space (by AMAT) mention biodiversity, "*but it's not clear how well they coordinate or interact with the Green Sector*" (M.1), raising doubts about how deeply biodiversity considerations are embedded in everyday design practice. emphasised the potential of integrating green-blue infrastructure more deliberately into the urban fabric, noting that current efforts proceed "*with difficulty*". She also described innovative ideas such as transforming bus stop shelters into green roofs that support pollinators and cool the surroundings – "win-win" small-scale prototypes that benefits both biodiversity (e.g. bees) and people (providing shade). However, these are pilot concepts that remain exceptions; the mainstream park design in Milan, according to one expert, often lacks long-term biodiversity vision falling back on monocultural tree planting without habitat diversity, or on maintenance regime that do little to cultivate ecological complexity. Although maintenance was not a central theme in the interviews, it implicitly surfaced in comments about species mixes, the need to prioritise native vegetation, and the importance of creating habitats such as ponds or meadows rather than manicured lawns.

References to flora and fauna were less frequent, but telling; for instance, M.3 mentioned pollinators explicitly, aligning her perspective with ecosystem-services thinking and pointing toward the need to protect insects that underpin urban ecological functioning. M.2 invoked the EU Habitat Directive, connecting local regeneration practices with broader European frameworks for restoring native ecological communities. No expert dwelled on specific species present in Milan, suggesting that biodiversity at species level remains weakly consolidated in the city's public narrative and policy discourse (it tends to be discussed in terms of green space generally). However, the issue of invasive vs. native species did underlie M.1's anecdote about clients asking for a "*beautiful biodiversity garden*" in developments but presumably expecting it to be low-maintenance, a misunderstanding that highlights the broader cultural challenge of distinguishing biodiversity from ornamental greening. This means that education of what true biodiversity might mean is necessary, while the the risk, in his account, is that biodiversity becomes aestheticised rather than ecologically grounded.

These accounts portray the physical dimension of urban biodiversity in Milan as a field defined by three converging needs:

→ expanding and reconnecting green spaces,

→ elevating their ecological quality beyond superficial greening, and

→ embedding habitat-oriented design principles within everyday urban development.

While this theme received less uniform attention than governance or engagement, the experts who discussed it (M.1, M.2, M.3) offered detailed insight into both the shortcomings of current practices (fragmented parks, one-dimensional greening, insufficient ecological planning) and the opportunities that arise when green infrastructure and habitat restoration are treated as structural components of the urban system rather than as decorative additions.

7.3.3 Public engagement and awareness

Across the interviews, public engagement emerged as a central yet fragile dimension of Milan's biodiversity landscape. Experts repeatedly noted that biodiversity remains a relatively new and weakly sedimented concept in the public imagination. M.2 observed that the public's sensitivity to biodiversity significantly lags behind that of climate change: "*biodiversity isn't even the most sensitive target audience out there, compared to climate change which has become common knowledge*". Five years ago, the average person had barely heard of these issues; now climate change is widely recognised, but biodiversity still often isn't on people's radar (M.2 implies this gap). The interviewers added that biodiversity has only recently entered the public debate and city agendas, with the consequence that many citizens conflate biodiversity simply with "green spaces" and trees, lacking an integrated understanding of its ecological importance. This was echoed in different ways: experts felt that people may appreciate parks aesthetically but not grasp the broader concept of urban biodiversity (e.g. species interactions, ecosystem health).

The everyday consequences of this limited awareness were illustrated vividly by M.6, who recounted a nature walk organised in a peripheral district (Ponte Lambro) to showcase local biodiversity along the Lambro River attracted only 20 residents out of 160,000, and those were mostly elderly people. Younger residents and the wider community were absent, illustrating the low interest or awareness. Despite the event being "*a really beautiful event… with an expert from WWF telling wonderful things*", the turnout was disappointingly small (M.6), suggesting that the public either did not know about it or did not find the topic compelling, an issue of both

awareness and communication. Several experts took this episode as symptomatic of a broader pattern: the topic does not yet circulate socially, and citizens do not encounter biodiversity as a meaningful urban issue in their daily lives.

A recurring theme was that the City of Milan's communication efforts on biodiversity are ineffective, perceived as weak, inconsistent or poorly targeted. M.6 bluntly stated that "*the communication of the City of Milan doesn't work*", which has been noted "*many times*" in comparisons with other cities. According to her, Milan lacks a dedicated environmental communication unit – "*there is no communications department on biodiversity or environment*" within the municipality; instead, communication on biodiversity falls under the general municipal press office or the councillor's small staff, which is overstretched. M.5 recounted an anecdote from his organisation's collaboration with a local district: a co-organised environmental event received criticism because "there was no communication…not even that minimum of celebration of a success", so people perceived it negatively. Essentially, even when good initiatives happen, they are not publicised or framed well, leading to misunderstandings or lack of recognition. M.1 discussed the city's use of modern channels, noting the mayor's podcast that occasionally talks about environmental topics. However, he critiqued It as "episodes coming out at random with no cadence" and no clear strategy. M.2 admitted he was not aware of the mayor's biodiversity podcast at all, calling that "quite telling" about its limited reach. These examples highlight a pattern: ad hoc or poorly planned communication that fails to build continuous public engagement. Experts suggested the city needs more innovative and targeted communication – (M.4), from a cultural perspective, said conveying the importance of biodiversity likely requires linking it to relatable narratives and leveraging cultural Institutions or creative methods (though he did not go into detail in the excerpt, his mention of "practices that produce discourse" hints at this). Overall, there was consensus that Milan must Improve how It "announces and explains" environmental policies to avoid public backlash or apathy.

When examining participation, the interviews presented a rather stark picture. Milan's biodiversity events, despite some efforts by the city, tend to attract small audiences, and in M.6's view "*Milan's citizens don't participate anymore*" in such activities. The reasons suggested include communication failures, as well as citizen fatigue or disillusionment. M.6 contrasts Milan with smaller cities where colleagues "working on biodiversity" manage to get better turnout and engagement. The implication is that Milan's larger scale and perhaps a sense of alienation, anonymity, saturation or busyness typical of large metropolitan contexts make community involvement harder, unless communication and

outreach are significantly improved. On the positive side, M.5 noted that civil society in Milan is active and "*has great drive and momentum*", particularly within climate movements (M.5 is involved in Climate Reality and Italian Climate Network, a privileged observatory but also a biased one). However, he suggests the institution needs to "*listen and support*" these bottom-up initiatives more. In other words, there is considerable citizen energy, but this energy has not yet been connected meaningfully to municipal biodiversity efforts (M.3). M.3 also stressed the importance of integrating bottom-up initiatives: "*in Italy [these] have not yet achieved [integration]… citizens, especially in Milan… still haven't been brought in on one side or the other*". M.3 indicates that citizen-led projects and municipal policy are not meeting in the middle; each side remains somewhat separate. To solve this gap, cities need to create inclusive platforms (workshops, co-design processes, volunteer programs, etc.) for citizens to contribute to urban biodiversity efforts. Milan does have participatory budgeting and collaboration pacts, but none of the experts could identify biodiversity-focused examples, which suggests that these instruments are not yet being used for ecological purposes or that their ecological potential is not widely known.

Education emerged across the interviews as a crucial long-term solution to raise awareness and engagement. M.1 emphasised the importance of engaging the youngest generations – "*actions on the youngest*" – seeing education as a way to embed biodiversity literacy early in life. M.6 expressed frustration that environmental topics, even today, remain marginal in school curricula and described this absence as a missed opportunity to shape ecological awareness: "*I would really start from nursery school…I have a 12-year-old son and [there is no] environmental education [in school]*". By incorporating biodiversity and ecology into education from early childhood through high school, future generations of urban citizens would be more conscious and supportive of biodiversity initiatives. The experts pointed to models elsewhere, such as school gardens, outdoor classes in parks and collaborations between schools and environmental NGOs, which could be adopted more consistently also in Milan. M.5 added that universities also have a role: Milan's universities are doing "*great scientific research*" and increasingly opening to society, for example by involving students and researchers in public events or "*open doors*" days. Strengthening these education and capacity-building efforts was seen as essential to underpin any long-term biodiversity strategy.

Across these perspectives, a coherent message emerges. Milan's biodiversity policies must be coupled with effective communication, public engagement, and education, or they will falter. Public buy-in is currently weak – due to low

awareness and inadequate outreach – but there are opportunities to improve this through three main pathways:

→ designing communication strategies that are stable and culturally attuned

→ leveraging civil society enthusiasm and creating genuine institutional openings for citizen initiatives, and

→ investing in education as a foundation for future ecological literacy.

Bringing these three elements together will be essential if Milan intends to consolidate biodiversity as a shared urban priority and align public perception with the city's ecological ambitions. Notably, there are pathways connected with governance (the city's approach to engaging citizens) and with cross-sector collaboration (working with schools, NGOs, etc., to educate and involve the public), interconnections later discussed.

7.3.4 Cross sectional collaboration

Interviewees noted that collaboration beyond the municipal government is promising but sporadic and could be improved, and partnerships with private actors, NGOs and community groups exist in embryonic or episodic form rather than as stable and structured practices.

M.1 observed that the city is highly active in international initiatives, often in contexts where private investors play a central role in urban transformation, yet cooperation with the local private sector or with NGOs remains "*limited and unstructured*". His view suggests that Milan is embedded in global networks but has not fully developed the connective tissue needed to work effectively with actors already present in its own metropolitan environment.

M.6 put this more bluntly when she argued that the city should "*collaborate more with organisations*" whenever internal capacity is insufficient. She recalled her experience with the WWF during the Ponte Lambro nature walk, which illustrated how NGOs can help both implement and give visibility to biodiversity activities.

M.5 offered a similar example through the partnership between Climate Reality, the Italian Climate Network and the Municipality Four district (Municipio 4). He saw this as evidence of the value of such collaborations, although he also implied that they remain exceptions rather than the norm

M.3 embodied this cross-sectoral movement in a more structural way. As a consultant who works both for the city and with a private landscape firm

(LAND), she showed how external expertise can inform public objectives when institutional channels are open enough to receive and translate it. One challenge hinted at is aligning priorities: the city's agenda versus private or NGO agendas.

From these accounts, the experts suggested that Milan has an underused collaborative potential. There are businesses interested in green solutions, as M.1 recalled when describing clients who request "biodiversity gardens" in new developments, and there are NGOs deeply experienced in environmental education, community planting and public advocacy. What seems to be missing is a more systematic approach capable of turning these scattered impulses into a shared platform. Several interviewees imagined forums, working groups or structured participatory arenas through which the municipality, NGOs, businesses and citizen groups could meet regularly and co-produce biodiversity strategies. Although not fully articulated, the idea appeared repeatedly in different forms.

The interviews also highlighted Milan's intense involvement in international city networks and European projects, which the experts described with a mix of appreciation and caution. On one hand, being part of networks like C40 Cities, the EU Cities Mission for climate neutrality, or specific projects brings in resources, innovation, and visibility. M.5 noted that "*Milan is part of the [network] that has high ambition for climate neutrality*", referring to a European network of cities aiming for zero emissions. M.1 and M.2 both referenced C40 and the Reinventing Cities competition (which Milan has participated in), initiatives that indirectly place biodiversity on the agenda within broader sustainability objectives. M.3 added that some international organisations are pushing cities toward integrated green infrastructure and that Milan participates in several European projects on sustainability, circular economy and urban metabolism, which have influenced local policy (her own work on an EU project in Milan relates to urban metabolism and circular economy, which intersects with biodiversity through green infrastructure).

The benefit of these international links is knowledge exchange and funding – indeed, dependence on European funds was noted as an issue, but without those funds some biodiversity actions wouldn't happen at all. M.4 added an interesting perspective: many progressive policies in Italian cities come "*almost from EU directives*" or initiatives, rather than originating locally. M.4 implies that Milan (and others) often wait for European Impetus (e.g. an EU biodiversity strategy or climate adaptation directive) before acting, which suggests international collaboration drives domestic action, but also that cities could be more proactive.

Overall, engagement in networks is high (Milan is quite internationally connected), but the challenge is to ensure these collaborations result in concrete, coherent local outcomes rather than just isolated pilot projects.

Knowledge institutions and civic movements constitute a further domain of collaboration that appears rich in potential but under-integrated into municipal practice. M.5 praised the work of universities like the Milan Polytechnic and others, noting "*all the universities are now doing great work*" on sustainability and they are "*opening up to civil society*". He suggests leveraging this by involving academics in public outreach (e.g. public lectures, open labs) and in advising policy. M.1 mentioned that Milan even has a "*Green and Biodiversity Ombudsperson*" composed of three experts – presumably academics or specialists appointed to advise on these matters – yet "*nobody knows*" about them and they have little influence. This is a case where a potentially great synergy (expert advisory body) exists on paper but isn't effectively integrated or publicised. Strengthening such mechanisms (making sure the Ombudsperson group's recommendations inform policy and are communicated) could improve science-policy linkages.

Civil society movements offer another reservoir of energy. Both M.5 and M.6 come from environmental networks, and their involvement in these interviews itself shows the city engaging activists. M.5 's mantra for institutions was "*listen and support*" citizen initiatives. M.4 M.4 added that in other cities civic mobilisation has exerted pressure on institutions and catalysed policy innovations; he remarked for instance that in Turin, one official's work is clearly an "*expression*" of people being ready to demand action ("*people who at a certain point will come looking for them with pitchforks*"), highlighting that bottom-up pressure can spur policy (though in Milan's case we haven't seen such extreme civic unrest on biodiversity). Instead, in Milan this mobilisation is less confrontational but nonetheless significant; groups like Climate Reality, Legambiente, WWF, etc., collaborate when possible. The open question, as several interviewees implied, is how the municipality can cultivate and channel this civic energy in ways that reinforce rather than remain parallel to public initiatives. M.3 described a recent experience in which NGOs, academia and a municipal district collaborated in a public talk on environmental issues, suggesting that formats of this kind could be expanded if adequately supported.

Cross-sector collaboration is recognised by the experts as essential yet underdeveloped in Milan's biodiversity governance. The experts saw three directions for strengthening this dimension.

→ One concerns the creation of more stable and structured arenas that bring together municipal actors, NGOs, businesses and knowledge institutions.

→ Another involves reducing dependence on project-based European funds by embedding collaborative practices within long-term, locally anchored strategies.

→ A third concerns improving science-policy and civic-policy linkages by activating existing but underutilised mechanisms, such as advisory bodies and university engagement.

These pathways suggest that collaboration is not merely an accessory but a central hinge through which Milan could overcome some of its governance bottlenecks and move toward a more integrated and participatory model of biodiversity stewardship.

7.3.5 Monitoring and data-driven decision making

Across the interviews, the absence of clear and shared metrics for biodiversity emerged as one of the most significant structural gaps in Milan's governance landscape. Several experts described a situation in which biodiversity is invoked rhetorically yet remains weakly operationalised because it is not accompanied by measurable indicators.

M.2 captured this with particular clarity when he explained that "*currently, in the city there are no formal obligations in this regard… there's a lack of effective indices to measure biodiversity*", which M.2 sees as one of the "*few ways to actually obtain results*". In his view, the absence of performance indicators means neither private operators nor municipal departments are encouraged or "*forced to measure biodiversity*" impacts, resulting in the issue being sidelined in both planning and implementation (M.2). The preliminary findings mirror this concern with the observation that "*there are no formal metrics to assess biodiversity in the city, making it difficult to track the impact of policies.*". offered a similar reflection when he described the "*lack of effective biodiversity indicators*", as part of the broader continuity gap that characterises many urban projects (that are not monitored post-implementation). In practice, this means Milan might plant X number of trees or create Y square metres of green space, but it does not measure outcomes like species richness, habitat connectivity index, pollinator counts, or other ecological indicators. The experts implied that establishing a set of biodiversity indicators for the city (e.g. number of native species present, population trends of key indicator species, percentage of permeable surface, etc.) would be a key

step toward evidence-based policy. Without such data, biodiversity remains an abstract goal that can be politically declared but not quantitatively evaluated.

Beyond indicators, the infrastructure for monitoring – who collects data, how often, and how it's reported – was also discussed. M.5 noted that there are bodies conducting environmental monitoring in and around Milan: "*technical monitoring by ARPA, by ERSAF, by these scientific entities*" is ongoing. ARPA is the regional environmental agency, ERSAF is a regional forestry agency; they gather data on air, water, maybe even some wildlife. However, M.5 implied this data is not integrated into a city-led monitoring system for biodiversity.

Citizen science could play a role as well. M.1 and M.2 mentioned that there have been "*citizen-led initiatives documenting species in urban parks*"(likely referring to groups that catalogue urban flora/fauna), but currently "*there is no official platform for tracking biodiversity data*" in Milan. The result is a patchwork of datasets that exists (from regional agencies, academia, NGOs, citizen groups) but do not converge into a citywide biodiversity baseline or feed into regular reporting. M.4 expanded this critique by pointing to the lack of transparency and evaluation that accompanies many municipal projects. He observed that the city often launches initiatives with considerable visibility but rarely follows up with assessments ("*there is no evaluation mechanism to assess its effectiveness*"). A robust monitoring system would mean the city routinely measures key indicators, publishes results (e.g. "State of Urban Nature" reports), and uses those to guide actions. The experts clearly found this lacking as of now.

Due to these gaps, decisions regarding urban biodiversity in Milan may not be as data-driven as they should be. M.2 remarks suggest that if biodiversity performance could be quantified, it would be easier to incorporate into regulations and planning ("*if you set constraints, like permeable surface indices, etc., you start to enforce it*" – he advocated for including biodiversity criteria in rules, akin to climate or permeability rules). Without data, however, decisions tend to rely on qualitative judgement or political priorities rather than ecological evidence. M.4 reinforced this by remarking that biodiversity issues are frequently absorbed into larger agendas such as climate or culture, which means biodiversity-specific knowledge does not always surface in policy deliberations. One positive mentioned: community monitoring can sometimes alert authorities to issues or successes (e.g. volunteers noting the return of certain fauna in Bosco in Città). But for systematic decision-making – like adjusting the city master plan to include new green corridors or investing in certain NbS – there needs to be evidence showing where biodiversity is most threatened or where interventions

yield results. Currently, as M.1 insinuated, Milan's decision-makers lack this feedback loop: "*no one has information on whether the biodiversity promises are being kept or whether biodiversity is improving or declining in the city.*"

While perhaps less visible to the public, the experts identified monitoring and data as an area needing improvement and suggested several directions for strengthening this dimension.

→ One involves creating a coherent system of biodiversity indicators that allows the city to move beyond counting trees and square metres of green space toward assessing ecological dynamics.

→ Another concerns integrating existing datasets, whether produced by regional agencies, universities, NGOs or citizen groups, into a unified and regularly updated platform. A third involves institutionalising evaluation practices so that projects are followed not only by public announcements but also by assessments that inform future decisions.

The experts viewed these steps as central to enabling evidence-based governance and to supporting more transparent communication with the public. Strengthening monitoring and data would therefore help Milan move from episodic interventions to a more systematic approach in which ecological outcomes become visible, measurable and actionable.

7.3.6. Climate change and urban resilience

In the interviews, climate change formed an important interpretive frame through which experts understood the role of biodiversity in Milan's ecological transition. Biodiversity and climate action were consistently described as intertwined fields rather than parallel agendas. Experts agreed that strengthening urban biodiversity can significantly enhance a city's capacity to adapt to climate change, since ecological systems mediate temperature, manage water flows and stabilise microclimates. M.4 characterised this convergence as part of a "*multi-layer*" sustainability discourse in which biodiversity is almost always bundled with climate issues. Although he viewed this entanglement as structurally logical, he also noted that it can obscure the specificities of biodiversity unless explicitly addressed.

Several Several interviewees offered examples of this convergence in practice. M.2 observed that many cities now include biodiversity chapters within their climate resilience plans, describing this as a positive synergy. In these documents, increasing green space and restoring habitats are recognised measures to cope with heat waves, manage stormwater, etc., thereby concurrently benefiting

biodiversity. M.4 added that although Milan does not yet have a dedicated biodiversity strategy, some of its elements are already embedded within climate adaptation planning. M.1 also pointed to climate adaptation indirectly, noting that measures such as permeable-surface rules or more aggressive tree-planting programmes often originate from climate goals. His concern was that biodiversity risks becoming subsumed under these larger umbrellas unless decision-makers actively ensure that biodiversity objectives remain visible and distinct. M.6, articulated this relationship in aspirational terms when she stated that a biodiverse and green city is also a city more capable of resisting climate change: "*we want to be biodiverse and green and resilient to climate change; the more nature we bring into the city, the more it helps us survive climate change*". This statement captures the essence of the nature-climate nexus – that urban nature is a defense against climate threats, and it requires citizens to take responsibility and be aware of this relationship.

The experts also reflected on Milan's progress in linking biodiversity to green infrastructure and urban development. M.3 praised the city's "big effort" in multisectoral governance for climate and energy plans and suggested that a similar model could benefit biodiversity and green infrastructure planning more explicitly. She pointed to international examples, such as the Netherlands, where small-scale urban elements like bus stops or rooftops are systematically greened. Milan has moved in that direction, and the Bosco Verticale green tower was mentioned by M.1 as an "*emblematic case*", but scaling up green infrastructure throughout the city is still a challenge, and opens to the risk of the already mention green/eco-gentrification. M.2 noted that many advances in this area come from European or national directives – e.g. he said "*until the EU issues a directive in this sense, it's harder for them to spread*" (speaking about nature and climate measures). However, once frameworks exist, Milan tends to incorporate them. For example, Milan is part of the 100 Climate-Neutral Cities EU mission (as hinted by M.5) and has a resilience strategy from the Rockefeller Foundation's 100 Resilient Cities program. These often encourage incorporating biodiversity (like tree canopy targets for heat reduction) into city planning.

Even so, the interviews revealed also structural gaps, such as the absence of binding local rules specifically on biodiversity. M.1 and M.2 both argued for concrete standards – e.g., "*guidelines that set constraints on soil permeability, plantings…*"– which would ensure urban development contributes to resilience. Without such integration, climate adaptation actions might ignore biodiversity (e.g., using purely engineering solutions) and vice versa. The overall expert view is that biodiversity and resilience should progress hand in hand. Milan's

recent Green Plan (Piano del Verde) and forthcoming climate adaptation plan are opportunities to formally link the two, by including biodiversity objectives like habitat connectivity or species protection as criteria for resilience.

Although none of the interviewees described concrete cases of biodiversity loss caused by climate events in Milan (such as extreme heat affecting urban trees or flooding impacting parks), they did offer indications that climate stress is already shaping urban ecological conditions. M.6, who served on a municipal commission examining heat islands, described how hotter summers are already affecting and reshaping the urban environment; her reflections suggested that trees and green spaces are increasingly important for managing heat but are simultaneously vulnerable to drought and extreme temperatures. M.4, comparing Milan with other Italian cities, noted that a lack of green areas in cities like Naples exacerbates their vulnerability to climate impacts, whereas Milan's relative abundance of green space offers partial protection . Even so, climate change is likely to intensify pressures through drought, invasive species or new pathogens, and these pressures could undermine biodiversity if not anticipated through robust adaptation planning.

The experts encourage Milan to treat biodiversity not as an isolated topic but as a critical piece of its climate adaptation strategy; they portray a city in which biodiversity and climate resilience are conceptually aligned yet not fully integrated in practice. They mainly pointed to three directions that Milan could pursue to strengthen this alignment:

→ One concerns the explicit incorporation of biodiversity objectives into climate adaptation plans so that ecological considerations are not overshadowed by infrastructural or engineering priorities.

→ Another concerns the development of binding local rules that translate climate and biodiversity ambitions into concrete land-use and design requirements.

→ A third concerns the expansion and ecological upgrading of green infrastructure so that NbS become the backbone of urban resilience rather than isolated pilot interventions.

These pathways reflect a shared conviction among the interviewees that Milan's climate agenda will be more effective, and its biodiversity stronger, if the two are treated not simply as overlapping agendas but as mutually reinforcing pillars of the city's ecological future.

7.4. Discussion on findings

The analysis of expert interviews on urban biodiversity in Milan reveals a complex yet interrelated set of challenges and opportunities. A recurring theme throughout the conversations is the tension between ambition and implementation, while Milan has positioned itself as a leader in urban sustainability, translating plans into concrete biodiversity action remains a challenge. Experts frequently pointed to institutional fragmentation, where biodiversity governance is scattered across different departments, often without effective coordination. This siloed approach makes it difficult to implement holistic biodiversity strategies, as responsibilities are split between urban planning, environmental agencies, and municipal green offices, with little overarching integration. Some Interviewees noted that Milan has started to move towards multisectoral collaboration, particularly In Its climate and energy strategies, yet biodiversity still lags behind in terms of cross-departmental coordination. The absence of a dedicated biodiversity strategy exacerbates this issue, making biodiversity a secondary consideration within broader urban policies.

One fundamental issue is the gap between policy commitments and execution. Several experts highlighted how Milan participates in high-profile international initiatives, such as C40's Reinventing Cities, yet struggles to maintain the integrity of projects as they move through the approval process. Policies and goals outlined in urban planning documents often undergo modifications, and the absence of mechanisms for monitoring and accountability means that biodiversity objectives may be diluted or abandoned altogether. This policy Inertia is further reinforced by political cycles, as biodiversity projects, which require long-term investment and maintenance, often face disruption when administrations change. Without sustained commitment and institutional mechanisms to shield biodiversity strategies from political turnover, many Initiatives risk remaining short-lived.

Public engagement emerged as another significant area of concern. Experts described how biodiversity remains an abstract or low-priority issue for much of the Milanese public, making it difficult to generate widespread support. Unlike climate change, which has gained mainstream recognition, biodiversity is still not fully integrated into public discourse. Citizens often associate it solely with the presence of green spaces, without a broader understanding of its role in ecosystem services, urban resilience, and quality of life. This lack of awareness results in low participation in biodiversity-related initiatives, even when they are designed to

involve the community. Events and outreach activities organized by local authorities have often seen minimal turnout, indicating that existing communication strategies may not be effective. Some interviewees pointed to the need for more innovative and audience-specific communication approaches, tailoring messaging to different demographic groups and utilizing platforms that reach diverse audiences, from social media campaigns for younger generations to collaborations with local newspapers and radio stations for older residents. Beyond communication, fostering active participation is crucial. Experts highlighted the potential of citizen science, volunteer programs, and educational Initiatives to bridge the gap between institutional biodiversity policies and everyday urban lives. By involving residents in monitoring projects, community gardens, and urban greening initiatives, Milan could cultivate a deeper sense of ownership and awareness of its biodiversity agenda.

A related challenge is the lack of systematic biodiversity monitoring and data collection. Experts pointed out that Milan does not yet have a formalized set of biodiversity indicators, making it difficult to track progress or assess the real impact of various interventions. While climate policies are increasingly based on measurable targets, biodiversity still lacks comparable metrics within municipal governance. This absence of data-driven decision-making not only limits the city's ability to evaluate success but also weakens the case for sustained Investment In biodiversity projects. Without clear evidence of biodiversity benefits, political and financial support may wane, particularly in competition with other urban priorities. Some experts suggested that Milan could benefit from integrating biodiversity monitoring into existing environmental assessment frameworks, leveraging collaborations with universities, research centers, and citizen-led initiatives to build a more robust knowledge base.

Despite these challenges, the interviews also highlighted opportunities for improvement. One recurring point was the need to frame biodiversity as a key pillar of Milan's climate adaptation and resilience strategies. As urban heat islands, flooding, and other climate-related risks intensify, NbS, such as expanding tree cover, restoring wetlands, and creating ecological corridors, can serve as both climate adaptation measures and biodiversity-enhancing interventions. Several experts noted that Milan has made significant strides in greening efforts through projects like Forestami, which aims to plant three million trees by 2030. However, concerns were raised about the extent to which such projects are strategically designed for biodiversity enhancement, rather than simply increasing tree numbers. More emphasis on ecological connectivity, native

species selection, and integrating biodiversity goals into broader urban planning frameworks could enhance the long-term effectiveness of these initiatives.

Another avenue for improvement lies in strengthening partnerships between the public sector, private enterprises, and civil society organizations. Experts highlighted the untapped potential of public-private collaborations, where businesses could be incentivized to integrate biodiversity into their corporate social responsibility initiatives, urban developments, or infrastructure projects. Similarly, NGOs and community groups already engaged in biodiversity-related work could play a greater role in co-managing urban green spaces, running environmental education programs, and fostering community engagement. Milan's participation in international networks also presents an opportunity to learn from best practices in other cities. Several interviewees referenced examples from Europe and beyond, where cities have fully mainstreamed biodiversity into their governance structures, integrated monitoring mechanisms, and Id effective public engagement strategies. Milan's challenge is not a lack of Innovation but rather ensuring that these lessons translate into sustained and coherent action on the ground.

Ultimately, the discussions reinforce the idea that biodiversity cannot be treated as an isolated environmental issue; rather, it must be embedded into Milan's broader urban agenda, encompassing governance, citizen participation, education, and climate resilience. The city already has many of the building blocks in place, a strong academic sector, active environmental movements, and access to European funding and expertise. What is needed now is a concerted effort to bring these elements together under a cohesive strategy that ensures biodiversity is not just an add-on to urban planning but a fundamental component of Milan's vision for a sustainable and liveable city.

The figure below distils the findings of the Milan case into a synthetic conceptual map, drawing together the structural challenges, the transformative levers and the policy domains through which urban biodiversity governance operates. The left column visualises the structural challenges that hold back biodiversity action, the central block shows the levers through which experts believe change can realistically occur, and the right column maps the policy fields in which these levers must operate. Read horizontally, the figure depicts the trajectory from constraint to possibility; read vertically, it highlights how Milan's biodiversity transition depends on simultaneous movement across institutional, ecological, civic and climate-related domains. Its governance is not simply the result of isolated technical shortcomings, but instead it reflects a systemic mismatch

between the nature of the problems, the capacities available to address them, and the arenas where action is currently concentrated. Put differently, meaningful progress depends on bringing institutional reconfiguration and shared metrics together with ecological innovation and civic mobilisation, so that biodiversity goals become clear, workable, and lasting across sectors instead of being dispersed into fragmented, project-based efforts.

Challenges

– Fragmented governance

– Disconnected and patchy green spaces

– Low public awareness and weak participation

– Episodic and unstructured cross-sector collaboration

– Incomplete and fragmented data, limited evaluation

– Biodiversity marginalised within climate agendas

Trasformative levers

– Transversal coordination and more stable resources

– Ecological networks and habitat-oriented urban design

– Strategic communication and continuous environmental education

– Stable multi-actor arenas linking municipality, NGOs, business, academia

– Unified biodiversity indicators and integrated monitoring system

– Explicit integration of biodiversity and climate in urban plans

Policy fields

– Institutional and multilevel governance

– Urban ecological and land-use planning

– Public engagement, awareness and education

– Public–private–civic collaboration

– Monitoring, data and knowledge production

– Climate resilience and nature-based solutions

Figure 1 *The conceptual figure summarises how the Milan interviews articulate the relationships between challenges, levers and policy fields*

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Other Urban Biodiversity Practices in Italy: Florence, Genoa and Palermo

Monica Bernardi and Pablo Gómez-Iniesta

8.1 Florence

Florence, capital of Tuscany, lies in central Italy within the Arno River valley, surrounded by the rolling hills of Fiesole, Settignano and Arcetri on the northern edge of the Apennines (see Image 2). The city sits at about 50 m above sea level in a basin-shaped landscape that shapes both its microclimate and air circulation patterns. Its climate is a transition between Mediterranean and humid subtropical, with hot summers and a well-documented history of flooding, notably the catastrophic Arno flood of 1966, which remains central to Florence's environmental memory. As of 2024, Florence has around 367,000 inhabitants in 102 km² (Statista, 2024), while its metropolitan area reaches 1–1.5 million people.

Figure 2 Location of Florence in the Tuscany region, central Italy. Created by the authors using MapChart.

Recent assessments show that air quality in Florence has gradually improved, with annual nitrogen dioxide (NO_2) concentrations at key monitoring stations (e.g., Viale Gramsci) falling below the EU limit of 40 μg/m³ for the first time in 2024, reflecting reduced traffic emissions and mitigation measures (ARPAT, 2025).

In terms of water resources, the ecological status of rivers in the metropolitan area remains mixed. ARPAT's 2024 Environmental Yearbook highlights that several river stretches are classified as "moderate" rather than "good," due to pressures from urban runoff and altered morphology. Coastal waters in Tuscany generally maintain high bathing quality, though episodic exceedances are reported (ARPAT, 2024).

Florence also faces challenges in land consumption and soil sealing. National land-use reports classify the city among the most artificialised territories in Tuscany, with a densely built and impermeable urban strip contrasting sharply with forested hinterlands. This fragmentation reduces ecological connectivity and ecosystem service provision (SNPA, 2023).

On the positive side, Florence has adopted innovative strategies for urban green planning, such as the recent *Urban Green and Open Space Plan* - called IRIS, which incorporates the "3-30-300" principle (three trees visible from each home, 30% canopy cover, and access to green space within 300 meters) aiming to strengthen ecological resilience and enhance biodiversity in the metropolitan fabric (Comune di Firenze, 2025).

Table 3 Florence case study – city profile	
City Positioning	• Globally recognised cultural capital with UNESCO World Heritage status for its historic centre, reinforcing Florence's international visibility (UNESCO, 1982). • Active member of the Covenant of Mayors and ICLEI, signalling strong commitments to climate adaptation, energy transition, and urban nature programmes (ICLEI, 2023). • Leader in integrating heritage preservation and environmental policy, pioneering measures to limit traffic, reduce pollution, and safeguard monuments (Municipality of Florence, 2023). • Positioning itself as a European "heritage green city", advancing tramway expansion, urban reforestation, and

	NbS aligned with EU Green Deal goals (EU Commission, 2021).
Governance	• Mayor–Council system with five Quartieri for local services and neighbourhood input. • Collaboration with Tuscany Region on tramway expansion and environmental programs. • Early adopter of open-data platforms for transparency on budgets, mobility, and energy use. • Strict heritage regulations in the UNESCO historic centre to protect buildings and monuments. • Governance challenge: balancing tourism pressure with residents' quality of life.
Climate Justice	• Heatwaves strongly affect elderly residents in top-floor historic apartments. • Green space inequality: wealthier areas have more parks, while dense districts like Novoli & Isolotto lack greenery. • Tree-planting programmes focus on neighbourhoods with greenery deficits. • Adaptation avoids flood-prone zones and upgrades drainage in vulnerable areas. • Climate Adaptation Plan shaped with inclusive participation, supported by EU/EIB funding. • Climate resilience and equity increasingly seen as linked priorities (Magenta Florence, 2022).
People Engagement	• Strong civil society with active neighbourhood committees and environmental NGOs. • "Angeli del Bello" mobilises volunteers to clean, green, and care for public spaces. • Online consultation portals allow feedback on plans such as Urban Forestry strategies. • "Walk&Learn" nature walks link citizens, experts, and policymakers in parks and river areas. • Youth activism visible through Fridays for Future and climate marches. • First Climate Citizens Assembly withing the 100 EU Smart and Net-Zero Cities programme.
Planet	• Car-Free Day reduces traffic, smog, and noise in the historic centre. • Expanded tram network and cycling routes cut emissions from congested corridors.

	• Former waste issues improved with higher recycling and some door-to-door collection.
	• Cascine Park and Boboli Gardens serve as major green lungs and carbon sinks.
	• Over 2,000 trees planted in recent years, prioritising low-greenery districts.
	• "Florence 2030" plan promotes polycentric growth, a green belt, and NbS.
	• Climate and heritage protection integrated in urban planning.
	• Sustainability actions documented in environmental reporting (Carbon Disclosure Project, 2020).
	• Florence recognised for green urbanism and climate action (The Florentine, 2020).
Prosperity	• Economy driven by culture, tourism, artisanal craftsmanship, and luxury fashion.
	• Heritage tourism sustains jobs but increases pressure on housing and public space.
	• Expanding tech, biomedical, and research sectors support economic diversification.
	• High-speed rail strengthens Florence's role as a regional services and mobility hub.
	• Innovation and sustainability increasingly shape the city's development model (Climate Adaptation Partnership, 2021).

8.2 Genoa

Genoa, capital of the Liguria region, is a major Mediterranean port city located on Italy's northwestern coast, wedged dramatically between the Ligurian Sea and the steep Apennine foothills (see Image 3). The municipality covers 243 km², much of it mountainous, and had approximately 580,000 inhabitants in 2023 (ISTAT, 2024). Its metropolitan area reaches around 800,000 residents. Genoa's Mediterranean climate features mild, rainy winters and warm, breezy summers, but its geography makes it highly exposed to intense autumn rainfall and flash floods. Known historically as La Superba for its maritime power, Genoa today remains Italy's largest seaport and a diversified urban centre balancing heritage, logistics, technology, and resilience.

Figure 3 Location of Genoa along the Ligurian coast in northwest Italy. Created by the authors using MapChart.

In environmental terms, recent assessments indicate that Genoa faces persistent air-quality pressures. ARPAL reports that annual concentrations of NO_2 and PM_{10} in the coastal urban corridor frequently exceed WHO guideline values, with the city's narrow morphology between sea and mountains amplifying traffic-related pollution episodes (ARPAL Liguria, 2024). Although Liguria as a whole shows modest improvements, Genoa remains structurally exposed to chronic air-quality stress.

Land-use analyses by SNPA and ISPRA classify Genoa as one of the most artificialised territories in the region, with a densely built and impermeable coastal strip contrasted by extensive forested areas in the hinterland (SNPA, 2023). This sharp urban–ecological divide creates significant discontinuities that limit ecological connectivity across the metropolitan area.

Hydrological monitoring further reveals that several river segments crossing the city, particularly the Bisagno and Polcevera, remain vulnerable to urban runoff, altered morphology and episodic pollution, while parts of the coastal waters achieve only moderate ecological status (ARPAL Liguria, 2024). These dynamics underscore how Genoa's biodiversity potential relies on bridging structural constraints in air quality, land artificialisation and hydro-ecological degradation.

Table 4 Genoa case study – city profile

City Positioning	• Award-winning Mediterranean sustainability leader, boosted by the 2023 Istanbul Environment Friendly City Award, which strengthened Genoa's international environmental profile (MedCities, 2023). • Active member of transnational urban networks, including MedCities and the Covenant of Mayors, projecting a strong commitment to climate adaptation and metropolitan resilience (MedCities, 2023). • Advancing a pioneering "Smart Port" strategy, using digitalisation and green technologies to position itself as a model for sustainable maritime innovation (Port System Authority of the Western Ligurian Sea, n.d.). • Promoting a global cultural identity, anchored in its UNESCO-listed Palazzi dei Rolli and maritime heritage, which enhances Genoa's international visibility as a Mediterranean cultural hub (UNESCO, 2006).
Governance	• Mayor–Council system with nine Municipalità providing neighbourhood-level services. • Metropolitan City coordinates transport, environment, and development across the wider urban region. • Winner of the Istanbul Environment Friendly City Award (2023) for sustainability and governance excellence (MedCities, 2023). • Active agencies like ARPAL provide environmental monitoring that supports local policy. • Member of networks such as MedCities, promoting cooperation on sustainable urban projects.
Climate Justice	• Floods and landslides disproportionately affect working-class districts in valleys and hillside areas. • Vulnerable neighbourhoods near creeks (e.g., Sestri Ponente) face recurrent damage from extreme rainfall. • Underground expansion of the Bisagno stream helps protect dense central districts. • Early-warning systems and SMS alerts support residents in at-risk zones. • Cooling centres and new green oases help elderly and vulnerable groups during heatwaves. • Port emissions historically affected low-income dockside communities; shore-to-ship power reduces exposure

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People Engagement	• "Genova Partecipa" platform gathers public feedback on plans and projects. • Strong civic activism with groups like Legambiente Liguria and Italia Nostra involved in gardening, clean-ups, and preservation. • Residents' committees in flood-prone areas collaborate on local defence measures. • Annual Science Festival promotes environmental education and youth engagement. • Participatory budgeting used in some districts for small-scale sustainability projects. • Community advocacy contributed to major cleanups such as the Cornigliano steel plant transformation.
Planet	• Rich ecosystems surround Genoa, from marine protected areas to forested hills. • Urban green belts like Parco delle Mura preserve biodiversity and limit sprawl. • NbS in the Polcevera valley integrate rain gardens and permeable surfaces. • Reforestation on steep slopes reduces erosion and landslide risk. • Shore-to-ship power cuts port emissions; older polluting vehicles restricted in central areas. • Recycling rates above 40% and rising, with targets aligned to EU directives (Comune di Genova, 2022). • Major remediation of industrial sites like Cornigliano and Multedo restores degraded land.
Prosperity	• "Smart Port" initiatives use AI and hydrogen pilots to cut emissions and modernise port operations. • Plans for renewable energy generation, including a wind farm on the outer breakwater. • Winning the Istanbul Environment Friendly City Award (2023) underscores Genoa's sustainability leadership (MedCities, 2023). • Environmental improvements help counter population decline and strengthen long-term resilience. • Green redevelopment projects build a healthier environment and enhance economic prospects.

8.3 Palermo

Palermo, capital of Sicily, lies on the northwestern coast of the island facing the Tyrrhenian Sea, set within the fertile Conca d'Oro plain and framed by dramatic mountains such as Monte Pellegrino to the northwest and Monte Catalfano to the east. The municipality counts approximately 650,000 residents across 160 km² (ISTAT, 2024). The city experiences a Mediterranean climate with long, hot, dry summers and mild, wetted winters, making Palermo one of the warmest winter cities in Europe, with January temperatures averaging 15 °C/9 °C. Rainfall is moderate but highly seasonal, often absent for weeks in summer, contributing to water-scarcity concerns. Occasional sirocco winds bring extreme heat and dust from North Africa, while abundant sunshine makes solar radiation a valuable environmental resource. Palermo's layered cultural history and socio-economic inequalities intersect with environmental challenges as the city strives toward climate adaptation, biodiversity protection, and sustainable mobility.

Figure 4 Location of Palermo on the northern coast of Sicily. Created by the authors using MapChart.

Recent monitoring indicates that air quality in Palermo continues to face structural pressures, particularly from traffic emissions. The 2024 ARPA Sicilia report highlights exceedances of the annual limit for nitrogen dioxide (NO_2) in the Palermo agglomeration, alongside frequent episodes of ozone (O_3) above the WHO guideline values during summer months (ARPA Sicilia, 2024).

Regarding water quality, ARPA Sicilia's 2024 assessments show that several river segments and coastal waters around Palermo remain vulnerable to urban runoff and episodic pollution. While bathing waters generally achieve "good" status, localized exceedances linked to stormwater discharges and altered morphology persist (ARPA Sicilia, 2024).

In terms of land consumption, Palermo is classified among the most artificialised territories in Sicily. The 2024 ISPRA/SNPA land-use report documents extensive soil sealing in the metropolitan area, with impermeable urban expansion contrasting sharply with surrounding agricultural and semi-natural areas. This fragmentation reduces ecological connectivity and ecosystem service provision (ISPRA, 2024; SNPA, 2024).

On the positive side, the broader urban planning framework (PUG – Piano Urbanistico Generale) includes references to green infrastructure and sustainability, but the city has not yet implemented a comprehensive Green Plan. In the last years it has also launched extraordinary green care plans allocating funds for weed removal, pruning, sanitary interventions across the eight districts of the city, and recently it has also recognized within the EU-funded *euPOLIS* project for adopting innovative approaches to urban biodiversity and resilience, aiming to expand green corridors and improve ecological integration across the city (Comune di Palermo, 2025; euPOLIS, 2025).

Table 5 Palermo case study – city profile	
City Positioning	• UNESCO recognition of its Arab-Norman heritage boosts cultural tourism and strengthens Palermo's international visibility (UNESCO, 2015). • Member of Eurocities and participant in national programmes. • Growing global profile driven by historic-centre regeneration and rising tourism linked to its Mediterranean cultural landscape (Municipality of Palermo, 2024). • Strategic port links and a strong stance on migration shape a progressive Mediterranean identity centred on openness and social inclusion.
Governance	• Mayor–Council system with 8 Circoscrizioni offering localised services, though with limited powers. • Sicilian autonomy gives the Region significant influence over transport and urban development.

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	• Coordination with the Metropolitan City on waste, transport, and planning beyond the city limits. • Governance shaped by the historic fight against Mafia influence and ongoing transparency reforms. • Environmental governance improving through climate plans, NBFC collaboration, and new recycling initiatives
Climate Justice	• Heatwaves disproportionately affect low-income households in dense, poorly insulated neighbourhoods. • Cool refuges in libraries and community centres support elderly and vulnerable groups during extreme heat. • Water scarcity hits peripheral, low-income areas hardest during drought-driven rationing. • Flooding events—like the 2020 flash flood—impact basement dwellings and vulnerable populations. • Low-emission zones and transit upgrades aim to reduce pollution burdens on traffic-exposed communities. • Waterfront renewal expands public access to green/blue spaces for residents across all social groups
People Engagement	• Strong grassroots activism pushes urban improvements and public space reclamation. • Community gardens like "Orto di Ballarò" transform abandoned lots into shared green spaces. • Youth and cultural centres promote workshops on recycling, sustainable fashion, and environmental awareness. • Citizen petitions influence city decisions, as in tree-protection campaigns on Via Libertà. • Partnerships with NGOs (e.g., Legambiente) mobilise volunteers for clean-ups and tree planting. • Social justice organisations integrate environmental action with community support.
Planet	• Favorita Park and Monte Pellegrino Reserve provide major biodiversity and recreational value. • Botanical Garden supports conservation, research, and public education on urban biodiversity. • Expansion of tram lines and low-emission measures aim to reduce traffic-related pollution. • Waste management improving through door-to-door collection and anti-dumping enforcement. • Coastal areas like Mondello benefit from better sewage treatment and improved water quality.

	• Port pollution addressed through shore power and cleaner maritime fuel initiatives
Prosperity	• Climate adaptation includes orchards, cool roofing, and daylighting historic streams into greenways. • Solar panels widely adopted on municipal buildings, leveraging Sicily's high solar potential. • New reservoirs, leak reduction, and water infrastructure upgrades support resilience. • Urban regeneration around degraded sites strengthens environmental health and economic prospects. • The Sicily Climate Observatory positions Palermo as a knowledge hub for regional climate planning.

8.4 Preliminary considerations

Understanding the perspectives of municipal officials is essential for developing effective and sustainable urban biodiversity policies; indeed, local government representatives play a crucial role in translating biodiversity strategies into concrete actions, navigating administrative structures, regulatory frameworks, and financial constraints; their insights provide a practical understanding of how biodiversity policies are implemented within municipal governance and the challenges encountered in integrating ecological considerations into urban planning.

For this study, semi-structured interviews were conducted with three municipal officials responsible for biodiversity and environmental policies in their respective cities. To ensure confidentiality, all interviewees have been anonymised and are identified as C.1, C.2, and C.3. These experts offer an internal perspective on local governance, decision-making processes, and institutional barriers, shedding light on the complexities of managing biodiversity within public administration.

- C.1: Director from the Parks, Gardens, and Green Areas Service of the Municipality of Florence.
- C.2: Head of the Public Green Spaces Office of the Municipality of Genoa
- C.3: Head of Environmental Planning and Management of Processes and Environmental Procedures of the Municipality of Palermo

8.5 Insights from Florence, Genoa and Palermo

Across the interviews, certain themes surfaced again and again. Governance and collaboration stood out immediately, as the officials spent considerable time describing how decisions are made, who is involved, and how different departments try – sometimes successfully, sometimes not – to work together. Funding constraints and communication problems also appeared frequently; often as quiet frustrations woven into other reflections.

Other aspects emerged only occasionally, like the use of social media that, for instance, is barely registered, as well as technical skill gaps that were mentioned mostly in passing. Their limited visibility is meaningful, suggesting that these matters either remain in the background or are overshadowed by more immediate operational concerns.

What emerged very clearly was a strong orientation toward the future. Many interviewees moved quickly from describing current challenges to considering what should change, for example how cities might improve planning, involve citizens more effectively or secure long-term support for biodiversity.

In general, the interviews reveal a group of practitioners who understand the complexity of urban biodiversity not as an abstract theme but as something tied to budgets, timelines, political cycles, and public expectations, a mix of recurring topics and quieter undercurrents that sets the scene for the thematic analysis that follows.

8.5.1 Governance and policy framework

All three municipal technicians highlighted the need to integrate biodiversity into urban planning and policy, albeit from different starting points. Florence and Genoa both admitted that until recently they lacked a dedicated strategy or plan for urban biodiversity. Florence is now "*about to release the Green Plan – the first plan, as Florence has never had one*"[30] (C.1), and similarly Genoa is "*working to equip itself with a Green Plan…the first, Ie until now there isn't one*" (C.2). In contrast, Palermo has not formulated a single biodiversity plan, but biodiversity is mainstreamed within a broad environmental mandate. The Palermo official oversees an Environmental Policies department that "*ranges from environmental education to environmental communication, deals with integrated waste management and circular economy, and [covers] all aspects of*

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[30] At the time of the interviews, the IRIS plan was still undergoing approval; it has since been formally approved.

regenerating compromised environmental matrices, [including] biodiversity" (C.3). In other words, Palermo's governance framework embeds biodiversity across various urban policy areas rather than in a standalone plan.

Coordination across government levels and departments emerged as a significant theme.

- The Florence interviewee identified the city's insularity as a weakness, noting that ecological processes ignore administrative boundaries. She argued that it is futile to "*reason about ecological corridors if I have to stop at the limits of the City of Florence…it's absurd*", concluding that the city is "*too concentrated on our own areas…if we join forces at the metropolitan city level…perhaps we'd get better results*" (C.1).

- Genoa's official likewise described a fragmented institutional landscape, explaining that "*in reality, there isn't just one office that deals with biodiversity, environment, green areas, but a plurality of offices and departments*" (C.2), each with specific competences ranging from public green maintenance to urban planning and EU fund management. This necessitates horizontal coordination within the municipality.

- Palermo's governance structure is more centralized, yet even there the official acknowledged silo issues – noting that "*very often there is no network even within the administration*" (C.3) – and stressed the importance of internal coordination to implement biodiversity initiatives effectively. In terms of vertical coordination, Palermo stands out for having delegated responsibilities from the regional government (e.g., issuing environmental impact assessments for Natura 2000 sites), which indicates a formal link between city and region in biodiversity governance. Genoa and Florence, by contrast, did not report strong direct coordination with higher levels, apart from abiding by regional laws or guidelines (such as Florence following a Tuscan regional directive to ban glyphosate use on public land).

Not only coordination, but also implementation of biodiversity policies on the ground is an ongoing challenge. Florence and Palermo have begun to turn policy ideas into action through pilot projects and new programmes, while Genoa is still laying the policy groundwork. The Florence interviewee described how biodiversity considerations are being incorporated into the city's planning tools for the first time. For instance, the IRIS Green Plan is being informed by scientific input (a renowned botanist was hired as a consultant to guide it) with the goal to set out concrete measures for urban nature. Palermo's official similarly

has initiated projects under her department's wide remit to translate policy into practice (as detailed in later sections on specific projects). Genoa's efforts to implement biodiversity policy have so far been ad hoc; they complied with a regional forestry law by developing a Forest Management Plan for city-owned woodlands, and they support other departments' projects with technical advice, but a cohesive biodiversity policy Implementation Is pending the new Green Plan. All cities recognise that sustained implementation will require cross-department collaboration and integration of biodiversity goals into various sectors of urban planning (parks, infrastructure, etc.).

One recurrent topic was funding and resources for biodiversity. The interviews revealed a common reliance on external funding sources, especially European programmes, to drive local biodiversity projects. Both Florence and Palermo emphasised their dependence on EU funds; Florence, for example, recently joined an EU-funded project to tackle urban heat islands through greening interventions, indicating that such climate–biodiversity initiatives materialise only when external grants are available. The Palermo official likewise recounted participating in a Horizon Europe project alongside international partners to finance and test NbS in the city (C.3). In the absence of dedicated national or municipal funding streams for biodiversity, these cities turn to competitive EU projects or one-off grants. This model, however, can limit long-term continuity. The Florence respondent noted that they "*need resources – human, time, and financial – to do more*" in promoting biodiversity (C.1), implying that existing municipal budgets are not sufficient for sustained action. Palermo has tried to allocate local funds where possible (e.g. designating €1 millions of city money for river restoration studies, see C.3), but such cases are the exception. In sum, under the current governance frameworks, sustainable funding is not yet secured: biodiversity initiatives largely depend on project-based funding and the ability of motivated officials to "piggy-back" biodiversity onto broader environmental programmes (like climate adaptation) to draw resources.

In sum, the governance and policy context for urban biodiversity in these cities is characterised by emerging strategic planning (with Florence and Genoa drafting their first green plans), a need for better multi-level and inter-departmental coordination, and resource constraints that make policy implementation heavily reliant on external support. Each city is taking initial steps to embed biodiversity in its planning framework, but they face structural and financial limitations in fully realising a comprehensive biodiversity policy.

8.5.2 Challenges and barriers to implementation

The interviews shed light on several challenges and barriers that hinder the implementation of urban biodiversity initiatives.

A notable administrative barrier is bureaucratic fragmentation and inertia, that can slow progresses as seems to happen in particular in Genoa and Palermo

- In Genoa, the division of responsibilities among numerous departments means biodiversity-related actions require coordination across separate administrative units, which can be cumbersome. Although Genoa's official did not explicitly complain about "*red tape*", the mere fact that multiple offices must concur (parks department, urban planning, economic development for funding, etc.) is a de facto bureaucratic obstacle.

- Palermo's official pointed out that even within her integrated department, overcoming ingrained silo-thinking is an ongoing effort, and internally, they have had to organise special knowledge-sharing sessions to ensure everyone is aligned on new biodiversity projects. C.3 observed that the administration needs to break out of its compartmentalised approach, implying that without proactive measures, important biodiversity measures could fall through cracks between offices.

- Florence's interviewee did not emphasise internal bureaucracy as much (perhaps because her city's smaller size or more centralised green unit makes it slightly less of an issue), though she did note they must coordinate with other departments (roads, education, sport, etc.) whenever biodiversity measures Intersect their domains.

A related barrier is the lack of specialised technical capacity within the local administrations.

- Genoa's technician frankly acknowledged that the city does not retain full-time biodiversity experts for niche tasks; for highly specific ecological studies or designs, the municipality "*brings in external consultants, but those cases are really sporadic*" (C.2), showing that the internal staff may lack certain expertise (for instance, in fauna ecology or habitat restoration) and the city must outsource when those needs arise.

Florence and Palermo did not cite a lack of expertise as bluntly, but the issue is implicit.

- Florence has no dedicated biodiversity unit; its staff are mainly parks and horticulture managers, so the city relies on partnerships with academics for scientific expertise (e.g., consulting a university professor on plant biodiversity).

- Palermo benefits from the fact that its departmental head (the interviewee) is herself an expert (she chairs a regional environmental impact commission), but it's not clear if there are junior ecologists or wildlife specialists on staff.

In effect, none of the three cities have a team solely devoted to biodiversity management, which can be a barrier when attempting advanced or large-scale projects, they must either upskill existing staff or hire external expertise.

One challenge mentioned is the difficulty of sustaining long-term action and vision, given political and funding cycles.

- The Florence official reflected that the urban environment inherently imposes limits on biodiversity outcomes; in her words, "*in the urban context we cannot expect to achieve who-knows-what objectives… the city's structure cannot be changed, and perhaps it wouldn't even make sense [to do so]*" (C.1). This pragmatic outlook highlights how long-term biodiversity goals must be tempered by realism about city constraints (dense built heritage, limited space for natural habitats, etc.). It can be seen as a barrier insofar as overly ambitious plans may not be feasible – planners must work within tight bounds. Additionally, her remark that focusing only within the city's boundary is a weakness (not engaging surrounding municipalities) suggests that long-term ecological connectivity goals are hard to pursue under current fragmented governance (a challenge of scale).

- Genoa's interview hinted at a long-term barrier; previously, without an overarching strategy, biodiversity actions were piecemeal. The challenge now is to maintain momentum in developing and implementing the new Green Plan across electoral terms and administrative changes – something not explicitly stated but evident as a general concern.

- Palermo's situation demonstrates the difficulty of long-term financing, since many of its projects depend on short-to-medium term grants. Once a project ends, maintaining its outcomes (e.g., continued monitoring of a restored area) could be at risk if new funding is not secured. C.3 talked of this "projectisation" of biodiversity action as a structural barrier to continuity.

Financial dependency itself is a barrier that was repeatedly noted. As discussed, Florence and Palermo rely heavily on external funds; this dependency can delay or derail initiatives when funding is not obtained. The Palermo interviewee, while optimistic about current projects, implicitly pointed out that without EU programmes the city would struggle to afford such work. Florence's comment that more resources (including funding) are needed came from a question about ideal support, implying that under current budget constraints, some biodiversity measures remain aspirational. In Genoa's case, the official mentioned that even when they do have projects, success is often measured in terms of completing them within budget – suggesting that simply executing projects with limited funds Is an achievement (C.2). All this reflects a barrier of insufficient dedicated funding and a reliance on unpredictable external financing.

Finally, some challenges are external to the administration but impact their work as well. Palermo touched on this indirectly when describing the environmental pressures linked to illegal activities. She spoke of the coastal area on the city's outskirts as "*a large open-air dump…they have destroyed age-old olive trees and citrus groves*" (C.3). Situations like illegal dumping, encroachment or vandalism create difficult conditions for officials trying to restore habitats. Reversing years of neglect or damage is never straightforward. These issues may not fit neatly into the category of bureaucratic barriers, but they are very real obstacles to achieving biodiversity goals (for example, cleaning up a river requires tackling pollution sources and enforcement against illegal behaviours).

To conclude the key barriers to implementing urban biodiversity policies in Florence, Genoa and Palermo include

→ administrative fragmentation and the coordination burden it imposes;

→ a lack of in-house specialist expertise;

→ the struggle to maintain long-term initiatives in the face of structural and financial constraints;

→ heavy dependence on external funding;

→ and dealing with adverse legacy conditions (like pollution and habitat degradation).

These challenges mean that even well-intentioned strategies can falter unless the cities find ways to address capacity gaps, improve cross-agency collaboration, and secure sustained support.

8.5.3 Best practices and success stories

Despite the obstacles, each city reported notable best practices or success stories demonstrating how urban biodiversity can be enhanced with creative approaches. These range from changes in routine management to ambitious restoration projects and innovative pilot schemes.

In Florence, a shift toward more ecologically friendly maintenance of green spaces was highlighted as a positive practice.

- the city's parks department has stopped using chemical herbicides (such as glyphosate) on public green areas for several years, in line with regional directives, allowing wild flora to recolonise verges and other areas, boosting plant diversity. The Florence official acknowledged that as a result "*we have a lot of weeds around the city, which people complain about as is*", but she maintained that if properly managed "*weeds, if kept under control, harm no one*". She argued that with better communication this ostensibly negative outcome (unkempt vegetation) can be reframed: "*explaining that we no longer apply those tens of litres of glyphosate… [means] there are more weeds – but that could be turned into a positive thing*" (C.1). This practice of pesticide-free urban green management is a success in terms of biodiversity (allowing native herbs and wildflowers to thrive, supporting insects, etc.), even though it requires balancing public perceptions.

- Florence also has experimented with differentiated mowing regimes (implied by the interviewee's comments that they are doing trials they "*know already work*"), which likely means cutting grass less frequently to let plants flower and seed. These on-the-ground measures are low-cost and replicable; they exemplify how tweaking maintenance routines can benefit urban biodiversity.

- Florence's engagement in pilot projects is one success avenue. The interviewee mentioned a project funded by the EU, aimed at mitigating the urban heat island in a Florence neighbourhood by planting and other green interventions. While primarily a climate adaptation project, it explicitly incorporates biodiversity goals. By partnering with a university department on this project, Florence is testing how creating new green infrastructure (like shade trees or green surfaces) can simultaneously reduce heat and provide habitats. The official noted this was "*the latest [project] we are participating in*" (C.1), suggesting Florence sees value in these collaborative projects to jump-start innovative practices. Although

results were not discussed in detail, the willingness to pilot NbS in an urban district Is Itself a positive step and can serve as a model for other Italian cities.

Turning to Palermo, the scale and scope of best practices are quite pronounced. Palermo's official described several urban ecological restoration initiatives either underway or in advanced planning.

- One major effort is focused on the Oreto River, a river that runs through Palermo which has suffered from pollution and neglect. The city, through her department, has launched a programme to rehabilitate the river ecosystem, investing in baseline studies and monitoring and proposing concrete renaturalisation and cleanup actions: "*we decided, as the City of Palermo, to allocate around one million euros to conduct monitoring and update knowledge on the environmental state of the [Oreto] river*" (C.3). This commitment of local funds to gather scientific data is a best practice, reflecting evidence-based planning.

- In tandem, Palermo is addressing its coastal zones. The interviewee detailed a plan for the "*requalification of the coastal strip of Palermo*" (C.3), particularly in the south-east periphery where illegal dumping had created an environmental disaster. The city has begun removing debris and restoring coastal habitats (she mentions clearing detritus and coordinating with the Port Authority and Marine Protected Area managers) and it is also employing NbS for climate adaptation and biodiversity. For example, the official spoke of creating a "*bio-lake*" and reintroducing native species as part of these efforts, aimed at regenerating lost wetlands and providing wildlife habitat. These projects are cited as success stories not only for the expected ecological benefits, but also for the collaborative approach – they involve various entities (local, regional, and international partners) and combine resources creatively.

- An outstanding best practice from Palermo is then its participation in international research and innovation networks. The city is a partner in a Horizon Europe project named "euPOLIS" that tests urban NbS, through which it has joined forces with other cities and universities (including Athen Polytechnic, London Imperial College, and even cities in China and Colombia) (C.3). In the project, Palermo has set up experimental areas in which to implement certain nature-based interventions and "*measure the effects together with citizens*" (e.g., monitoring microclimate improvements or biodiversity changes) (C.3).

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This is a best practice on multiple levels: it brings cutting-edge scientific support to the city's biodiversity actions, it engages the community through citizen science, and it allows Palermo to benefit from knowledge exchange with global peers. According to the interviewee thanks to euPOLIS project the city is measuring "*the large-scale benefits delivered by NbS*" (C.3), indicating that Palermo will have concrete data on outcomes like ecosystem services. Such rigorous evaluation is often lacking in municipal projects, so Palermo's involvement here is exemplary. Moreover, Palermo has leveraged the momentum from this project to host a national meeting on NbS, effectively positioning the city as a leader in this space within Italy.

Genoa, having fewer big projects to showcase, nonetheless offered emerging practices.

- One is the establishment of the Consulta del Verde (Green Council), which although primarily a stakeholder engagement mechanism (discussed in the next section), also serves to surface and support good practices. Through the Consulta, Genoa has begun to gather input on projects and generate ideas for urban greening that the administration alone might not conceive. The Genoa official also recounted fulfilling a Regional Forestry Plan requirement by developing a comprehensive Forest Management Plan for the city's peri-urban forests . While this might look like a routine compliance exercise, it is actually significant from a biodiversity perspective, as the plan maps the city's semi-natural areas, where "*the majority of biodiversity is concentrated*" in Genoa's territory, and sets out guidelines for their sustainable management. This is effectively extending biodiversity stewardship to urban fringes and natural reserves around the city. By treating city-owned rural land with an ecological management plan, Genoa is ensuring long-term preservation of habitats (woodlands, streams, etc.) that ultimately support urban biodiversity (for instance, those areas can act as sources of species that populate urban parks). It's a good practice showing that urban biodiversity policy need not stop at the city's densely built core but can encompass the larger socio-ecological system.

- Another positive example from Genoa is the effort to bring biodiversity into new urban projects. Although no specific project was mentioned, the official explained that different departments such as the capital works department now include a green component in their designs. In practice

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this means that biodiversity is becoming a normal consideration in urban development, so new public works may include tree planting, habitat features or the creation of green spaces as part of the overall plan. This gradual shift within the administration, supported by the work of the Consulta, suggests that a change of mindset is taking shape. It shows a growing recognition that biodiversity should not be treated as an optional extra but as an element to be built into the structure of city projects.

Across the interviews, a common best practice was learning from other cities and adapting successful ideas. Though not an implemented project per se, each official expressed interest in networking. Florence's interviewee explicitly said they try to "*hear what others are doing*" and suggested more inter-city exchange. Palermo's extensive networking through EU projects and Genoa's networking via its Consulta (which brings in national organisations like WWF, Legambiente, etc., with broader reach) are vehicles for transferring best practices. In Florence, the influence of external expertise (like Professor Mancuso's ideas on urban forestry) can be seen as importing best practices from academic research into municipal practice, highlighting in this openness a positive trend.

Also, in terms of measures, the three cities have implemented a variety of successful measures:

- Florence has improved everyday practices (eliminating pesticides, experimenting with adaptive management of green spaces) and engaged in pilot projects linking biodiversity with climate goals;
- Genoa has instituted consultative processes and planning instruments that incorporate biodiversity into urban and peri-urban management;
- and Palermo stands out for undertaking ambitious ecological restoration and innovation projects through multi-stakeholder partnerships.

These best practices, while context-specific, illustrate effective strategies such as working with nature (not against it) in maintenance regimes, leveraging external expertise and funding for experimentation, and tackling large-scale restoration by mobilising wide support. They provide hopeful examples that, even in challenging urban settings, biodiversity can be preserved and enhanced with the right approaches.

8.5.4 Stakeholder engagement and collaboration

Engaging stakeholders beyond the municipal administration is seen as crucial by all three interviewees, and each city offers a distinct model of collaboration with citizens, experts, and organisations. Such stakeholder engagement ranges from formal advisory councils to grassroots citizen initiatives, and it has been one of the more successful aspects of their urban biodiversity efforts.

- Genoa's Green Council/Consulta del Verde is a flagship example of institutionalised stakeholder collaboration. As described by the Genoa official, it is "*an advisory body born from the municipal regulation on public and private green spaces, which the administration makes use of*" (C.2); it is notably broad in composition and "*quite active*", bringing together environmental NGOs, professional associations, academia, and even other government entities. "*Associations, professional orders – the college of agrarian experts, the order of agronomists and foresters – as well as trade associations like CIA, Coldiretti, Confagricoltura… basically important stakeholders… and the Liguria Region*" all participate in the Green Council (C.2). Major conservation groups such as WWF, Legambiente and Italia Nostra are members alongside local civic associations. This diverse "*network of interested parties*" serves as "*an interface of civil society with the public administration*" on specific green and biodiversity issues (C.2). In practice, the municipality presents its plans and projects to the Council for discussion and non-binding feedback. The Genoa interviewee stressed that while the Council's opinions are advisory (not legally binding), they carry cultural and political weight, namely they reflect public and expert expectations that the city cannot ignore. The existence of the Green Council has improved transparency and trust, allowing external stakeholders to have early input, heading off potential conflicts (for example, around tree removal or park designs) and harnessing collective expertise. As a collaboration model, Genoa's Green Council is quite advanced in Italy, and the interviewee seemed proud of its role in shaping greener policies collaboratively. For sure it exemplifies multi-stakeholder governance, where city officials and civil society co-create solutions together, a clear best practice in engagement.

- Palermo on its side, has pursued stakeholder engagement through the creation of thematic forums and direct partnerships with community groups. The Palermo official detailed that the city "*had launched a large communication portal where all stakeholders and associations are*"

registered" (C.3) to facilitate ongoing dialogue. Within this framework, they initiated forums such as the *Contratto di Fiume* (River Contract forum) and a coastal forum, which bring together all actors concerned with specific ecosystems – *"the forum is the ensemble of all the associations that work on coastal biodiversity regeneration"* – under the coordination of the city's department (C.3). She noted *"the forum is active. The secretariat has been established within [our] department"* (C.3), ensuring continuous interaction. What makes this approach stand out is that the city has effectively formed an alliance with local environmental associations, that from their side have their own networks and communication channels, which means information and initiatives diffuse outward through civil society. According to the interviewee, *"the associations themselves continuously animate the territory"* (C.3) – organising clean-ups, educational events, monitoring, etc. – with the city playing a supporting and coordinating role. In addition to these ecosystem-based forums, Palermo also maintains a *"Forum del Verde"* (Green Forum) similar in spirit to Genoa's Consulta, with regular dialogue on urban green matters.

A particularly noteworthy aspect of Palermo's stakeholder engagement is the openness to citizen-led proposals. The official gave an example that from direct dialogue with associations and citizens, *"two projects emerged that we hope to be able to submit [for funding]"* (C.3). One project idea came from a university thesis by a citizen, and it was a "gift" from associations – specifically, plans for two green corridors or "sentieri verdi" (green trails). Palermo's team embraced these external ideas, requested the proponents to elaborate them, and is now seeking funding to implement them. This illustrates a high level of co-production, where citizen initiatives are not only welcomed but integrated into the city's portfolio of projects. It also shows Palermo's flexibility and community trust – recognizing that good ideas can come from outside City Hall. Such direct collaboration ensures that biodiversity actions have public buy-in and often volunteer support, which can improve their success and longevity.

- Florence has been comparatively slower to develop structured stakeholder engagement specific to biodiversity, but it has started some initiatives. The interviewee mentioned "Firenze per il Clima" (Florence for the Climate), a participatory process held in the previous administration (around 2021) that for the first time engaged different

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segments of the public in discussing climate and environmental actions. She participated in a table on her area of competence (urban green) during that process. While that initiative was broader than biodiversity alone, it included nature-based themes and can be seen as a steppingstone towards involving citizens in biodiversity planning. Within the municipal organisation, Florence has an Office of Sustainability (recently renamed) dedicated to citizen relations and engagement on sustainability issues (C.1). Through that office, Florence runs programmes like "Dona un albero" ("Donate a Tree"), "*in which a citizen can contribute to the purchase [of a tree] …with a personalised message attached*" (C.1). This initiative encourages residents to sponsor new urban trees, directly involving individuals in expanding the city's urban forest while raising both funds for planting and awareness, as donors become more invested in the wellbeing of "their" trees; although relatively modest, Donate a Tree has proved popular and stands as an example of public–private cooperation at the micro level, yet the Florence interviewee noted that such engagement efforts are only one part of the Sustainability Office's duties, an office that "*does not only do this, it does many other things*", thus implying that citizen involvement remains a developing area.

On collaboration with NGOs and other external institutions, Florence currently relies on case-by-case partnerships. The official mentioned informal contacts with the University's botanical garden and indicated interest in collaborating more with cultural institutions like museums on public education. These remain opportunities rather than established practices, whereas Genoa and Palermo have firmly institutionalised NGO involvement (through the Consulta and forums respectively) with Genoa's Green Council explicitly including NGOs and Palermo's forums functioning as coalitions of NGOs and community groups. Therefore, in terms of NGO–municipality cooperation, Genoa and Palermo offer strong examples, while Florence acknowledged room to grow, noting no formal partnership with environmental NGOs beyond consulting experts such as Prof. Mancuso.

Public–private partnerships (PPPs) in the sense of businesses working with the city on biodiversity were not prominently discussed, suggesting this is a less experienced area.

- Florence's interviewee did allude to instances of private sector support: she noted it "*happened that private companies sponsored [projects]...or donated [resources]*" according to sponsorship arrangements. For example, she recalled "*Toscana Energia and the American University of Florence*" each contributing to green initiatives (C.1). This indicates that Florence has received some corporate social responsibility contributions for urban greening (perhaps tree planting or park refurbishments), but however, these appear occasional.

- Genoa's official observed generally that private enterprises are often "*far from the world of research and development funding*" in green initiatives and need to be "*caught*" by universities to participate (C.2)– implying the city itself hasn't yet drawn local businesses into biodiversity projects.

- Palermo's engagement with the private sector seems minimal in this context; the interview focused on civil society, and the official even noted challenges in involving enterprises. For instance, in Palermo's Horizon project efforts, they found that companies "*do not see [value] in the general public good*" unless incentivised (C.3). Thus, across the board, public-private partnership in biodiversity is still nascent. The more fruitful collaborations have been with non-profit actors, academia, and citizens rather than companies.

Transnational and inter-city collaboration is another form of stakeholder engagement – where other cities and international organisations are the "stakeholders." Here, Palermo excels, with its involvement in EU networks and projects (Horizon, and likely the National Biodiversity Future Center initiative alluded to as a national "hub") that demonstrates active engagement beyond local boundaries. Genoa admitted it is not yet part of any international biodiversity network (the interviewee was unsure of any such memberships, C.2). Florence also is not currently in a dedicated biodiversity city network (the official could not name one and said she would check, C.1). However, Florence and Genoa do engage through more general channels (Eurocities, C40 for climate, etc., not mentioned in interview but plausible). All three expressed interest in more city-to-city learning, effectively treating peer cities as collaborators rather than competitors. Florence explicitly advised "talking more among municipalities" to improve outcomes (C.1). This points to a future direction of collaboration – forming city networks within Italy (and beyond) to exchange best practices on urban biodiversity (Palermo's hosting of a national meeting is a step in this direction).

Stakeholder engagement in these cities takes multiple forms: Genoa's institutional advisory council integrates expert and community voices into municipal decision-making; Palermo's network of forums empowers local organisations and citizens to drive and co-own biodiversity projects; and Florence is beginning to involve citizens through targeted initiatives and broader participatory processes. All approaches underline that urban biodiversity governance is not the task of city authorities alone – it benefits greatly from the enthusiasm, knowledge, and resources of the wider community. The interviews suggest that where stakeholders are actively engaged (as in Genoa and Palermo), initiatives gain legitimacy and momentum, whereas cities that engage less (as was historically the case In Florence) are now actively looking to catch up, recognising that collaboration and public involvement are key to success.

The cases reveal that stakeholder engagement is not an accessory dimension of urban biodiversity policy but one of its most generative forces.

→ Genoa's institutionalised advisory council demonstrates how structured dialogue can deepen transparency and pre-empt conflict.

→ Palermo shows that when civic networks are treated as partners rather than audiences, biodiversity initiatives gain social depth and continuity.

→ Florence illustrates that even in cities where engagement has historically been more episodic, emerging participatory practices can become the bridge through which ecological issues acquire public resonance and administrative priority.

8.5.5 Communication and public awareness

In the interviews, communicating the importance of urban biodiversity to the public and raising awareness emerged both as a priority and as a recurring challenge, since officials described the ways in which they attempt to share their efforts (and at times fail to do so) highlighting the gap that often exists between internal actions and public perception. They also reflected on the tools and channels available for outreach, ranging from traditional media to digital platforms and educational programmes, which together illustrate the complexity of building a shared understanding of biodiversity in the urban context.

A clear theme is the difficulty of communicating complex ecological issues to residents.

- The Florence interviewee was candid in acknowledging that: "*we realise that the communication of these things is very difficult and often insufficient*"

(C.1). She noted that biodiversity and environmental nuances often do not reach citizens effectively under current practices; she explained that communication tends to be "*very slow*" (C.1), so by the time information trickles out through official channels, misunderstandings may have already spread. For instance, in Florence's case, the decision to stop using herbicides led to more weeds in public spaces, but the rationale (biodiversity and health) was not widely conveyed at first. The official lamented that "*people have forgotten that for 7–8 years we haven't used herbicides*", implying that the public is unaware of the positive intention behind what they see as neglect. She believes that a more proactive communications strategy could "*flip in positive*" what appears to be a negative outcome by clearly explaining its environmental benefits; and this example demonstrates how insufficient communication can undermine public support for biodiversity-friendly practices, since citizens might simply see overgrown weeds and conclude the city is doing a poor job, whereas, in fact, it's an intentional ecological choice.

- Genoa's official similarly highlighted issues in public understanding, sharing a telling anecdote about misinformation and trees. He noted that often when the city needs to remove or prune a large tree for safety, external commentators (sometimes on social media or the press) circulate "*data not supported by facts*". For example, "*a large tree becomes a centuries-old tree [in public discourse] …where is it written that a big tree is centuries old? A 50-year-old tree can be very large but it's not centuries old*" (C.2). This confusion – equating size with ancient heritage – "*creates significant problems*" (C.2) for the city's management. Essentially, poor public knowledge about tree biology has led to outrage and protests whenever a mature tree is touched, with people claiming the city is destroying "secular" heritage even when that is not true. The Genoa official's frustration here underlines a communication failing, since the city has not effectively educated the public on how it manages urban trees or why certain interventions are necessary. As a result, narratives fill the void, often casting the administration as a villain cutting down priceless trees, which can stall or complicate legitimate management work. This scenario, likely playing out on local news or Facebook groups, suggests Genoa could benefit from a more robust public communication campaign about urban forestry (e.g., publishing tree risk assessments and explaining decisions in advance). Both Genoa and Florence examples show that reactive communication (trying to

clarify after controversy erupts) is much less effective than proactive, ongoing communication.

In terms of communication channels and strategies, none of the cities currently have a dedicated biodiversity communication team or strategy, but they utilise existing structures with varying success.

- Florence relies on the municipal press office and the political leadership (assessors) to disseminate information (C.1). As the interviewee explained, communication is "*handled at a political level*" with the Environment Councillor's office liaising with the central communication unit, so technical staff like her do not run social media or awareness campaigns directly and instead contribute only when there is something to announce. This arrangement tends to steer messaging toward political priorities and can leave smaller biodiversity updates in the background; while Florence does issue press releases on specific initiatives, such as the tree inventory or new park projects, there is no steady public-facing narrative on biodiversity, and the official acknowledged that "*we should do more*" on communication and outreach if resources permitted (C.1).

- Palermo's approach to communication is deeply entwined with its stakeholder engagement. Rather than separate mass campaigns, Palermo channels information through its network of associations and the aforementioned portal. The interviewee described that after creating the stakeholder portal, much of the dissemination happens via the associations in the forum: "*they have their own dissemination pipeline*" and the forum is "*centred*" as the hub of communication (C.3). In essence, Palermo's communication strategy is decentralised, empowering the NGOs and community groups with information and let them spread it to their members and the public. This has the advantage of credibility (people may trust community organisations more than government pronouncements) and reach (each association has an audience), even if it might miss those not involved with any group. For broader public awareness, Palermo's official also mentioned that her department covers environmental education programmes (C.3), covering activities in schools and communities to educate about biodiversity and sustainability. While details were sparse, it's clear Palermo invests in educating youth and citizens as a long-term communication strategy, building understanding and stewardship

values. She also hinted at events and campaigns, for instance, Palermo organised events with the euPOLIS project that were "*very important… where we did small lessons for our colleagues in the municipality*" and by extension Informed the public (C.3). So, Palermo's outreach is a mix of community-driven communication, formal education, and targeted events rather than continuous media messaging.

Digital tools and social media were surprisingly not emphasised by any interviewee, possibly indicating an area for improvement. When specifically asked each city about the use of social networks and digital platforms

- Florence declared not having a a dedicated social media presence for biodiversity, instead any content would go through the city's main social media or website.

- Genoa didn't detail any digital outreach; given the strong presence of the Consulta, much info might spread through those stakeholder networks or on the city website (Genoa's site has a section for green spaces where they publish documents, as the interviewee advised exploring the website structure).

- Palermo's portal is effectively a digital platform, but for registered stakeholders.

None mentioned using Facebook, Twitter, or Instagram actively for biodiversity awareness, nor any apps or interactive maps for citizens (tools some cities employ for tree mapping or reporting wildlife sightings, for instance). This suggests that traditional communication channels (meetings, press releases, stakeholder emails) are currently more in use than innovative digital outreach for this topic in these cities. That said, Palermo's integration of an online portal for stakeholders is a noteworthy digital element, even if it's not public facing in the way social media is.

An interesting point is the internal communication and knowledge dissemination, which Palermo touched on. Effective internal communication can indirectly improve public communication as a well-informed staff can become ambassadors to the public, and the Palermo official mentioned they conducted internal seminars (inviting partnership members to give "lessons" to municipal colleagues) to ensure everyone in the administration is up-to-date and speaking the same language on biodiversity initiatives. This internal awareness means that frontline staff (e.g., district officers, gardeners, educators) can better

communicate with citizens in their daily interactions, reinforcing official messages.

Finally, all three interviewees see public awareness as vital to success, recognizing that without public support, even the best policy will falter. Florence's official tied public appreciation of green spaces directly to the prevention of vandalism and misuse, arguing that when residents genuinely value urban nature they are less inclined to litter or damage it and more inclined to look after it. In Florence, concerns about parks being used in negative ways, such as accumulating trash or hosting inappropriate activities, are being addressed not only through rules or enforcement, but by actively encouraging more people to use these spaces in positive, everyday ways, on the assumption that a park filled with people enjoying nature is itself the strongest deterrent to misuse. This perspective shows that communication is not just about providing information, but also about nurturing an emotional connection between residents and urban biodiversity, even though the interviews suggest that this remains very much a work in progress. Municipal experts recognise that many citizens still have a limited awareness of biodiversity, often treating it as something abstract or separate from city life, and they therefore see stronger communication and engagement as essential to building a culture in which urban biodiversity is understood as a shared and lived value. Palermo's multi-pronged strategy, combining education, public forums, and other initiatives, offers one route toward that goal, and Florence has explicitly expressed its intention to move in a similar direction, even floating collaborations with cultural institutions as a way to reach wider and more diverse audiences (C.1).

Communication is a double-edged sword in these cases: when done well, it has led to community buy-in and avoided conflicts (Palermo's inclusive approach); when done poorly or not at all, it has resulted in public backlash or apathy (the weed and tree controversies in Florence and Genoa). The cities are learning that simply implementing biodiversity actions is not enough – those actions must be accompanied by clear, transparent communication and public education. Currently, much of the communication relies on conventional means and intermediary groups, with social media underutilised, so there is room for adopting more direct and modern communication tactics (e.g. interactive web portals for biodiversity, regular social media updates, signage in parks explaining biodiversity features). All interviewees agree that raising public awareness is essential, and their experiences make clear why messaging matters so much, because urban biodiversity initiatives tend to succeed or fail depending on whether citizens actually understand what is being done, see its value, and are willing to support it and take part in.

8.5.6 Future directions and aspirations

The interviews point to a broadly forward-looking attitude across all three cities, where officials are not only keen to continue their urban biodiversity work but to strengthen and scale it up. They spoke in concrete terms about what they hope to do next, policy priorities they want to push, new strategic directions they are considering, and the kinds of support or innovation they see as necessary to move faster and further. What comes through repeatedly is a sense that this agenda is still at an early stage, paired with a clear determination to expand efforts significantly over the coming years.

A prominent future direction concerns the expansion of collaboration and networking beyond the scale of the individual city. All three interviewees, without being prompted, insisted that cities cannot advance their biodiversity agendas in isolation, and that meaningful progress will depend on the ability to share experiences, confront similar challenges, and build forms of collective intelligence across municipal boundaries.

- The Florence technician was particularly explicit on this point. When asked what advice she would give to other administrations, she responded that the most important step would be "networking among us", noting that if cities spoke to one another with greater regularity and openness "*it would be a great thing*" (C.1). Her emphasis was not on occasional exchanges but on sustained dialogue, through which administrations can compare approaches, refine their methods and perhaps begin to coordinate their actions on a regional scale. She drew attention, for example, to the impossibility of planning ecological corridors within the tight perimeter of a single municipality, since such infrastructures, by definition, cut across administrative boundaries and demand forms of cooperation that remain largely underdeveloped.

- A similar sensibility emerges in Palermo, where official described her strategy in explicitly relational terms, explaining that "*from a strategic point of view, [is to] network – and with this first meeting we'll organise in Palermo… the network is already established*" (C.3). She explicitly mentioned networking with hubs and "*other cities*" as well as networking with the local territory as key to moving forward (C.3). This indicates an aspiration to break out of silos not just internally, but externally too, creating a community of practice among Italian cities on biodiversity.

- Genoa's interviewee, while less direct, agreed that horizontal and vertical coordination will be crucial. He concurred with the idea of both vertical

coordination (with higher levels of government) and horizontal coordination (with peer cities) being strengthened: when the Florence official suggested networking, he interjected that it needs to be "*both horizontal and vertical*" (C.2).

Thus, a future with more multi-level governance – e.g., metropolitan authorities, regional bodies, and municipalities all aligning their biodiversity policies – is envisaged. Practically, this might mean establishing formal networks or working groups, lobbying together for national support, and standardising approaches (for example, shared indicators or joint projects across cities). The interviews imply that such collaborative frameworks are not fully in place yet, but the desire for them is strong, and steps like Palermo's national NBS hub meeting are paving the way.

In terms of policy priorities, each city is gearing up to integrate biodiversity more firmly into urban planning and climate strategies.

- Florence's immediate priority is to adopt and implement its Green Plan, which set targets and actions (e.g., increasing native tree diversity, expanding green space connectivity) that the city must pursue. The interview suggests Florence is prioritising measurable gains in biodiversity; as the official explained, the administration embraced the idea of enhancing urban biodiversity early on and "*started it immediately*," because they were "*convinced it was an excellent idea*" (C.1). This proactive approach is likely to carry on, focusing on planting a wider mix of species, safeguarding existing natural assets, and making biodiversity a standard consideration across all urban projects.

- Genoa is moving in a similar direction, first by putting a clear strategic framework in place through its Green Plan and then using it as the basis for sustained action. The city will likely focus on catching up – for example, creating more green infrastructure in the dense city and better managing its protected areas – following the guidance of its new plan and the input from the Green Council.

- Palermo's policy priorities are somewhat more advanced and multi-faceted: implementing NbS, advancing its climate adaptation agenda (which overlaps with biodiversity through ecosystem-based adaptation), and continuing the rehabilitation of key sites (river, coast, urban parks). Palermo's official is also concerned with measuring and demonstrating success – she is keen on putting in place indicators and monitoring (evident in the Horizon project work). So, a priority for Palermo is to

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develop a robust monitoring and evaluation system for biodiversity (so that they can track improvements in, say, species richness or ecosystem health over time).

One future aspiration common to all the cities is securing long-term funding and resources for biodiversity initiatives. While this was expressed in the context of challenges, it is also a forward-looking goal since allow to move from opportunistic funding to stable programmes. The interviewees hope for more support from higher levels (national or EU) and perhaps to institutionalise some budget for biodiversity in their municipalities. For instance, one can foresee that Florence with the IRIS plan in place will lobby for a budget each year to implement it. Genoa might seek regional or EU development funds to realise parts of its plan. Palermo will likely continue to aggressively pursue external funds (as it has already done) but also possibly integrate biodiversity actions into broader urban development funding (mainstreaming into budgets for public works, etc.). None of the interviewees said this in a definitive way, but the subtext is that financial sustainability of biodiversity efforts is on their wish list. In Florence's ideal scenario (the interviewer prompted "*ideally, with money no object, what would you do*"), the official spoke about the city needing to "*regain credibility*" and generate attention for these issues, which suggests that if they had more funds, they would invest in higher-profile, larger-scale projects that could capture public imagination (and thereby attract more funding – a virtuous cycle).

Innovation and the use of technology also feature in the cities' future, albeit implicitly. Florence already has a comprehensive tree inventory database, and the official noted they keep a close eye on species composition and have data on biodiversity within city trees. Building on that, Florence could implement new tech like GIS mapping of green corridors, or digital tools for biodiversity monitoring (e.g., apps for crowdsourcing sightings). Genoa's approach might be using technology for managing its extensive natural areas (remote sensing to monitor land cover changes, for example) or deploying sensors in parks to assess ecosystem services benefits from new projects. Palermo, through its Horizon project, is at the forefront of innovation, testing citizen science and smart monitoring (they mentioned using streaming and remote participation in events and measuring Impacts with citizens). Palermo's future likely holds more such tech-enabled participation – perhaps mobile apps for citizens to report on biodiversity or Interactive maps linking to their portal. Additionally, NbS are a clear future pathway for Palermo and, by influence, for the others. Palermo's involvement in NBS is prompting it to update regulations (the interviewee noted that incorporating NBS is "*one of the themes of norms and rules*" they are working

on, C.3). In coming years, we can expect updated building codes or urban plans in these cities that encourage green roofs, permeable surfaces, wildlife-friendly design, etc., embedding new technologies and designs (like green walls, IoT sensors for environmental monitoring) into the urban fabric for biodiversity gain.

Another aspiration is expanding public engagement and education, essentially scaling up what has worked in stakeholder involvement and communication. Florence aims to establish more continuous citizen participation channels (the interviewee acknowledged the value of the one-off "Firenze per il Clima" process and hinted it should be repeated or built upon). Genoa will likely strengthen its Green Council and perhaps initiate outreach programmes under its Green Plan to involve neighbourhoods in planting or caretaking green spots. Palermo plans to maintain its forums as living Institutions and perhaps Inspire other cities to replicate them. All three see educating the next generation as crucial, so we might see enriched school programmes, partnerships with universities (e.g., urban ecology courses that involve municipal projects), and events like urban biodiversity days, exhibitions or festivals to raise the profile of the topic.

Finally, the interviews suggest a future shift in mindset that will allow to see urban biodiversity as a fundamental urban asset on par with other infrastructure. This was not explicitly stated, but it underpins their aspirations. The Florence official's statement that the administration needs to "*regain credibility*" and get people's attention on these initiatives points to a desire to make biodiversity a mainstream concern that the city is respected for addressing. The ultimate success for them would be when protecting and enhancing biodiversity is a routine part of city planning, ingrained in institutional culture and supported by the public, essentially, when it's no longer a niche issue but part of what defines a "*good city*". Achieving that will involve better governance frameworks, overcoming barriers, scaling best practices, engaging stakeholders, communicating effectively, and innovating.

The interviews end on a broadly optimistic note. Officials feel that this path is realistic, especially because cooperation across cities is already starting to take shape, as shown by the wider project within which these interviews took place. Their plans also fit with larger national and European agendas, such as Italy's National Biodiversity Future Center and EU biodiversity policies, which they expect to draw on for support and legitimacy. Overall, the direction is to move toward more joined-up, collaborative, and better-resourced governance for urban biodiversity, so that Florence, Genoa, and Palermo can steadily become greener

and more biodiverse cities. The foundations are there; the next step is to build on them in a more consistent and systematic way.

8.6. Discussion on findings

The findings from the analysis of municipal experts in Florence, Palermo, and Genoa reveal a complex but interconnected landscape of urban biodiversity governance, marked by both structural limitations and emerging opportunities. Across the three cities, biodiversity management is gaining institutional recognition, yet it remains challenged by fragmentation, limited resources, and a need for stronger integration into urban policies. Experts broadly agree that biodiversity should not be treated as an isolated environmental concern but rather as a cross-cutting issue requiring holistic governance, long-term financial planning, and active public engagement.

One of the most recurrent themes in the interviews is the

→ difficulty of implementing biodiversity strategies within municipal frameworks that are not fully prepared to accommodate them. While Florence and Genoa have recently initiated the development of dedicated Green Plans, Palermo has taken a different approach, embedding biodiversity considerations within broader environmental policies. This variation reflects different governance models, yet all three cities face similar obstacles in ensuring that biodiversity commitments translate into concrete and lasting actions. A significant barrier is the structural fragmentation within municipal administrations, where responsibilities related to green spaces, land-use planning, and environmental protection are often spread across different departments with limited coordination. This lack of integration slows down decision-making processes and results in inefficiencies that hinder the implementation of biodiversity policies. As one expert noted, ecological processes do not adhere to administrative boundaries, meaning that effective urban biodiversity management requires not only Internal coordination but also collaboration at the metropolitan and regional levels.

One persistent challenge is the

→ reliance on external funding, particularly from European programmes such as Horizon Europe. While these funds have facilitated ambitious biodiversity projects, they also create uncertainty regarding the long-

term sustainability of initiatives. Without dedicated municipal budgets for biodiversity, efforts often remain tied to the lifespan of specific grants, limiting their potential to produce structural change. Some cities have attempted to overcome this by linking biodiversity projects to broader climate adaptation strategies, thereby accessing more stable funding streams. However, financial constraints continue to be a major concern, with experts stressing the need for institutionalising biodiversity funding within municipal financial frameworks.

Beyond governance and financial barriers, a key difficulty identified in the interviews is the

→ challenge of communicating biodiversity's importance to the general public. In many cases, biodiversity policies face resistance or indifference from citizens due to a lack of awareness about their relevance to everyday urban life. For example, Genoa has encountered public scepticism regarding tree management decisions, while Florence has struggled with misconceptions around Its policies to reduce pesticide use. These instances highlight the necessity of proactive and targeted communication strategies that make biodiversity concerns tangible and relatable for residents. Experts emphasised that improving public understanding of biodiversity requires moving beyond technical language and connecting the Issue to broader societal values, such as public health, cultural identity, and climate resilience.

Despite these challenges, the interviews also point to promising developments and best practices that can serve as models for other cities. Florence's experimentation with pesticide-free green space management and Genoa's participatory Green Council illustrate how municipal administrations can engage communities in biodiversity governance, while Palermo, meanwhile, has made strides in urban ecological restoration, particularly in coastal and riverine environments, demonstrating how biodiversity initiatives can be integrated into urban resilience strategies. These examples suggest that while the road to effective biodiversity governance Is complex, progress Is being made through a combination of policy innovation, institutional adaptation, and citizen Involvement.

→ Stakeholder collaboration emerges as a critical factor shaping urban biodiversity policies. In all three cities, universities, NGOs, and local communities play an important role in filling gaps left by municipal administrations. Partnerships with research institutions have been

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particularly beneficial in bringing scientific expertise into policy design, ensuring that biodiversity strategies are based on ecological evidence. For example, some cities have involved university students in biodiversity monitoring projects, generating valuable data while also fostering public engagement. However, collaboration with the private sector remains relatively underdeveloped. Unlike other sustainability domains, where businesses are increasingly involved in green initiatives, biodiversity conservation efforts in these cities are still largely led by public Institutions and civil society. Experts noted that expanding public-private partnerships could provide additional resources and accelerate the Implementation of NbS, such as green roofs, permeable surfaces, and biodiversity-friendly urban planning regulations.

Looking ahead, the findings suggest that advancing urban biodiversity governance will require a multi-dimensional approach that addresses both structural and cultural barriers. The expert interviews suggest the following interconnected directions:

(I) Strengthening institutional and planning frameworks

- → Embed biodiversity systematically within all urban planning instruments, rather than isolating it in sectoral environmental documents.
- → Reform bureaucratic processes to improve flexibility, reduce delays, and enable effective interdepartmental cooperation.
- → Align municipal, metropolitan and regional frameworks to mitigate fragmentation and achieve ecological continuity across administrative boundaries.

(II) Securing long-term and stable financing

- → Move beyond reliance on short-cycle, project-based funding, especially EU competitive programmes, which currently drive most initiatives.
- → Develop internal, multi-year municipal funding streams dedicated to biodiversity and NbS.
- → Integrate biodiversity objectives into broader climate, mobility and public-works budgets to ensure financial durability.

(III) Reinforcing communication, awareness and public engagement

→ Improve the visibility and clarity of biodiversity policies in public discourse, countering misconceptions and "controversies of perception" around practices such as tree management or pesticide-free maintenance.

→ Expand participatory environmental education, citizen science, school-based monitoring, community-led greening, as a means of cultivating shared responsibility for urban ecosystems.

→ Build sustained communication strategies rather than episodic announcements, ensuring that ecological choices are understood before becoming points of contention.

(IV) Learning across cities and scaling best practices

→ Draw systematically on successful governance models within and beyond Italy to adapt tested approaches in planning, ecological restoration and stakeholder governance.

→ Strengthen participation in international networks and inter-city platforms, using them as mechanisms for knowledge exchange, policy learning and upscaling of NbS.

→ Ensure that lessons learned are operationalised locally, recognising that network membership alone does not guarantee institutional transformation.

(V) Building a collaborative, multi-actor governance ecosystem

→ Mobilise municipal authorities, academic institutions, civil society organisations and, where possible, the private sector into coordinated biodiversity coalitions.

→ Address existing capacity gaps by fostering expert–practitioner partnerships and expanding technical competencies within municipal structures.

→ Promote governance cultures that regard urban biodiversity as essential infrastructure, rather than an accessory element of environmental policy.

Overall, the expert interviews reflect a growing recognition that urban biodiversity is a fundamental component of sustainable city planning. However, the transition from recognition to action is not easy and remains uneven, with

significant gaps in governance, funding, technical capacity, and public engagement. Addressing these challenges will require a concerted effort from multiple stakeholders, including municipal authorities, research institutions, civil society, and the private sector.

The following figure distils the findings from the three cities into a synoptic scheme that show the pathway from structural constraints to transformative capacities. What emerges is that the urban biodiversity gap is not mainly the product of one-off technical deficits, but of a deeper mismatch between the problems that are visible on the ground, the institutional capacities that are actually in place, and the policy arenas where action tends to concentrate. What follows is fairly straightforward, even if demanding in practice. A credible transition requires progress on several fronts at once, including planning frameworks, stable resources, professional and administrative know-how, and ongoing civic engagement. If these moves do not advance together, biodiversity initiatives are likely to stay scattered and short-lived, shaped more by project cycles than by a sustained governance shift.

Challenges

– Fragmented administrative responsibilities

– Limited specialised technical capacity

– Dependence on external funding

– Project-based implementation cycles

– Weak inter-municipal ecological coordination

– Legacy environmental degradation (e.g., polluted rivers, degraded coasts)

– Low public awareness and communication gaps

Trasformative levers

– Emerging strategic planning (Green Plans, NBS frameworks)

– Scientific partnerships and evidence-based monitoring

– Stakeholder governance (Green Council; River/Coastal Forums)

– Pilot projects and experimentation (NBS, adaptive maintenance)

– Citizen contributions (tree donations, community proposals)

– Inter-city networking and horizontal learning

– Narrative reframing of 'nature in the city'

Policy fields

– Urban planning and land-use regulation

– Green space management and maintenance regimes

– River and coastal ecological restoration

– Peri-urban forest management

– Climate adaptation and heat-island mitigation

– Environmental education and awareness programmes

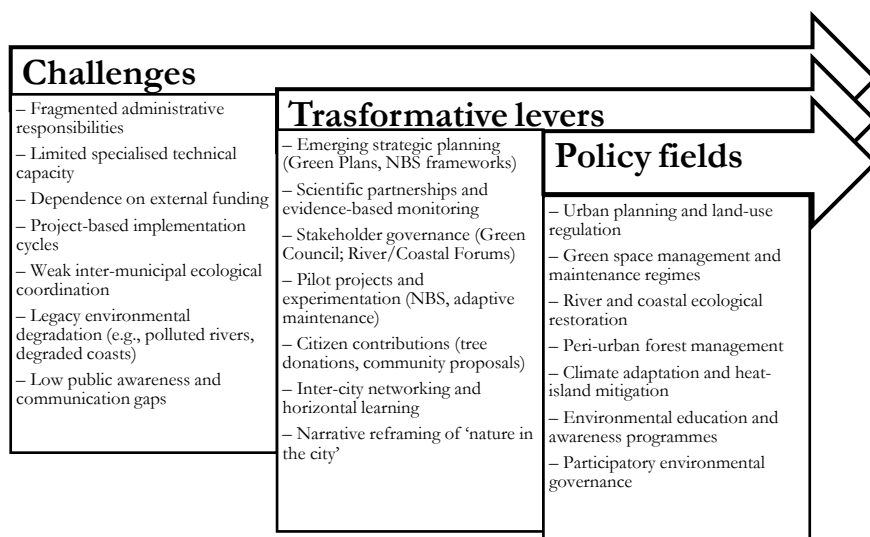– Participatory environmental governance

Figure 5 The conceptual figure summarises how the interviews articulate the relationships between challenges, levers and policy

Chapter 9

Beyond Italy: Tirana Biodiversity Path

Monica Bernardi and Pablo Gómez-Iniesta

9.1 City context

Tirana is the capital and most populous city of Albania, located in the centre of the country within a broad valley framed by hills and mountains, with Mount Dajti rising to the east and the Adriatic coastal plain extending to the northwest (see Image 5). The city experiences a humid Mediterranean climate and is among the sunniest yet most humid cities in Europe, with around 2,544 hours of sunshine per year (Euronews, 2023). Administratively, the municipality includes both the urban core and surrounding rural areas. As of 2023, Tirana hosts nearly 600,000 residents, while its metropolitan area reaches around one million people, accounting for one-third of Albania's population (ATA, 2024). Rapid post-1991 urbanisation has reinforced its role as the country's leading economic hub, concentrating 44% of national economic activity and recording a per capita income 134% above the national average (Euronews Albania, 2023).

Figure 6 Location of Tirana in central Albania. Created by the authors using MapChart.

Nevertheless, urbanisation has been rapid and only partially regulated; the collapse of the socialist regime triggered rural-urban migration, expansion of informal settlements on former agricultural land and a proliferation of small private buildings along the main transport corridors radiating from the city (Dino et al., 2019). Much of this growth occurred before a stable planning framework was in place and left a legacy of fragmented land tenure, irregular street patterns and congested urban infrastructure. The result is that today Tirana functions as the country's administrative and economic hub, but also as an archetypal post-socialist metropolis in which accelerated transition has translated into pronounced spatial and environmental inequalities. As several critical urban observers have noted, this accelerated transition has also facilitated a model of development where private actors gained substantial influence over land use and spatial restructuring, with limited public oversight and weak regulatory safeguards (Gainsforth, 2025). This trajectory has produced a city where rapid modernisation coexists with the erosion of spatial commons and the marginalisation of ecological concerns.

Environmental indicators also reflect this tension between dynamism and vulnerability. The 2018 Tirana Green City Action Plan (now expired) prepared with the EBRD identifies air pollution, car-dependent mobility, insufficient wastewater treatment and flood risk along the Lana and Tirana rivers as key pressures that directly affect urban liveability and ecological quality (EBRD & Municipality of Tirana, 2018). Earlier monitoring showed that concentrations of nitrogen dioxide in central areas regularly exceeded European Union limit values and that levels of PM10 and PM2.5 were significantly higher than recommended thresholds, particularly during winter inversion events (Co-PLAN & GreenAL, 2025). Road traffic, the dominance of private vehicles and the continued use of wood and fossil fuels for domestic heating contribute to these episodes of poor air quality. At the same time, the absence of full wastewater treatment means that stretches of the Lana and Tirana rivers still act as open collectors for urban effluents, with implications for downstream ecosystems and coastal waters (EBRD & Municipality of Tirana, 2018). Analyses such as those by Tozzi (2025a, 2025b) emphasise that these environmental pressures are not merely technical deficits but symptoms of a governance model centred on spectacular redevelopment and accelerated growth, in which long-term ecological infrastructures have historically received little investment.

Land-use patterns further illustrate the constraints on urban nature. Satellite analyses summarised in the Green City Action Plan (GCAP) show a steady loss of agricultural and peri-urban green land in the Tirana plain and a significant increase in sealed surfaces since the 1990s (EBRD & Municipality of Tirana,

2018). Accessible public green space within the urban area remains limited, with an estime of of approximately 2.6 m² of publicly accessible green space per inhabitant, a figure well below World Health Organization recommendations and markedly lower than the average of many European capitals (Ibid). Recent construction booms in central and peri-central districts, oriented towards high-rise residential and commercial development, risk further compressing the land available for ecological infrastructure unless counterbalanced by strong planning controls. Critics note that this densification is often justified through a narrative of "European-style modernisation", yet in practice it has reinforced land take and reduced public space, while the promise of new green areas is frequently deferred into future-oriented imaginaries of metropolitan greening that celebrate grand ecological visions without guaranteeing the material conditions required for ecological functioning (Gainsforth, 2025; Tozzi, 2025a, 2025b).

Yet Tirana's metropolitan setting also offers significant ecological assets, such as the eastern Dajti National Park and the Mali me Gropa–Bizë-Martanesh protected landscape, which together host a rich assemblage of forest, shrub and alpine habitats and function as major refugia for birds, mammals and endemic plant species (NAPA, 2022). Within the municipal boundary, the Grand Park around the Artificial Lake, the restored Lake Farka and Lake Kashar landscapes, riparian corridors along the Lana and Tirana rivers and residual agricultural areas preserve patches of semi-natural vegetation and agro-biodiversity. Surveys in the Grand Park and adjacent hills document diverse bird communities and amphibian populations, indicating that even heavily urbanised settings can retain non-trivial ecological value when continuous or semi-continuous green corridors are maintained (NAPA, 2019; Municipality of Tirana, 2022).

In recent years the municipality has experimented with large-scale greening initiatives that explicitly link climate adaptation, public space and biodiversity. The Orbital Forest project, introduced in the Tirana General Local Plan and promoted internationally as a flagship intervention, envisages a green belt of parks, forests and agricultural land encircling the city, with the long-term goal of planting up to two million trees and reconnecting some 14,000 hectares of green areas and productive landscapes (European Sustainable Cities Platform, 2018; Stefano Boeri Architetti, 2018). National audits, indicate that its implementation has lagged behind initial ambitions, with only tens of thousands of trees planted by the early 2020s and limited monitoring of their survival rate (Albanian Supreme State Audit, 2023). This gap between visionary narrative and on-the-ground delivery echoes broader concerns raised by activists and experts regarding the pace and quality of urban greening in Tirana.

Overall, Tirana appears as a city defined by a dual environmental trajectory. On one side it concentrates population, capital and political attention, projects an image of innovation and experimentation and has begun to articulate an ambitious discourse on green transformation. On the other side persistent air-quality problems, limited and unevenly distributed green space, incomplete water and waste infrastructures and strong development pressures constrain its capacity to protect and regenerate biodiversity.

Table 6 Tirana case study – city profile	
City Positioning	• Member of the Open Government Partnership, signalling international commitment to transparency and citizen participation (OGP, 2020). • Increasing visibility through European Youth Capital 2022, enhancing its profile as an innovative and civic-oriented city. • Active in climate-related parternships through vulnerability assessments and adaption plans supported by international agencies (UNFCCC). • Strengthening global presence as a fast-transforming Mediterranean capital engaged in urban greening and resilience projects.
Governance	• Mayor–Council system with strong executive leadership and a 55-member Municipal Council (OGP, 2020). • Municipal responsibilities include planning, transport, community services, and environmental management (Cooperation and Development Institute, 2022). • Close coordination with national institutions due to Tirana's capital-city status. • Member of the Open Government Partnership (OGP), promoting transparency, digital participation, and co-creation. • International recognition through initiatives such as European Youth Capital 2022.
Climate Justice	• Increasing exposure to heatwaves and intense rainfall, with recurrent flooding when rainfall exceeds sewer capacity (Observatori, 2024). • Vulnerable neighbourhoods along the Lana River historically had <15% green space and poor air circulation, exacerbating heat and flood risk (GIZ, 2015). • Early adoption of climate vulnerability assessments and an adaptation action plan at city level (UNFCCC).

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	• Green and blue infrastructure interventions—such as Lana River restoration and creation of buffer-zone parks—support flood mitigation (UNFCCC).
	• Urban tree planting and new green spaces help counter the heat island effect (UNFCCC)
People Engagement	• Community centres provide services and cultural programming for vulnerable groups such as youth, women, seniors, and persons with disabilities (OGP, 2020).
	• Participatory budgeting in neighbourhood units allows residents to vote on small local investments (OGP, 2020).
	• Co-creation approaches were strengthened under the 2021–2023 OGP Action Plan with consultations involving youth and marginalized groups (OGP, 2020).
	• Public open-air meetings such as "Open Terrace" foster dialogue and feedback between citizens and municipal authorities (OGP, 2020).
	• Some groups still report low awareness of services and concerns over transparency, highlighting participation gaps (OGP, 2020).
Planet	• Rapid urban expansion after the 1990s contributed to pollution and loss of natural areas (UN-Habitat, 2016).
	• Air pollution frequently exceeded recommended limits in high-traffic areas until recent mitigation measures (UNFCCC).
	• Monthly Car-Free Day events reduce smog and noise levels in the city centre (Euronews Albania, 2022).
	• Historically poor waste management resulted in informal dumpsites now undergoing remediation (UNFCCC).
	• Key ecological lungs include the Grand Park and Artificial Lake, complemented by over 2,000 recently planted urban trees (UNFCCC).
	• The "Tirana 2030" plan promotes a green belt, controlled vertical growth, and expanded public space (Boeri, 2023).
Prosperity	• Economic center of Albania with rapid infrastructure upgrades (The Guardian, 2019).
	• Persistent socio-spatial inequalities.
	• Public transit relies heavily on buses (no metro).
	• Strong cultural, educational, and creative sectors growing.
	• Increasing attractiveness as a European cultural hub (Cooperation and Development Institute, 2022).

9.2 Preliminary considerations

To gain a comprehensive understanding of the state of urban biodiversity in Tirana, interviews were conducted with experts and public administration officials involved in biodiversity governance and urban planning which provided first-hand insights into the opportunities and challenges of integrating biodiversity into the city's development framework. The interviewees included academics, environmental consultants, municipal officers, and urban planners, ensuring a diverse range of perspectives on the institutional, social, and ecological dimensions of biodiversity management. Additionally, representatives from local government agencies offered crucial perspectives on policy implementation, regulatory frameworks, and the extent to which biodiversity considerations are embedded in urban decision-making processes.

To ensure confidentiality, all interviewees have been anonymised and are identified as T.1, T.2, T.3, and so forth. These experts represent a diverse range of backgrounds, including municipal governance, environmental consultancy, and academic research.

- T.1: Municipal officer in charge of environment and sustainable development
- T.2: Professor in Natural Sciences with expertise in biodiversity research
- T.3: Professor in urban sustainability and environmental governance from a private university
- T.4: Environmental anthropologist and executive director of a national NGO for biodiversity protection
- T.5: Researcher and project manager at an institute for habitat development
- T.6: Executive director of an urban research institute with expertise in urban planning and development

9.3 Key themes
9.3.1 Governance and urban planning

All experts agreed that biodiversity has not been effectively mainstreamed into Tirana's urban planning processes; it is simply not treated as a priority by city authorities, who often do not even understand the concept in an urban context. As one expert put it, "*the notion of biodiversity… is not integrated at all within the*

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planning of the municipality", and any benefits to nature occur only as a "*side effect*" of maintaining green areas rather than as intentional policy. According to T.1, city officials tend to equate biodiversity with basic greenery; he noted that the moment one talks about biodiversity "*you might get some blank looks*" – the authorities see urban spaces only as "*green spaces with native trees*" and hardly consider wildlife or ecosystem services.

This dismissal of biodiversity in planning reflects a governance gap also identified in other cities, where local biodiversity is often overlooked in development decisions. In Tirana, the low institutional emphasis on biodiversity is compounded by a lack of clear environmental mandates and coordination. The NGO representative from T.2, highlighted bureaucratic inertia and poor transparency as major obstacles, stating "*they should put everything online for us to see… but instead they don't… if we try to ask… they do not reply at all. This Is lack of communication, besides lack of transparency*". This opaque governance climate undermines public accountability for biodiversity protection and was cited by experts as a reason biodiversity consideration "*stay on paper*" within plans rather than being implemented.

Indeed, while Tirana's General Local Plan (Tirana 2030) and the 2018 Green City Action Plan – now expired – include sustainability principles on paper, experts observe a persistent gap between policy and practice in the city's planning institutions. According to T5, the first document includes a vision of a "Metrobosco" and a system of green and blue corridors, but these elements are weakly operationalised and rarely translated into financed projects; in general, the plan "*lacks coherence*" when applied to concrete development decisions. The second document contained several strategic actions linked to biodiversity (such as pocket parks, the Metrobosco afforestation belt and ecological corridors), but it remains unclear which of these actions have been implemented in practice.

A recurrent theme was the tension between rapid urban development and the conservation of green areas. Tirana's post-1990 urban boom – much of it informal or weakly regulated – has led to unchecked sprawl and habitat loss on the city's fringes. "*City growth has been rapid and unplanned, leading to the loss of green areas and natural habitats within the urban environment,*" explained T.4. Within the city, public lands that could have been used for parks or community greenspace have instead been allocated to private development. As T.1 lamented, "*public lands… are being given to companies for basically building apartment buildings [and] hotels… very bad and very dangerous*". He and others described cases of former public open spaces or even ex-industrial brownfields being

entirely built over without reserving any land for parks, despite policy stating that redevelopment should include green space. This reflects a wider challenge of enforcement – even when sustainable urban plans or regulations exist, they are often "*infringed*" or ignored in practice by both local and central authorities in pursuit of short-term economic gains (e.g., permits for high-rise construction that exceed the city's own planning limits).

The experts' accounts align with documented patterns within Tirana's recent growth: for example, uncontrolled urban sprawl has been recognized as a key threat to the city's environment, driving "*destruction of the natural environment*" on the outskirts. The interviews suggest that weak governance – characterised by ad-hoc decision-making and lack of transparency – has allowed development to override ecological considerations. In addition, T5 stressed that the municipality lacks a dedicated unit for urban biodiversity. Responsibilities fall primarily on the Agency of Parks and Recreation (APR), whose mandate focuses on recreation, maintenance and forest management rather than on biodiversity conservation in the urban fabric. T.5 further highlighted that the General Directorate of Environment and Sustainable Development is mainly engaged in awareness-raising and cleaning campaigns, without playing a strategic role in biodiversity governance. Finally, T.5 pointed out that Tirana is not part of international networks specifically dedicated to biodiversity or environmental protection; instead, it participates in networks such as the Network of Youth Capitals and "Balkan 40 Cities", which only indirectly relate to environmental issues.

This governance shortfall underlies many of the other themes identified, from the loss of green space to poor public awareness, indicating that strengthening institutional commitment and accountability is pivotal to improving urban biodiversity outcomes.

9.3.2. Green spaces and Urban Biodiversity

The rapid urban expansion has drastically reduced the quantity and connectivity of green areas in Tirana. Several experts noted that aside from two historic parks – the Grand Park at the Artificial Lake and the small Youth Park – the city has created virtually no significant new parks since the 1990s. T.1 observed that Tirana still relies on "*the same parks that [it] used to have at the beginning of the '90s", with very few new additions, so the overall green space per resident Is now "one of the lowest… in the whole of Europe*".

Official data support this, the ratio of open green space in Tirana is only about 4.6 hectares per 100,000 inhabitants (EBRD & Municipality of Tirana, 2018, p.

63) – indicating a severe lack of parks and greenery accessible to the population. The little new green space that has been added tends to be peripheral (e.g., at the city edges or in surrounding hills) and not easily accessible for daily use. Meanwhile, construction has encroached on or replaced many plots that could have served as neighbourhood green oases. This has led to a fragmentation of habitats within the urban area, with remaining green spots isolated amid dense development. T.4 gave a striking example concerning wildlife: as old low-rise neighbourhoods and even derelict sites have been redeveloped, roosting sites for bats and birds have been lost. Traditional houses and unused structures that "*were hosting not only bats, but also birds of prey… we are aware that we are losing some of them because of the new construction techniques that are not friendly*", he explained – modern buildings leave no crevices or niches for urban fauna (T.4).

This kind of habitat loss within the city illustrates how reduced green space and aggressive construction combine to diminish urban biodiversity. The experts frequently connected this issue back to urban planning, considering that without deliberate planning intervention, open spaces have been steadily converted to concrete. One interviewee mentioned an attempt to create a new park on a former airfield, but noted wryly that it ended up "*more like a concrete area rather than a park… most of the concrete was laid over and some trees were planted*" (T.1), undermining its ecological value. Such outcomes underscore the need for stronger planning protections for green sites, as unplanned growth continues to nibble away at Tirana's already sparse green network.

Beyond the quantity of green space, experts stressed that the ecological quality of existing parks and greenery is poor. Many urban green spaces in Tirana are designed and managed with an ornamental or recreational mindset rather than for biodiversity. According to T.4, "*sometimes they plant exotic species… that do not provide any habitat for native fauna. You have green areas but not functional [ecological] connections*". In other words, the city may boast tree-lined boulevards and planted flower beds, but these often consist of non-native ornamental plants that offer little food or shelter for local Insects, birds or other wildlife. Both T.4 and T.1 noted that park maintenance is narrowly focused on aesthetics – keeping lawns mown and flower displays tidy – instead of promoting natural vegetation structure or ecosystem services. "*Even the parks… [are managed] mostly from the aesthetic point of view… rather than from a natural functioning point of view*," T.1 observed. T.5 expanded on this aspect by explaining that many of Tirana's greening interventions prioritise visual impact over ecological performance. He noted that municipal projects often rely on fast-growing ornamental species

"*chosen for appearance rather than ecological value*", and highlighted that these choices undermine habitat quality and fail to support native biodiversity.

The consequence is that urban green spaces in Tirana are under-performing as habitats. Anecdotal evidence compiled by local researchers similarly indicates that biodiversity in the city is in a degraded state despite the presence of parks and street trees. One factor mentioned in the interviews is the use of alien ornamental species (such as eucalyptus or acacia) in city greening projects, which can even become invasive and "*backfire*" ecologically. According to T.5, this problem is exacerbated by the absence of ecological guidelines in municipal greening programmes; for instance tree-planting campaigns tend to be politically driven, focusing on the sheer number of planted individuals rather than on species composition, survival rates or ecological function. The experts called for a shift in how parks are conceived, indeed rather than just "*looking nice*" on the surface, green spaces should be managed to support native species, provide ecosystem functions, and connect with each other to allow wildlife movement. This point connects directly to the governance issues above. Without ecological expertise and priorities integrated into park planning, even the limited green areas that exist will not fulfil their potential for biodiversity. Notably, the lack of expertise was itself identified as a problem, since the municipality rarely consults biologists or ecologists, and as a result, it designs initiatives like mass tree-plantings in a way that prioritizes visual impact (and political visibility) over ecological benefit. This critique emerged in multiple interviews, pointing to the need for better and closer collaboration between city planners and environmental experts in order to enhance the biodiversity value of urban green spaces. T.5 also insisted that the municipality's limited consultation with ecological experts leads to systemic underperformance, with many parks that "*are not designed with ecological functioning in mind*", and management practices, such as excessive mowing and the removal of understory vegetation, that further reduce the habitat potential of existing green areas.

9.3.3 Communication and public perception of biodiversity

The interviews revealed a consensus that both local authorities and the general public in Tirana have a low awareness of urban biodiversity – what it is, why it matters, and how to protect it. T.1 noted that within the municipal government, biodiversity remains largely an "*unknow land*", often conflated with generic greenery and met with "*blank looks*" when the topic is raised. This limited understanding at the decision-maker level means that biodiversity rarely features in public discourse or city campaigns, while experts suggested that ordinary

citizens themselves also tend to perceive it superficially, mostly seeing nature in the city as native trees or picnic parks. One interviewee remarked that "*citizens are even less educated on environmental issues than local governments*", tending to prioritize immediate urban conveniences – "*recreational things… roads to use their cars more freely*" – over green causes (T.2). The general population thus may not demand biodiversity action from leaders, creating a vicious cycle of inattention. T.3 emphasized that there have been "*no clear strategies to educate the population about the importance of biodiversity in the city*"; in her view, the city lacks any systematic public awareness or environmental education programmes related to urban nature; no significant efforts (e.g., through schools, media or community outreach) have been made to inform residents that biodiversity is more than just the trees in the main park, but it includes the birds, pollinators, and other organisms that contribute to a healthy urban ecosystem, and that its loss can affect quality of life (for instance, via reduced air quality or resilience). This finding is consistent with broader challenges seen in post-communist cities where environmental awareness is still developing and often takes a back seat to pressing economic and social issues. T.5 provided further confirmation that biodiversity communication is virtually absent in the municipality unequivocally stating that "*there is no communication on urban biodiversity*", noting that the only concept that received extensive promotion was the Metrobosco during the approval of the General Local Plan. According to T.5, this communication was oriented toward international visibility rather than citizen education.

However, the experts agreed that raising public consciousness is crucial and without a basic understanding, citizens are unlikely to support biodiversity-friendly policies or participate in conservation initiatives. T.2's representative noted that some emerging efforts are underway – for example, campaigns to introduce concepts like ecosystem services to the public – but these are recent and not yet widely effective; the city is still at the beginning. Indeed, participants described the current public participation in environmental matters as minimal, sometimes characterising official "participation" processes as mere formalities. For instance, one expert described the city's public consultations on plans as a "*smokescreen… done just as a tick in the box*", rather than a genuine dialogue (T.2), demonstrating that the communication gap concerns not only content but also trust and inclusion, since citizens lack accessible information and meaningful channels to engage with biodiversity issues.

All experts pointed to the absence of a clear communications strategy from the municipality regarding biodiversity. T.3 frankly stated that the city administration has no coherent programme to educate or engage citizens on

biodiversity, and the other interviewees confirm the same. The result is that any awareness that does exist tends to be localized or driven by NGOs and academia rather than by city-led initiatives. For example, T.4 mentioned that some university-led outreach (e.g., citizen science projects on urban bats) has tried to spark interest, and T.2 has organized awareness campaigns (one expert mentioned a recent campaign "Being Rais[ing] Biodiversity"). Despite ongoing efforts, the absence of municipal support makes progress particular challenging. T.5 detailed the municipality's communication machinery, noting that the city employs a large communication team of up to 300 staff, and that even the Agency of Parks and Recreation has its own communication directorate with around 12 staff. Despite this substantial apparatus, T.5 explained that municipal communication focuses overwhelmingly on broadcasting tree-planting events and promotional content for urban interventions, with very little educational material on biodiversity, access to greenery, ecological functions, or ecosystem services. Instead, the city's messaging prioritises visibility and branding rather than substantive ecological awareness.

There is also a noted disconnection between generations, with a few interviewees that observed that younger people in Tirana might have slightly more exposure to global environmental ideas through social media or education, whereas the older generation often has very traditional views of urban nature (seeing trees simply as shade or decoration). Still, even among youth, awareness of urban biodiversity (as opposed to national parks or wildlife in general) remains low. Some independent media and civil society groups (such as the "Citizens Channel", as T.2 cited) have started to highlight urban environmental issues, which is a positive sign. T.5 also indicated that the municipality occasionally supports NGO-led campaigns, such as PPNEA's "Albania is Biodiversity", but this support is sporadic and reactive, not part of a structured communication strategy.

However, all interviewees converged on the idea that communicating the value of biodiversity remains a significant, unresolved task. Without effective communication, public support for biodiversity initiatives tends to remain limited and familiar misconceptions tend to persist; many residents still assume that any increase in greenery automatically enriches biodiversity, or that wildlife has its proper place only outside the city. These misunderstandings persist because communication is not simply an informational gap but reflects a broader culture in which biodiversity is treated as a marginal concern. When authorities do not prioritise it, the public receives few cues to consider it important, and this in turn allows biodiversity to slip further down the political agenda. Breaking this

cycle requires a more deliberate commitment to public engagement. Interviewees mentioned the need for long-term educational initiatives, well-designed media campaigns and more frequent inclusion of biodiversity in public debates. One expert (T.2) argued that education should start within the government itself: "*this campaign of education should be done, first of all, for the public administration*" – meaning that city officials and planners need training on biodiversity so that they can then lead by example in raising awareness among citizens.

In sum, the experts suggest that addressing Tirana's communication gap requires:

→ a stronger ecological literacy within the administration, more consistent and educational public messaging,

→ and closer collaboration with schools, universities, NGOs and independent media.

→ as well as a more transparent and regular participation processes in order to rebuild trust and make biodiversity more visible in everyday urban life.

9.3.4 Impact of urban growth and construction

Rapid urban growth in Tirana has put significant pressure on the city's natural environment. T.3 described the expansion of the built-up area in recent decades as largely "*unplanned*" and driven by ad hoc construction, with little regard for environmental constraints. A clear consequence of this sprawl is the reduction of peri-urban green belts and the encroachment on once-natural areas around Tirana. Several experts noted that hillsides and fields on the city outskirts that acted as important ecological buffers have been urbanized. T.4 provided a concrete illustration: Tirana's population roughly tripled since the 1990s, leading to conversion of semi-natural habitats into suburbs and high-rise districts.

T.4 observed that areas which used to host rich biodiversity (from bats in old military bunkers to migratory birds in wetlands) have steadily shrunk or disappeared under new development. This mirrors documented trends; according to city reports, if sprawl continues uncontrolled it will result in "destruction of the natural environment and productive land" and rising infrastructure costs. Within the city proper, the construction boom has manifested in a wave of new towers, roads, and other Infrastructure. Experts described how Infill development has taken over many garden plots and vacant lands that previously offered some urban nature. One Interviewee mentioned that just last year the city issued permits for 27 new buildings around central Tirana (T.4).

The cumulative effect on biodiversity is significant: habitat fragmentation, fewer green refuges, and increased disturbance (noise, light, pollution). "They are really transforming the city," one T.4 remarked, "and so the point is how much in this kind of transformation the idea of keeping green areas is included or not". The implication was that, so far, it is mostly "not". In fact, participants suggested that the current urban transformation is largely hostile to biodiversity – an impression consistent with global findings that urban expansion Is a major driver of biodiversity loss. The lack of strategic environmental assessment means that each project erodes greenery incrementally. The interviews collectively paint a picture of Tirana's growth as environmentally unsustainable to date, characterized by short-term development gains at the cost of long-term ecological health.

A theme repeatedly raised was the weakness or absence of environmental regulations on new construction in Tirana. Experts argued that urban development projects rarely undergo rigorous environmental impact evaluations. "*Building construction and infrastructure expansion do not consider ecological criteria*", noted T.5, whose analysis of planning instruments confirms that biodiversity safeguards are practically absent from municipal permitting. She noted that the Territorial Plan contains provisions that could protect green areas and limit construction intensity, yet these are routinely overlooked when politically attractive projects emerge, reinforcing a pattern in which economic visibility outweighs environmental coherence.

An example that illustrates this pattern came up from high-rise buildings; as the interviews recalled, towers above a certain height are approved at the national level, allowing local authorities to claim limited responsibility even when such buildings contradict the city's own planning framework. T.1 strongly criticized this deflection of accountability, arguing that the municipality should intervene to uphold its plan rather than "*wash its hands*" while the rules are bypassed. Such breaches have allowed towers far taller than planned to sprout in the city, intensifying the urban footprint.

Enforcement of planning norms remains inconsistent; as reported by T.2 there is often "*a lack of synergy, a lack of willingness to do things*" including collaboration among agencies, with the result of piecemeal decisions that that ignores the bigger sustainability picture. T.5 reinforced this by explaining that coordination failures make it difficult to align construction permits with environmental objectives, especially when responsibilities are dispersed and procedures focus on formal compliance rather than ecological outcomes.

Additionally, the experts discussed how pollution issues have been neglected in the rush to build. Infrastructure to manage environmental pressures and mitigate pollution has not kept pace with growth; most starkly, "*there is no [municipal] sewage treatment plant in Tirana*", as T.4 noted, and only about three-quarters of the population is even connected to sewers. Consequently, urban runoff and wastewater flow directly into the Lana and Tirana Rivers and into the Artificial Lake. "*All our sewage is discharging… without any prior treatment, which is a huge problem*," T.4 explained, "*and… the ecological conditions of the lake are deteriorating*". Environmental monitoring confirms elevated biochemical demand and ammonia levels in several water bodies due to untreated discharges. Air and soil quality also suffer: dust from construction sites worsens air pollution, and improper waste disposal affects soils, even though these aspects were less extensively discussed in the interviews. T.5 added that the municipality tends to prioritise high-visibility development projects over essential environmental infrastructure, which contributes to delays in addressing pollution and in upgrading systems such as sewage treatment, stormwater management and soil protection.

Overall, the experts painted the impact of urban growth as twofold: direct loss of green and natural areas, and indirect degradation through pollution and neglect, both facilitated by weak environmental governance. The need to strengthen and enforce urban environmental regulations – from land-use plans to building codes and impact assessments – emerged as a clear imperative to curb further harm to urban biodiversity.

9.3.5 Participation and Environmental Education

A striking insight from the interviews was that improving urban biodiversity in Tirana will require educating not just the public, but also the authorities themselves. The experts consistently called for capacity building within local institutions. As the T.2 representative argued, "*this campaign of education should be done, first of all, for the public administration*". In other words, municipal staff, planners, and decision-makers need training to understand biodiversity concepts and how to integrate them into their work. Without enlightened administrators, even well-meaning policies may falter in implementation.

In parallel, experts see a need to educate the broader community about biodiversity, since its environmental literacy and public awareness is uneven and often limited. observed that, in several cases, citizens appear even less aware of biodiversity issues than municipal officials, and this becomes visible in

preferences that can conflict with ecological goals. Residents often value ornamental tidiness over ecological function, favour manicured lawns rather than "wild" green spaces, and occasionally oppose trees due to pollen or maintenance concerns. Raising ecological awareness through school programmes, community workshops and local media campaigns was seen as essential for fostering a long-term culture of care for urban nature. A positive example mentioned in the interviews refers to schoolchildren participating in tree-planting activities, which simultaneously greened small areas and familiarised young participants with local species and ecosystem functions, although such initiatives remain isolated.

The experts agreed that a more systematic incorporation of urban nature topics in education at all levels would provide an essential foundation for future engagement. A well-informed public is more likely to support ecological policies, participate in community initiatives and mobilise pressure on authorities to act. This resonates with broader experiences in other cities where citizen engagement has helped drive urban greening efforts (for example, citizen groups in some cities frequently lobby for community gardens or bird-friendly policies). In Tirana, making biodiversity a relatable topic – connecting, say, the presence of pollinators with fruit production or the role of urban trees in cooling neighbourhoods – could help shift perceptions. Several experts mentioned the importance of of the younger generation, whose exposure to global environmental debates might enable them to champion biodiversity-friendly practices if schools and universities offer the right support.

The role of civil society, NGOs, and academic institutions in Tirana's biodiversity efforts emerged as a notable theme. Given the institutional shortcomings, these non-governmental actors often fill the gap producing research, implementing local greening projects and advocating for conservation. Experts cited examples of projects led by NGOs or universities – such as biodiversity surveys, urban gardening initiatives, or conservation advocacy – which have been beneficial but often "*restricted due to a lack of government support*" (T.3). There was a shared sense that the impact of NGOs and academia is limited by resource constraints and official indifference. T.4, himself affiliated with both academia and an NGO, highlighted that while these groups are "*key in promoting biodiversity strategies,*" they cannot scale up their impact without integration into formal governance processes.

A recurring issue is also the lack of institutionalized platforms for collaboration. One expert explained that the municipality rarely consults external experts when making decisions about green spaces or environmental plans, even though

knowledgeable ecologists, landscape experts and planners outside government who could provide relevant guidance. "*We have raised this issue with the city government, saying that you have to consult… academia or NGOs*" when developing plans, said T.4, stressing the importance of expert input, a request that has rarely produced sustained changes.

The interviews also touched on citizen participation in biodiversity initiatives. Currently, volunteerism and community-based projects (planting trees, cleaning riverbanks, etc.) exist but are not widespread. One bright spot mentioned was the Metropolitan Forest campaign – an ambitious project in the city's Green City Action Plan that aims to plant 2 million trees around Tirana as a "*green belt*". The mayor's office actively solicited contributions to this, and indeed 60% of the first 100,000 trees were donated by businesses, citizens, and institutions, showing public willingness when mobilised. This example was cited to illustrate that with the right encouragement and organisation, community involvement can be achieved at scale.

However, experts cautioned that these moments of mobilisation are episodic and often driven by external programmes or one-off events rather than embedded in a broader participatory framework. Genuine participation would mean continuous engagement of residents in planning, caring and co-manage their local green spaces, forming neighbourhood environmental groups and taking part in monitoring activities such as bird counts or pollution reporting. Transparency plays an important role too: "*lack of communication… and lack of transparency*", as one participant put it, continues to limit people's ability to understand or influence decisions. Better access to project information, clearer consultation procedures and stronger public feedback mechanisms would make participation more substantive.

T.5 contributed an additional layer to this reflection by noting that while the municipality maintains an extensive communication apparatus, including large internal teams and active social media channels, these efforts have focused mainly on promoting events and municipal achievements rather than enabling informed participation. Messaging tends to highlight planting days and architectural projects, while offering little sustained educational material or opportunities for residents to contribute knowledge or feedback. This imbalance reinforces a model where participation remains symbolic rather than deliberative.

In summary, the interviews suggest that while a few NGOs and academic groups are championing urban biodiversity, a more inclusive, participatory approach – where the city, experts, and citizens work hand-in-hand – is needed to overcome current limitations.

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9.3.6 Solutions and future strategies

Looking forward, the experts converged on a vision for a more biodiversity-friendly Tirana that involves implementing NbS and integrating ecological thinking into urban planning. There was recognition that some groundwork has been laid – for instance, Tirana has approved a Climate Change Mitigation and Adaptation Plan that includes actions to expand greenery and enhancing ecosystem services. T.6, which participated in formulating parts of this plan, noted that "*substantial 'nature-based solutions' have been proposed in recent plans, such as creating greener areas and converting some grey infrastructure to green or blue space*". However, T.6 cautioned that these proposals are often treated superficially, as "*nicer, more green area[s]*" for beautification rather than systemic measures. Many are pilot projects in very small sites – "*areas less than one hectare*"– rather than citywide interventions. The execution of NBS thus remains limited and while the plans look good on paper, the city has so far implemented few of the larger-scale ideas. This assessment aligns with the experience of other C40 and European cities, where ambitious urban greening targets sometimes falter at the implementation stage. The experts in Tirana advocated moving from isolated greening (like planting a few trees along a street) to strategic ecological planning, establishing green corridors to connect parks, protecting remaining natural patches (such as the Tirana River floodplain or hills) from development, and using green infrastructure (parks, rain gardens, green roofs) to provide services like flood mitigation and cooling.

T.1 emphasised that the city should "*preserve the areas that are already green*" and enlarge them wherever possible. "*What we have right now is not enough – it's far from being enough,*" T.1 said, referring to both the quantity of green space and its distribution. T.1 and others argued for setting concrete targets to raise the per capita green space toward European norms (e.g., 9 m² per person), and for creating new parks in under-served neighbourhoods.

A promising direction concerns the integration of ecological design principles into new developments, in order to make buildings contributing to urban biodiversity rather than undermining it. This can be achieved through features such as green roofs, vegetated façades, permeable surfaces or the systematic inclusion of trees and shrubs within architectural and landscape design, an approach called biophilic or biodiversity-sensitive urban design, that aims to weave living systems into the built environment. T.4 observed that several of the newest high-rise buildings promote themselves as examples of "*green architecture*", although in many cases this label rests on minimal additions, such

as a few rooftop trees. T.4 noted that genuinely biodiversity-friendly design requires far more robust measures, supported by clear ecological criteria and enforceable guidelines.

Clearly a mix of policy instruments and incentives are required to make step forward; experts called for stricter land-use regulation to protect green assets – for example, legally designate certain urban zones as green space or ecological reserves where no building is permitted. The already mentioned concept of the "Metropolitan Forest" was for instance highlighted as a positive step in this direction, since the project, as described in Tirana's Green City Action Plan (2018), envisioned planting 2 million trees in a ring around the city, creating continuous forests and parks that would "*girdle urban Tirana in a ring of parks, forests and agricultural land, providing the city with green lungs and limiting sprawl*" . Experts generally endorsed this idea, noting that if fully realized it could significantly improve connectivity between urban and peri-urban ecosystems and check uncontrolled expansion. However, they also cautioned that it must be managed ecologically (using native species, ensuring plant survival, etc.) and accompanied by protections so that those newly planted areas are not later sacrificed to development.

Economic and policy incentives were also considered essential for shifting development practices. One recommendation was to encourage or require property owners to include green features – for instance through a green building certification or urban biodiversity index. T.2's policy specialist argued that introducing incentives (like fast-track permits or tax breaks) for projects that incorporate green roofs, vegetated public spaces, or habitat restoration could shift current practices.

Others highlighted the value of encouraging citizens to green vacant lots or supporting neighbourhood groups and businesses that participate in street tree planting or habitat restoration. Such approaches have precedent in other cities that offer grants or recognition for biodiversity-friendly initiatives (e.g., the Singapore Index on Cities' Biodiversity provides a framework for this).

The experts also emphasised the importance of monitoring and data in guiding future strategies. T.4 mentioned ongoing monitoring of bats and water quality in the Artificial Lake as an example of how scientific data can inform the city where urgent action is needed (his team's findings of deteriorating lake ecology due to sewage spurred discussions on accelerating the wastewater treatment project). Institutionalising such monitoring and making the results public could build momentum for interventions.

Finally, the interviews underscored that none of these strategies will succeed without political will and community buy-in. The interdependencies between themes become clear here: good governance is needed to enforce land-use rules and implement plans; public awareness and participation ensure these plans are supported and maintained; and technical solutions like NBS require knowledge and collaboration to be effective. Encouragingly, the experts did note some progress – for example, the municipality's rhetoric has recently become "greener" and there are pilot projects (pocket parks, tree planting events) signalling a shift in mindset. But the consensus was that much more comprehensive and concrete action is needed. As T.6 put it, the vision is there in strategies and it "*appears… beneficial*", but the reality on the ground will improve only when plans are translated into tangible projects and consistent practices.

The coming years, in the experts' view, will be critical: Tirana can either continue the path of unsustainable growth, or it can leverage plans to turn the tide and serve as a model for urban biodiversity management in the region.

9.4 Discussion on findings

Analysing the interviews in depth reveals that these thematic areas are not isolated; they reinforce and influence one another in a dynamic way. For instance, governance failures exacerbate the loss of green spaces and hinder effective responses. When city authorities lack knowledge or will (Governance), they are less likely to enforce regulations or invest in green infrastructure (Growth impact and Solutions), and they may not initiate public awareness campaigns (Communication). This was evident as experts often moved from talking about policy gaps straight to how those results in uncontrolled building or poor park management.

In the interviews, when T.1 described the absence of biodiversity in planning, he immediately connected it to the conversion of public lands to development – linking Governance with Green Spaces and Urban Growth themes. Similarly, public perception issues feed back into governance. T.3's point about the lack of citizen pressure due to low awareness (Communication theme) suggests that politicians feel little incentive to change the status quo, perpetuating weak environmental governance. Conversely, greater public engagement could push governance to improve – an interplay noted by T.2, who indicated that community mobilisation (Participation) can drive political action, as seen in the tree donations example

Another key relationship is between urban growth, pollution, and public perception. As Tirana's construction boom leads to visible problems like river pollution, it can gradually raise public concern (some experts mentioned that residents by the lake have started complaining about water quality). However, if communication from authorities is lacking, the public may not connect these issues to biodiversity per se. T.4's detailed explanation of sewage impacts on lake ecologyis exactly the kind of information that, if communicated widely, could make urban environmental problems tangible to citizens and spur greater support for infrastructure solutions. Thus, improving communication could amplify the pressure to address the impacts of growth.

The role of education and participation cuts across all themes as a facilitating factor. Well-informed officials and citizens can improve governance, safeguard green spaces, moderate the negatives of urban growth, and embrace innovative solutions. It was telling that in discussing future strategies, many experts circled back to the need for training municipal staff and educating youth – essentially saying that without knowledge and buy-in, technical solutions alone won't succeed. For example, T.5's hopes for Implementing NbS hinged on decision-makers adopting a new vision (which comes from awareness) and citizens accepting greener practices in their neighbourhoods (which comes from education and participation). This echoes findings in urban ecology literature that social and cultural support are key to sustaining ecological initiatives in cities .

Solutions and strategies are seen as the Intersection of all themes. Crafting effective solutions will require good governance (political will, integrated planning), public support (stemming from awareness and participation), technical know-how (from experts and data), and preservation/restoration of green spaces. In the interviews, when experts talked about solutions like the Metropolitan Forest or green corridors, they often mentioned the prerequisites: e.g., enforcing stricter land-use (Governance), securing community collaboration (Participation), and maintaining native biodiversity in new green areas (Green Spaces). There was an implicit understanding that success lies in a holistic approach.

In summary, the expert interviews on urban biodiversity in Tirana provide a nuanced and candid picture of a city at a crossroads. The analysis – structured around six major themes – shows a city struggling with familiar issues: weak integration of environmental priorities in governance, rapid urbanisation devouring green space, poor public awareness, and scarce community
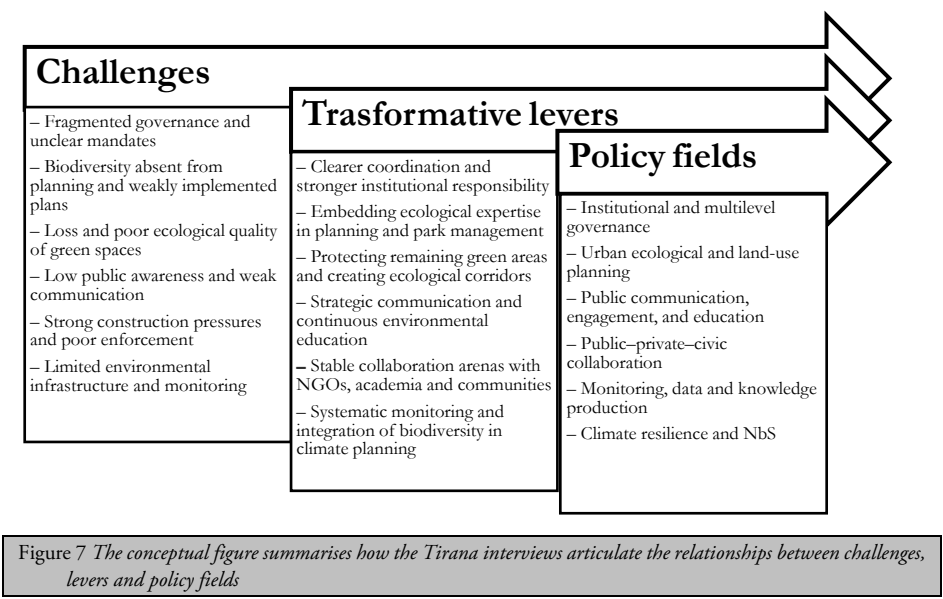
engagement. These challenges are deeply interrelated, creating a cycle where lack of awareness enables poor governance, which in turn allows unsustainable growth that further erodes biodiversity and so on. Yet, the interviews also highlight pathways forward. There is clear knowledge among local experts of what needs to be done: strengthen institutional frameworks, educate and involve citizens, protect and enhance green spaces, and implement the NbS already envisaged in plans.

The findings resonate with broader urban biodiversity research that advocates for "whole-of-society" approaches – engaging government, academia, NGOs, and the public in tandem. Tirana's situation, while challenging, is not without hope. The very discussion of a metropolitan green belt and the presence of active environmental NGOs suggest that the seeds of change are present. What emerges strongly from these interviews is that improving urban biodiversity is not just an environmental task but a governance and social project: it requires political courage, public consciousness, and expert guidance working together.

As one expert optimistically noted, a city can achieve a great deal "if all the people mobilize and work together for a good cause". The task ahead for Tirana is to turn the insights from these expert testimonies into concrete actions – integrating biodiversity into the city's development model so that urban growth and nature can coexist in a more harmonious balance. The interviews analysed here provide a roadmap of sorts, delineating both the pitfalls to avoid and the opportunities to seize in making Tirana a greener, more biodiverse city for the future.

The following figure brings together the findings from Tirana into a concise conceptual scheme that illustrates how different elements of the city's biodiversity governance ecosystem relate to one another. The column on the left outlines the structural pressures that continue to hold back ecological progress, from fragmented governance to the combined effects of construction-driven land conversion and limited public awareness. The centre block reflects the levers that experts see as both realistic and necessary, greater coordination, embedded ecological knowledge, strategic communication, and more stable arenas of collaboration. The right column identifies the policy domains in which these levers must materialise if Tirana is to move beyond episodic greening and towards a more coherent ecological transition. What emerge is that Tirana's biodiversity challenges are tightly interlinked, with fragmented governance, construction-led land conversion, and low ecological awareness reinforcing one another, so that no single fix can work in isolation. The levers identified by the experts, such as stronger coordination, embedded ecological knowledge, strategic

communication, and stable collaboration arenas, only become effective when they advance together within the relevant policy domains. So Tirana can move beyond episodic greening only through an integrated governance shift that navigates these interdependencies deliberately, rather than through scattered projects or standalone initiatives.

Challenges

– Fragmented governance and unclear mandates

– Biodiversity absent from planning and weakly implemented plans

– Loss and poor ecological quality of green spaces

– Low public awareness and weak communication

– Strong construction pressures and poor enforcement

– Limited environmental infrastructure and monitoring

Trasformative levers

– Clearer coordination and stronger institutional responsibility

– Embedding ecological expertise in planning and park management

– Protecting remaining green areas and creating ecological corridors

– Strategic communication and continuous environmental education

– Stable collaboration arenas with NGOs, academia and communities

– Systematic monitoring and integration of biodiversity in climate planning

Policy fields

– Institutional and multilevel governance

– Urban ecological and land-use planning

– Public communication, engagement, and education

– Public–private–civic collaboration

– Monitoring, data and knowledge production

– Climate resilience and NbS

Figure 7 *The conceptual figure summarises how the Tirana interviews articulate the relationships between challenges, levers and policy fields*

Part IV

Lessons and Future Directions

Chapter 10

Reflections

Monica Bernardi and Pablo Gómez-Iniesta

This concluding chapter returns to the central question that guided the book, that is how biodiversity is governed, communicated, and lived in contemporary cities, and what this reveals about the possibilities and limits of ecological transition. Drawing on the trajectories of Milan – an economically advanced EU city, Tirana – a Western Balkan capital aligning with EU standards, and Florence, Genoa and Palermo – understood as emblematic cases of Southern European urbanism marked by historical density, uneven administrative capacities and complex socio-ecological legacies, the chapter synthesises the insights emerging across governance arrangements, communicative framings, citizen engagement and everyday ecological practices. The Mediterranean context, with its mixture of institutional fragmentation, civic ingenuity, uneven capacities and dense socio-ecological histories, offers a privileged lens for understanding both the structural constraints and the transformative openings of urban biodiversity. The analysis developed throughout the volume indicates that biodiversity is governed through fragile assemblages of institutions, instruments and actors; communicated through narrative repertoires that oscillate between technocratic framings and attempts at civic mobilisation; and lived through practices of care, conflict, appropriation and neglect that reveal the socio-political nature of the urban ecological condition. These dynamics do not merely describe what cities "do", but say something about the material and symbolic infrastructures that sustain or inhibit ecological transition. In this sense, urban biodiversity becomes a diagnostic tool that exposes the governance architectures, cultural imaginaries, and socio-spatial inequalities underpinning contemporary Mediterranean urbanism.

10.1 Governance: Institutional Contexts and Approaches

Governance remains the central stress test of urban biodiversity transitions in Mediterranean cities, revealing how institutions, often shaped by path-dependent

administrative cultures, struggle to adapt to ecological processes that do not align neatly with bureaucratic categories or municipal borders. As illustrated throughout the book, urban biodiversity cannot be understood as a purely ecological matter but must be situated within the political and organisational arrangements through which cities operate. This becomes especially clear in Mediterranean contexts, where long socio-ecological histories intersect with climate pressures that demand coordination, foresight and vision, and institutional flexibility.

The patterns that emerge across the cities examined confirm that the governance of urban biodiversity is shaped not only by institutional design but also by competing priorities, uneven capacities, and the diverse ways in which cities imagine their place within ecological transitions. It's not simply about organising green assets or complying with directives, but about making space for the living world within administrative cultures that were not originally designed for this purpose, and that therefore often move more slowly than the issues they try to address, struggling to adapt to the demands of a more-than-human urban condition.

(I) One of the clearest findings is that effective biodiversity governance requires *strong institutional coordination* – something many cities still struggle with. In Milan, experts noted that responsibilities for urban nature are dispersed among multiple departments and agencies, leading to fragmented efforts and an absence of a unified vision. Different offices, spanning from urban planning to the municipal green company, operate with overlapping roles and *"little integration"*, making it difficult to mainstream biodiversity across the city's agenda. This internal fragmentation is mirrored in urban landscape itself, where Milan's green spaces form an isolated patchwork that lacks ecological connectivity. Recognising this, Milan's experts have argued for the creation of transversal governance structures, such as a dedicated biodiversity task force or an interdepartmental working group, that would allow currently siloed actors to sit at the same table and articulate a clearer shared strategy. Encouragingly, Milan's governance culture has shown capacity for multisectoral collaboration in other fields (e.g. combining social and environmental objectives in an energy poverty plan), suggesting that similar models could be applied to biodiversity too. Despite this potential, the gap between planning and execution remains significant. Ambitious greening initiatives risk being diluted as they move through bureaucratic procedures, and there is often no dedicated mechanism

capable of ensuring that approved projects maintain their original biodiversity objectives This reveals a broader governance challenge. Even when cities adopt progressive plans, effective implementation and clear accountability structures are essential to transform written commitments into tangible outcomes.

If Milan illustrates how silos persist in a mature EU governance environment, Tirana shows a contrasting but complementary trajectory, indeed its governance context is marked by rapid development and strong external alignment. As part of Albania's EU accession process, Tirana has overhauled its urban policies to conform with European norms, after decades of unregulated post-1990s growth that left limited green infrastructure. The city has pursued large-scale greening and restoration (tree planting, new parks, riverbank rehabilitation...) not only as environmental interventions but as visible signs of modern governance and European orientation. Tirana's biodiversity agenda therefore functions simultaneously as nation-building and as diplomatic signalling. However, this rapid transformation also reflects a governance model strongly centred on mayoral authority, where large interventions are often decided with limited public deliberation and increasingly steered by private developers. Flagship greening and redevelopment projects become instruments of international visibility and place-branding, accelerating urban regeneration but raising concerns about market-driven logics overshadowing long-term ecological stewardship. This concentration of power and reliance on private actors sharpens the question of whose interests biodiversity-oriented interventions ultimately serve, and how inclusive or durable such transformations can be. Moreover, Tirana's institutional capacity is still developing and relies heavily on donor-supported projects. As the city moves closer to EU accession, one challenge will be ensuring that these externally driven initiatives become embedded into a lasting local governance structure, rather than one-off projects.

Florence, Genoa, and Palermo help to situate these two main cases within the wider Southern European landscape. Both Florence and Genoa have only very recently adopted their first city wide Green Plans, marking a late but explicit institutional recognition of biodiversity as a dedicated strategy. Palermo, by contrast, has not drafted a single biodiversity masterplan at all, but is mainstreaming biodiversity within a broad Environmental Policies department. Its approach is to embed

biodiversity goals across various urban policy areas – from waste management to environmental education – rather than siloing nature in a standalone plan. Each model has pros and cons: Florence and Genoa's new plans signal political commitment and scientific guidance (Florence even hired a botanist to advise its plan), but those plans are not yet tested by implementation. Palermo's mainstreaming shows pragmatism in a resource-constrained city, but without a focused plan, there is a risk that biodiversity gets diluted amid competing priorities. Read comparatively, these three cities show that Mediterranean biodiversity governance is currently split between late formalisation through new plans and pragmatic integration through mainstreaming, with both routes still seeking stable instruments of execution.

(II) A second pivotal issue emerging across all cities, is the *multi-level coordination*, with vertical integration between municipal, regional, and national authorities proving uneven. Palermo stands out in this regard because the Sicilian region has formally delegated to the city certain biodiversity responsibilities, such as environmental impact assessments for protected sites. This arrangement gives Palermo a clearer mandate and greater responsibility in biodiversity governance at the local level. By contrast, Milan, Florence and Genoa reported relatively little direct coordination with higher levels of government on this issue. They follow national or regional laws (for example, Florence adhering to a regional ban on pesticides), but proactive collaboration or co-management is limited. Florence's officials, in fact, saw the lack of metropolitan/regional coordination as a weakness, noting it's *"absurd"* to talk about ecological corridors only within city limits when nature ignores administrative boundaries. This points to a need for more joined-up governance. Cities might benefit from metropolitan biodiversity strategies or regional frameworks that connect urban cores with their peri-urban and rural surroundings. Genoa, for instance, has begun moving in this direction by creating a Forest Management Plan for its city-owned woodlands, effectively extending biodiversity stewardship to the urban fringe. Managing these peri-urban forests not only protects biodiversity hotspots on the city's edge but also supports urban nature (as these areas can seed wildlife into parks and act as green buffers). It's an example of how cities can collaborate with, or at least complement, higher-level environmental conservation efforts. These cases suggest that the

ecological rationale for connectivity is widely recognised, but the institutional architecture to support it remains partial and city bound.

(III) *Adequate funding* and *human resources* are another common constraint emerging through our cases. Many biodiversity actions in Milan are driven by opportunistic use of external funds, illustrating how financial "carrots" spur local action. Milan, Florence and Palermo all leverage European or other external grants to kick-start projects. Florence recently joined an EU-funded climate adaptation project to finance new urban greening, and Palermo participates in a Horizon Europe project to test NbS. These external funds have been invaluable – they allow cities to launch pilot projects and innovative interventions that local budgets alone might not cover. However, the flip side is a dependence on short-term projects that may not be sustained. Officials acknowledged that without structural funding (or dedicated municipal budget lines), it is hard to maintain continuity once a grant ends. Milan's case shows even a wealthy city can struggle with this: new national legislation in Italy now mandates urban ecological restoration, a "big victory" on paper, but outcomes will depend on actual resourcing and enforcement at city level. Human resource constraints are similarly pressing. Milan's green department reportedly lacks sufficient staff to handle all tasks *"complains about the lack of personnel"*, leaving little capacity for outreach and education efforts. Genoa's environmental unit doesn't retain full-time biodiversity experts at all – it hires external consultants for specialized tasks Ie those needs are too sporadic to justify permanent hires. Such gaps mean that even when policies exist, day-to-day implementation and public engagement might suffer due to limited staffing. In summary, whether in an advanced economy like Milan or a less affluent city like Palermo, the fundamentals of governance – clear mandates, inter-departmental coordination, stable funding, and skilled staff – are crucial. Different socio-political contexts influence how close each city is to achieving those fundamentals: EU membership can provide funding and policy pressure (benefiting Italian cities and motivating Tirana), while weaker economies or more centralized systems might concentrate efforts in a single department (as in Palermo's broad department approach). But all cities, regardless of context, face the task of breaking silos and planning for the long term.

Our cases therefore confirm a shared Mediterranean challenge of integration and continuity, but they also clarify what is at stake when biodiversity becomes a

policy horizon rather than an isolated environmental add-on. Our cities show that biodiversity governance is simultaneously an institutional bottleneck and a transformative lever. It is a bottleneck because ecological processes continuously exceed bureaucratic categories, funding cycles, and municipal borders, so that even progressive plans risk remaining aspirational unless cities build transversal coordination, stable resources, and multi-level architectures for connectivity. Yet biodiversity is also a lever because it obliges administrations to renegotiate priorities, to experiment with new instruments, and to recognise that urban transition is not only a technical re-greening agenda but a reorganisation of how cities govern the living world. In this sense, the "fragile assemblage" documented across the Mediterranean is not merely a deficit to be corrected, but the empirical form through which ecological transition is currently unfolding, unevenly, politically, and with different degrees of inclusiveness and durability. The political uses of biodiversity that we observed, from EU-driven alignment to mainstreamed pragmatism, are therefore not secondary to ecological outcomes, but part of the same process through which Mediterranean cities are learning, or struggling to learn, how to govern a more-than-human urban future.

The following table shows the main findings about biodiversity governance emerged from the analysis:

Table 7 *Governance main findings*

Governance first	Biodiversity is not a sectoral add-on, but a political and organisational problem that forces institutions to govern living processes
Fragmentation is the main bottleneck	Across cases, horizontal silos within municipalities and weak vertical coordination with regional or national levels are the main reasons why biodiversity struggles to become a stable urban agenda.
Ambition–implementation gap	Plans are often strong on paper, yet biodiversity goals dilute during delivery because procedures are slow and accountability unclear.
External funding as double-edged driver	EU and donor projects accelerate innovation, but dependence on short

	cycles makes continuity fragile without structural budgets.
Two Mediterranean pathways	*Late formalisation* through dedicated Green Plans versus *Pragmatic mainstreaming* across departments. Both are still searching for stable execution tools.
Institutions are city-bound, ecologies cross borders	Connectivity is widely recognised, but governance remains city-bound, so corridors and peri-urban stewardship lack a solid vehicle.
Fragility is also a lever	The current "fragile assemblage" is not only a deficit but also an empirical way transition is unfolding, unevenly and politically, and it can trigger transversal innovation.

10.2 Communication and Awareness Strategies

Communication is the main interface between policy ambition and public meaning, and it often determines whether biodiversity becomes a shared urban value or remains an expert concern. In this sense, communication is not an accessory to biodiversity governance but one of its enabling conditions. It works best when it makes ecological issues tangible in everyday life, connects them to locally meaningful co-benefits, and is treated as a sustained institutional function rather than a project-based activity. Across the cities we studied, communication repeatedly appears as a catalyst, although in several cases it remains underdeveloped or dependent on temporary resources.

For biodiversity policies to gain traction, it is not enough for officials and experts to be persuaded; residents, community groups, professionals and political actors also need to see the relevance of urban nature to their own lives. Many interviewees stressed that the gap between policy intentions and public awareness can be wide, especially in Mediterranean cities where biodiversity loss often feels abstract or distant. Making biodiversity visible and relatable – whether through heat-reducing parks, cleaner riverbanks, birds and pollinators that enliven neighbourhoods, or community gardens that strengthen social ties – on the contrary helps counter the perception that nature is a "luxury issue", which protection is accessory and reserved to those with more time or resources.

Cities are already experimenting with a range of communication and education tools. In the analysis we saw school programmes, social media outreach during planning processes, public events and workshops, all elements that aim to draw residents into the conversation. In Milan, volunteer-based greening activities – colloquially referred to by some experts as 'citizen foresters' – illustrate how hands-on participation can double as a communication strategy, signalling that biodiversity enhancement is a shared civic task rather than a purely municipal responsibility. Citizen science initiatives such as bioblitzes or the City Nature Challenge play a similar dual role, providing useful ecological data while encouraging residents to observe urban wildlife, discover overlooked species and develop a sense of curiosity and pride toward local nature.

Despite these emerging practices, communication continues to represent a fragile link within many administrations. Departments responsible for green spaces often operate with very limited staff, and structured communication requires skills and budgets that are not always available. Even Milan, with its comparatively greater resources, struggles to maintain consistent outreach because of understaffing. Florence and Palermo have underlined that more substantial communication and education efforts usually become possible only through EU-funded projects, as in Palermo's collaboration with international partners on a NbS programme that enabled community workshops. Genoa's officials, meanwhile, acknowledged that their communication has historically been reactive, focusing on informing residents about maintenance works rather than proactively framing the role of biodiversity. Yet this approach is beginning to shift with the introduction of the new green strategy and the discussions taking place within the Green Council.

Effective communication is always shaped by cultural and social context. In places where environmental awareness is already well established, communication can build on this foundation by focusing on co-creation and shared messaging, involving NGOs, schools and civic groups. In cities where awareness is still emerging, communication first needs to prepare the ground, explaining why trees matter, how urban greenery contributes to comfort and safety, or why river restoration improves everyday life. Across these different situations, framing biodiversity through its co-benefits proves particularly effective. Mediterranean cities, including those examined in this study, increasingly present biodiversity as part of broader agendas such as climate adaptation, public health, social well-being or neighbourhood revitalisation. Messages about cooling effects, reduced flood risk or job opportunities in green sectors resonate strongly in contexts marked by heat, flooding and economic fragility. Tirana, for instance, presents

new parks and tree planting as symbols of a modern, healthy and European metropolis, while Milan often ties its identity as an innovative and liveable city to the expansion of green infrastructure. These communicative framings matter because they translate ecological restoration into civic aspiration, helping biodiversity policies gain both public support and political legitimacy.

While tools and messages vary across cities depending on their resources and socio-cultural environments (ranging from high-tech apps and civic-tech platforms in wealthier contexts to town-hall meetings and youth clubs where digital divides persist) the underlying trend is that biodiversity requires a shared narrative. In Southern Europe this narrative increasingly centres on restoration and reconnection, restoring ecosystems within urban areas and reconnecting people with the environments that sustain them. Communication thus becomes the thread that weaves together otherwise isolated initiatives, turning ecological projects into collective commitments and embedding them within a broader urban story.

Strengthening communication capacity through dedicated staff, partnerships with educators, collaborations with media and community engagement programmes therefore emerges as a central recommendation of this research, since the cities that have advanced the most are precisely those that invested early in public outreach, building constituencies capable of supporting long-term ecological commitments and, in turn, encouraging political continuity.

The following table summarises the main findings related to communication:

Table 8 *Communication and awareness main findings*

Framing through co-benefits	Across cities, biodiversity gains support when framed as climate adaptation, health improvement, and urban liveability.
Practices and messaging reinforce each other	Cases such as Milan and Genoa show that communication is strongest when tied to participatory practices.
Context shapes the register	Tirana mobilises around modernisation and European identity, while Italian cases rely more on civic cultures, education, and heritage-linked narratives.

Communication capacity is a governance capacity	Reliance on short-term projects and limited staff keeps awareness episodic and fragile
Narrative is part of transition	Without a shared story of restoration and reconnection, biodiversity policies remain isolated interventions rather than collective urban change
Making biodiversity tangible	Communication works when it connects biodiversity to everyday experiences and local examples, countering the idea that it is a luxury issue.

10.3 Citizen Engagement and Public Participation

From the empirical data it is clear that citizen engagement is a core enabling condition for urban biodiversity. Initiatives in this field prove more durable when citizens are involved as active participants and stewards, when participation is institutionalised rather than episodic, and when engagement is supported by education and administrative capacity. In cities the importance of citizen involvement, outreach, and education in biodiversity matters is increasingly evident, and there is a shift away from purely top-down delivery of green interventions toward more collaborative models in which urban nature is co-produced and socially maintained over time. This aligns with the transformative learning lens developed in the theoretical chapters, where repeated hands-on engagement shifts people from passive awareness to active stewardship.

Urban biodiversity indeed is not only an institutional matter but is deeply connected to the coexistence of people and nature, especially in urban contexts. The local setting plays a crucial role in shaping how citizens mobilise. Milan and Genoa for instance illustrate how engagement becomes particularly effective when it is formalised through stable channels that allow civic energy to translate into continuity. In Milan, there is a strong civil society tradition and examples of volunteer and community initiatives that complement official policies. The Citizen Foresters initiative, where volunteers help plant and monitor trees as part of the ForestaMI campaign, is emblematic in this respect. Milan's experts stressed that citizen and NGO involvement is facilitated when cities create working

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groups and forums that bring NGOs, scientists, and community representatives into the implementation process. This reflects a broader European trend that recognises how inclusive governance improves outcomes, because when locals have a voice, policies are more likely to be accepted and sustained. Genoa provides a parallel case in a different civic environment, having recently established a Green Council that convenes stakeholders from environmental groups, experts, and citizens to advise on urban greening plans. New ideas for projects are emerging from this council, offering channels for public input that the administration alone might not conceive. Together, the two cases show that institutionalising participation, whether through volunteer programmes or consultative bodies, turns engagement into a form of social maintenance infrastructure that helps biodiversity policies endure beyond single projects. In theoretical terms, these initiatives work as civic ecology arenas that cultivate environmental citizenship, linking everyday stewardship to the public governance of urban nature.

Tirana shows a contrasting pathway in which engagement is closely entangled with trust building and democratic reform. Because civic trust has historically been low, engagement has developed mainly through social inclusion initiatives. The city has opened multifunctional community centres in several neighbourhoods and tested participatory budgeting on a very local scale, allowing residents, including young people and marginalised groups, to have a voice in decisions about local improvements. Tirana's participation in the Open Government Partnership has encouraged the city to adopt co-creation approaches, such as open consultations and "Open Terrace" meetings where citizens can discuss projects and provide feedback. This resonates with the co-creation and participatory design framework discussed earlier, which shows that engagement becomes transformative only when it involves real power-sharing, transparency, and iterative co-learning rather than symbolic consultation. For a post-socialist city these are important steps toward a more engaged public. Yet local studies cited by officials reveal persistent apathy and low awareness among some residents, suggesting that participatory forums are necessary but not sufficient, since genuine engagement grows only when supported by continuous outreach, transparency and visible follow-through. Tirana's role as European Youth Capital in 2022 further illustrates the growing involvement of young people in urban issues, and the city's leadership appears eager to harness this energy in shaping a greener future. Overall, Tirana shows that engagement is not simply a procedural add-on but a gradual relational process in which biodiversity governance becomes a platform for rebuilding trust between institutions and residents.

Florence and Palermo illustrate additional entry points into engagement that depend on local civic cultures and socio-economic conditions. Florence, with its strong cultural identity, has many active citizen groups around heritage and quality of life issues, and these can be assets for biodiversity too when residents collaborate with the city to create more liveable, green public spaces, for instance by reclaiming squares from traffic. The challenge for Florence is to integrate these grassroots efforts into a broader strategy, and its new IRIS Green Plan process offers an opportunity to formalise roles for community input. Palermo, facing socio-economic hardships, has placed particular emphasis on environmental education and awareness within its governance approach. In practice, this has involved working with schools and local associations in projects such as urban gardens and clean-up campaigns. Palermo's officials noted, however, that even within the administration a culture shift is needed to truly embrace participatory approaches, because silo mentalities can exist internally just as they do in the public arena. The two experiences show that engagement can grow either from strong grassroots cultures or from education anchored policies in constrained settings, but in both cases it needs institutional recognition to avoid remaining episodic or peripheral.

Across all cases citizen engagement emerges as both invaluable and demanding, requiring city officials to invest sustained effort in reaching out, listening and incorporating public input, while also relying on the empowerment of community leaders and NGOs. Experts highlight the importance of working through respected local figures and community-based channels, and of designing participation in ways that are continuous rather than symbolic. The specific form of engagement varies across contexts: Milan relies on volunteer networks, Genoa on stakeholder councils, Tirana on community centres and co-creation forums, Florence on grassroots collaborations, and Palermo on educational and association-based projects. Despite these differences, the overall trajectory is convergent showing a shifting from purely top-down models toward more collaborative approaches. This transition generates new ideas, distributes the burden of implementation, fosters a sense of shared ownership over urban nature that is essential for long-term sustainability. In Mediterranean contexts, where institutional fragilities and socio-spatial inequalities are pronounced, engagement is also the arena in which biodiversity becomes a common good rather than a branded intervention, and where ecological transition acquires its social depth.

The following table presents the main findings related to this topic:

Table 9 *Citizen's engagement main findings*

Co-production, not consumption	Biodiversity lasts when citizens act as stewards, not only as beneficiaries
Institutionalised channels matter	Volunteer programmes, working groups, councils, etc. turn civic energy into continuity
Many forms, one trajectory	From Milan's volunteer networks to Genoa's Green Council and Tirana's co-creation forums, cities are shifting from top-down to collaborative models.
Trust is a precondition	In Tirana, engagement grows only with outreach, transparency, and visible follow-through
Education build stewardship	Palermo shows that schools and associations can anchor participation where resources are scarce
Engagement needs resources	Participation is hard work for administrations and requires staff and skills

10.4 Contributions and Limitations of the Study

The study offers several contributions to the understanding of urban biodiversity governance in Mediterranean and Southern European cities, while also recognising the boundaries that inevitably shape the kind of evidence we were able to gather. Holding these two dimensions together clarifies what this research adds to current debates, and, at the same time, what remains open for future work. It also reflects the way biodiversity governance itself unfolds, always suspended between what cities aspire to do and what their institutional realities allow them to accomplish.

A first contribution concerns the geographical and analytical gap that characterises much of the existing literature. Studies of urban biodiversity still tend to focus on Northern Europe or North America and often privilege ecological metrics, nature-based solution performance or species inventories. By

shifting the focus to Mediterranean cities and including Tirana as a Western Balkan capital, this research broadens the evidence base and shows how global and European biodiversity agendas are interpreted within institutional trajectories that are neither linear nor uniform. In these cities, biodiversity is never simply a technical matter; it becomes entangled with administrative legacies, political priorities, territorial histories, etc. This comparative angle, ranging from Milan's mature yet fragmented governance system to Tirana's rapidly evolving and externally aligned transition, helps illuminate how different cities mobilise ecological narratives to position themselves within wider political and cultural landscapes.

A second contribution emerges from the comparative design itself. The research provides practical insights at a time when they are much needed, indeed cities across Europe are currently drafting or updating urban greening plans, spurred by the EU Biodiversity Strategy for 2030 and, in the Western Balkans, by the Green Agenda for the Western Balkans. The contrast between Milan and Tirana shows how cities situated at different stages of EU integration operate with different governance capacities while confronting similar pressures to integrate biodiversity into broader urban agendas. Florence, Genoa and Palermo add further nuance, illustrating how historically dense cities with constrained municipal budgets and uneven administrative trajectories negotiate biodiversity within their institutional realities. These trajectories demonstrate that biodiversity governance is not defined solely by ecological ambition, but also by how institutional history and local political economies shape the scope of what can be attempted and sustained. This is a crucial insight, as it reminds us that ecological transitions do not happen in a vacuum; they are always mediated by the structures, routines and expectations of the cities that attempt to realise them.

The methodological approach based on the combination of expert interviews with document analysis and cross-case comparison, also constitutes a contribution. The study captures the operational realities that lie behind policy documents and formal commitments, amking visible the frictions produced by fragmentation, the vulnerabilities created by uneven resources and the ways in which implementation gaps accumulate over time.

Considering limitations, it should be highlighted that the selection of cases, with two examined in depth and three comparatively, cannot fully represent the diversity of Southern European and Mediterranean cities. Smaller towns, rapidly expanding peri-urban areas or cities governed under markedly different political conditions may encounter dynamics that fall outside the scope of this study.

Furthermore, the qualitative design privileges the perspectives of actors already engaged with biodiversity agendas, loosing voices of residents for example who are more distant from environmental debates or of political figures who question the value of investing in biodiversity. Including these viewpoints in future research would help deepen the sociopolitical understanding of how ecological priorities are negotiated in urban contexts.

Overall, the study suggests that Mediterranean cities offer a particularly clear vantage point from which to observe the tensions that shape contemporary ecological transitions. Their trajectories show how biodiversity governance emerges at the intersection of institutional ambition and administrative capacity, where long-standing organisational routines confront new ecological, political and climatic pressures. In these contexts, biodiversity operates less as a technical domain and more as a field in which cities negotiate how they understand and manage ecological change. What becomes visible across the cases is the constant interplay between inherited structures and emerging demands, and between local histories and the transnational agendas that increasingly orient urban policy. Attending to these dynamics helps clarify the conditions under which cities can realistically advance more ecologically grounded and socially inclusive urban futures.

10.5 Recommendations for Future Urban Biodiversity Policy and Communication

The work developed across our cases makes it possible to articulate a coherent set of insights that can support cities navigating the complex terrain of urban biodiversity governance. What follows is a synthesis of what we have learned, a kind of *blueprint* that translates empirical evidence, expert interpretations and recurring patterns into a practical orientation framework for city makers. It reflects the institutional realities of cities in the Mediterranean, where dense urban fabrics, fragmented capacities and accelerating climate pressures make ecological governance both necessary and structurally difficult. It also recognises that cities operate with different administrative starting points, because some work within mature yet fragmented institutional settings, others advance under rapid transformation in dialogue with European norms. This unevenness does not weaken the blueprint; rather, it shows that multiple pathways are possible so long as institutional durability and cross-sectoral coordination become stable features of local governance.

The blueprint is articulated into five strategic areas that emerged consistently across the cities studied and that indicate what needs to be strengthened for urban biodiversity governance to progress (the why and the what).

(I) Governance matters because fragmentation remains the central barrier

The research makes clear that biodiversity governance becomes effective only when institutional actors are able to work together across traditional silos. Milan's experience shows what happens when urban planning, the green office and sectoral agencies have overlapping responsibilities but do not work closely together. In this situation, ambitions lose strength as they move across administrative layers and projects become less coherent. Other cities encounter similar difficulties. A transversal governance structure, whether established through a dedicated task force or an interdepartmental forum, can provide the continuity needed to articulate shared priorities and maintain alignment over time. Such arrangements become particularly relevant in cities where political cycles or administrative instability threaten to disperse ecological commitments, making it difficult to sustain long-term strategies. In these contexts, the presence of a visible figure or unit with the authority to keep biodiversity firmly on the urban agenda can play a decisive role, ensuring that nature-related goals remain central rather than being absorbed or marginalised by competing priorities.

(II) Financial and organisational stability is a precondition for ecological ambition

All five cases reveal dependence on short-term external funding, which expands opportunities but rarely guarantees continuity. The experiences of Milan and Palermo show how European projects can accelerate innovation while at the same time exposing fragility once the grant period ends. To prevent the drift that accompanies projectisation, it becomes crucial to embed biodiversity within ordinary municipal budgets and to establish permanent staff positions. This is not simply a fiscal concern but a recognition that ecological transition requires continuity, since trees planted today need care tomorrow, monitoring systems demand ongoing maintenance, and citizen engagement cannot depend on occasional initiatives. Strategic partnerships with universities, NGOs and research centres, already active in several cities, offer an additional way to strengthen municipal capacity, particularly where ecological expertise is unevenly distributed.

(III) Biodiversity must be integrated into the core of urban planning and climate policy

The cases highlight that ecological commitments remain fragile unless they are anchored in binding rules and planning instruments. Florence and Genoa have just developed their first Green Plans, which represent an important step forward but will need to prove their effectiveness through implementation. The research indicates that when ecological objectives are translated into local regulations, such as rules on soil permeability, standards for green quality and connectivity, and guidelines for native species, biodiversity gains the same regulatory weight as other urban priorities. Linking biodiversity with climate adaptation strategies further enhances political legitimacy and opens access to broader funding channels. Milan's experts, for instance, emphasise that biodiversity should be understood as part of the city's resilience infrastructure, where habitat connectivity, cooling effects and stormwater management are integrated into a unified framework.

(IV) Public communication and civic engagement are not supplementary, they are infrastructural

Conflicts around tree management, pesticide bans, greening interventions in Florence and Genoa show how quickly ecological initiatives can be questioned when communication remains reactive or overly technical. Cities gain much more when they explain in advance why certain measures are introduced, how they contribute to climate resilience or public health, and what residents can expect as tangible outcomes. When biodiversity is translated into everyday concerns, such as cooler neighbourhoods, cleaner air, safer streets, support extends beyond environmental constituencies and becomes part of a shared urban agenda, because people not only understand but share the motivations. Structured participatory arenas, such as Genoa's Green Council, Palermo's stakeholder forums, or Florence Climate Citizens Assembly, illustrate how civic and expert knowledge can be brought together, reducing tensions and strengthening legitimacy. Citizen science programmes and community-led greening initiatives add another layer, turning residents into active stewards rather than passive observers. Schools and community centres, as well as museums and eco-museums, can further consolidate these practices, nurturing ecological literacy among younger generations and embedding biodiversity into the social fabric of the city.

(V) Ecological continuity requires collaboration across scales

Nature does not recognise municipal boundaries, yet governance structures often do, and this mismatch creates significant challenges. The cases show that while connectivity is widely acknowledged as essential, it remains difficult to achieve without metropolitan or regional coordination. Officials in Florence highlight the paradox of planning ecological corridors within a single administrative limit, while Genoa's forest management plan illustrates how peri-urban spaces can function as ecological buffers. Palermo's delegated responsibilities from the Sicilian region further demonstrate the potential of vertical integration. Building stronger collaborations across municipalities and with regional authorities is therefore crucial for advancing ecological corridors, coastal systems, river restoration and metropolitan greenbelts. These efforts gain additional strength when cities participate in international networks, which provide opportunities for learning and positioning. For cities like Tirana, such engagement also serves as a form of diplomatic signalling, aligning local greening initiatives with broader European ecological standards.

While these five areas define what cities need to do, the empirical material also reveals where cities must begin. The table below translates the findings into a diagnostic map of the structural constraints that repeatedly hindered action across contexts, showing the operational terrain in which the blueprint must be implemented.

Table 10 *Where cities must begin. A Diagnostic Map*

Structural constraint	Transformative direction	Operational action arena
Governance fragmentation and dispersed mandates	Transversal coordination and stable leadership	Interdepartmental task forces, clarified roles, vertical and horizontal alignment
Project-based funding and resource volatility	Long-term financial and organisational stability	Multi-year municipal budgets, permanent staff, scaling pilots into routine practice
Weak implementation and reliance on voluntary guidance	Binding ecological standards within planning tools	Updated regulations, permeability and connectivity criteria, integration with climate adaptation

Low public awareness and technical communication	Sustained and relatable communication strategies	Proactive outreach, co-benefit narratives, indicator-based reporting
Limited monitoring and accountability	Data-informed governance and unified indicators	Harmonised monitoring systems, regular reporting, citizen science involvement
Ecological fragmentation and lack of continuity	Nature-based solutions as resilience infrastructure	Habitat-oriented design, ecological corridors, metropolitan greenbelts

These insights suggest that progress depends not on isolated ecological interventions but on sustained institutional coordination, stable resources, credible communication and meaningful public engagement. They also make clear that biodiversity governance cannot be separated from broader urban questions such as planning, climate resilience, civic trust and political legitimacy.

To complement the analytical blueprint presented above and its diagnostic table, the figure below (made by the use of AI) offers a visual synthesis that organises the core findings into three interconnected domains: strategic governance, community empowerment and integrated action. Unlike the five-part blueprint, which lays out thematic areas for change, and unlike the table, which identifies structural constraints, the figure offers a conceptual map that distils the architecutre of urban biodiversity governance in one glance. It captures the institutional, social and ecological shifts required for more durable policies, reflecting the convergent evidence from Milan, Tirana, Florence, Genoa and Palermo.

While the blueprint does not pretend to provide universal answers, it does offer a structured way of thinking about what cities require in order to move from intention to action. It points to the moments when governance must adapt, when regulation needs to become more explicit, when communication should reach wider audiences, and when collaboration must extend beyond administrative boundaries. In this way, it gives city makers a grounded and realistic orientation for shaping nature-inclusive futures across the Mediterranean.
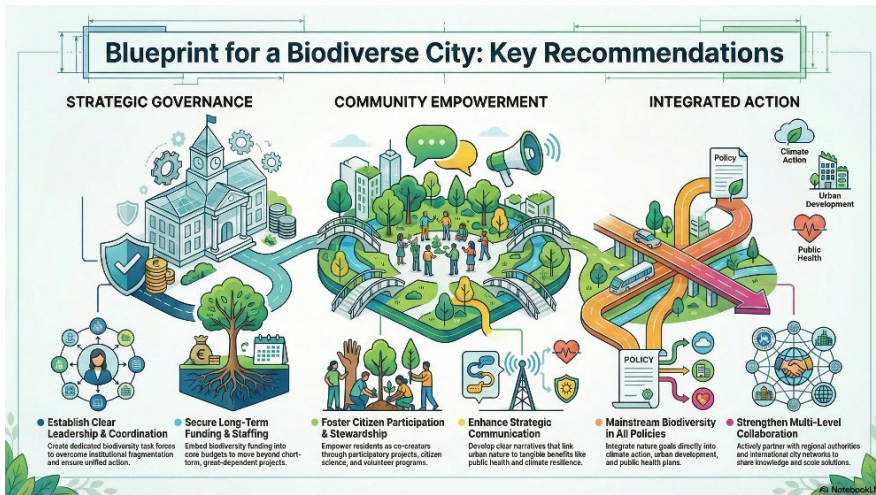
Figure 8 *Blueprint for a Biodiverse City: Key Recommendations (AI-generated)*

Chapter 11

Final Remarks

Monica Bernardi and Nunzia Borrelli

This book has been written in the conviction that cities are no longer a marginal theatre for biodiversity policy but one of its decisive frontiers, and that Mediterranean and Southern European cities in particular concentrate both the fragilities and the possibilities of contemporary socio ecological transitions. The whole research trajectory should be put within the wider horizon of the NBFC Center and in particular of Spoke 7, the workstream that focuses on communication, culture of nature and societal impact, which starts from the idea that biodiversity cannot be handled as an external object of protection but must be understood through the institutions, languages and everyday practices that shape urban life.

The starting question of the work was deceptively simple: how do cities in a Mediterranean, climate vulnerable and institutionally fragmented context take up the challenge of biodiversity, translate it into their own languages, and weave it into the everyday infrastructures and practices of urban governance. To answer this question the research has combined comparative case study work on specific cities with a systematic reading of the emerging global literature on urban biodiversity governance, which has progressively shifted attention from rural protected areas to the socio ecological dynamics of urban regions. Early work on Swedish cities already showed that urban authorities are capable of adopting explicit biodiversity policies, building coalitions across departments and with civil society, and translating broad environmental concepts into spatial patterns and planning decisions, even though they often do so under the pressure of competing development interests. More recent analyses of cities and biodiversity under the Convention on Biological Diversity, as well as the global assessment of urbanization, biodiversity and ecosystem services, have reinforced the idea that cities are not only sources of ecological pressure but also potential laboratories for conservation, restoration, innovation and environmental recovering.

Within this wider field, the contribution of the present research is twofold. Empirically, it offers a dense portrait of how specific cities approach urban

biodiversity in the context of climate transitions, institutional reforms and social claims for healthier and more liveable environments. Adopting a comparative design makes it possible to see that, beyond local idiosyncrasies, there are recurring patterns in the ways municipal administrations conceptualise biodiversity, where they place it in their planning hierarchies, how they fund it, and how they narrate it to citizens. Conceptually, the book proposes to treat urban biodiversity not as an isolated environmental theme but as a relational infrastructure that interconnects climate policy, environmental sustainability, health, social cohesion, urban design and economic choices, in line with One Health and Planetary Health approaches that understand the co evolution of ecosystems and human systems.

One of the strongest comparative findings is the persistent tension between ambitious narratives and fragile implementation. Across the cases, cities have adopted strategies, masterplans, climate roadmaps and strategies that explicitly mention biodiversity, ecosystem services and NbS, reflecting the global diffusion of new ecological paradigms, from the recognition that urban biodiversity can contribute to climate adaptation, public health and well-being, to the emerging evidence that biodiverse, rather than simply green, spaces provide stronger regulating and cultural ecosystem services. At the same time, the research has documented how these ambitions are filtered through bureaucratic silos, unstable funding, resistances, rigid procurement rules and competing land uses. Biodiversity is frequently entrusted to small environmental units with limited authority over key planning and investment decisions, while the everyday practices of urban maintenance and construction continue to erode habitats, simplify vegetation and disconnect ecological corridors. This mismatch between the rhetoric of transition and the inertia of routines is not unique to the cities studied here, it resonates with global reviews that find few city plans equipped with quantified biodiversity targets, robust monitoring frameworks or clear delivery mechanisms.

Yet the research has also shown that biodiversity can operate as a boundary concept that gently destabilises existing institutional patterns. Because it cuts across land use, climate mitigation, adaptation, health, education and public space design, it obliges departments that rarely talk to each other to share data, negotiate priorities and co-design interventions. Because it is both scientifically complex and symbolically rich, it invites new forms of collaboration between universities, observatories, museums, citizen science groups and municipal offices. In this sense, urban biodiversity becomes a vehicle for the kind of systemic, interfecund relationship between science and society that Spoke 7 aims

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to foster. What this book documents, through the concrete trajectories of different cities, is the slow and partial but real emergence of such relationships, in which scientific knowledge on species, habitats and ecosystem functions begins to inform urban policy, and in which the conflicts, emotions and imaginaries of urban residents begin to feed back into research priorities and communication formats.

The centrality of communication in this process has emerged with particular clarity. Spoke 7 insists that new languages and formats for communicating biodiversity are indispensable if ecological knowledge is to have tangible and measurable impact, and if policies are to be co-produced with those who will live with their consequences. Our empirical findings converge on this point showing that where biodiversity is confined to technical reports or legal designations, it remains distant from public concern and therefore politically fragile, while where it is narrated through locally resonant stories, visible species, concrete benefits in terms of cooling, mental health, food, play and neighbourhood quality, it becomes part of urban common sense, something that citizens expect their administrations to care about. Communication here is not simply diffusion of information but a form of translation between different epistemic communities and everyday worlds, between scientific classifications and vernacular attachments, between systemic risk assessments and lived experiences of heatwaves, flooding, pollution or loss of familiar landscapes.

In this light, the *blueprint* proposed in the book should be read as both an analytical synthesis and a communicative device. Its purpose is to offer city makers an orientation map that connects structural challenges, governance levers and policy domains. It distils, in a form that can travel, what has been learned about the conditions under which urban biodiversity governance can move from marginal, project-based experiments to more stable and integrated trajectories; it invites municipal actors to look at their own institutions through new lenses, asking where biodiversity sits in their planning instruments, which departments own or contest it, how it is budgeted for, which monitoring systems exist, what forms of public engagement are privileged, and how these elements can be brought into alignment. In doing so, the blueprint resonates with international calls to bring ecological science more explicitly into urban design and planning, seen for instance in the work on the seven lamps of planning for biodiversity, which translates ecological principles into metaphors and practices intelligible to architects, planners and engineers.

Placing this blueprint and the broader research project within the NBFC architecture gives them an additional layer of meaning. NBFC was conceived as a national platform capable of connecting basic ecological research, long term monitoring, technological innovation and transformative policies across different ecosystems and sectors. Within this architecture, Spoke 7 on biodiversity and society has the specific task of giving the Center a public voice, of developing cross cutting communication, education and policy interfaces that can make biodiversity knowledge socially and politically operative. The present volume responds exactly to this mandate. It takes research strands on urban biodiversity that are often scattered across disciplines and cases, and recomposes them into a coherent narrative oriented towards impact. It speaks simultaneously to academic debates on urban governance, to national and local policy makers charged with implementing biodiversity strategies, and to the broader community of practitioners and activists who are experimenting with new forms of urban nature.

The research trajectories developed in the book intersect with several of the thematic priorities that structure the "Biodiversity and Society" hub of the NBFC, and in particular with the work of Spoke 7 on communication and impact. By examining how biodiversity is framed and communicated in urban contexts, and by analysing citizen science, participatory projects and educational pathways, the book speaks directly to ongoing efforts to renew science communication and to widen outreach towards schools, universities and local communities. The comparative engagement with municipal departments, metropolitan authorities and national agencies that underpins the blueprint resonates with Spoke 7's ambition to strengthen public administrations as key interlocutors for biodiversity policy; at the same time, the critical discussion of real estate driven greening, public–private partnerships and market narratives around urban nature connects with the hub's concern for industrial and economic stakeholders, highlighting how corporate strategies can reshape ecological infrastructures and social inequalities in the city.

Placed within the wider international debate on cities and biodiversity, the findings of the book speak to and nuance several trends that have been identified in recent global assessments. Reviews of urban biodiversity research have shown how empirical studies remain strongly concentrated in the Global North, tend to privilege a limited set of taxa such as plants and birds, and only occasionally connect biodiversity patterns to ecosystem functions and services in a systematic way. At the same time, global policy syntheses, from the Cities and Biodiversity Outlook onwards, underline that urbanisation is progressing fastest in

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biodiversity rich regions and that cities act both as drivers of biodiversity loss and as potential sites for its mitigation, making governance innovations at the urban scale crucial for the achievement of national and international targets. Against this background, Mediterranean and Southern European cities occupy a distinctive position since they belong to a highly urbanised continent that has already undergone major demographic transitions, yet they maintain marked ecological gradients, strong cultural landscapes and persistent socio-economic inequalities. They are at once shaped by European regulatory frameworks and constrained by fiscal austerity and fragmented competencies. The analysis developed in this volume shows how these broader conditions take specific institutional and spatial forms in the cases considered, generating both opportunities and obstacles for urban biodiversity governance.

The research has also brought to the surface a set of unresolved tensions and potential social trade-offs that any honest account must acknowledge. Biodiversity friendly interventions can contribute to green gentrification when they concentrate in already attractive districts and are folded into narratives of urban branding, while less visible or less affluent neighbourhoods remain ecologically and socially neglected. Efforts to densify cities for climate mitigation can collide with the need to preserve existing green spaces and soil permeability, especially in contexts where vacant lots and residual spaces currently host unexpected biodiversity. Energy and transport infrastructures that are central to climate transitions may fragment habitats or create barriers for species movement if ecological considerations are not integrated from the outset. Studies in rapidly growing cities beyond Europe, such as work on Kuala Lumpur, remind us that the homogenisation of urban biotas and the loss of specialist species can occur even in very green cities if planning focuses on ornamental vegetation and simplified habitats. These examples underline that urban biodiversity governance must be constantly attentive to who benefits and who pays, which species are favoured and which are marginalised, which temporal horizons are considered and which are ignored.

Against this backdrop, the most meaningful way to look forward is to return to the *blueprint* that has been distilled from the comparative work. It is a kind of diagnostic and orienting device built out of the institutional frictions, financial constraints, communicative gaps and civic energies observed across the cases. It captures where Mediterranean and Southern European cities currently stand in their attempts to govern biodiversity and, more importantly, it indicates where they need to move in order to turn ambitious declarations into durable practice. It does so by pairing structural weaknesses with concrete levers for change,

showing that progress depends less on isolated projects than on sustained coordination, stable resources, credible communication and meaningful public engagement woven together in time.

Read in this way, the blueprint offers a forward-looking orientation that is both demanding and realistic.

(I)   It suggests first of all that the most promising advances will come from cities that are willing to treat biodiversity not as a decorative supplement but as a structuring principle of their climate and development strategies. This involves a deliberate reordering of planning priorities in which ecological quality, connectivity and diversity are given the same weight as infrastructure, housing and economic competitiveness. It requires, as the book has argued, a careful differentiation among types of green space and habitat, recognising that not all parks, lawns or tree rows contribute equally to biodiversity and that design and management choices deeply influence ecological outcomes. It also calls for a recalibration of planning instruments so that biodiversity criteria are embedded in zoning, building regulations, environmental impact assessment and urban design guidelines rather than confined to isolated biodiversity plans with limited legal traction.

(II) At the same time, the blueprint insists that governance architectures alone are not sufficient if they are not accompanied by stable institutional capacities for communication, participation and co-design. Temporary campaigns or project-based outreach cannot by themselves shift the culture of nature within cities or build lasting trust between institutions and residents. The perspective developed within the wider programme on communication, culture of nature and societal impact that frames this research shows that cities need dedicated teams, long term partnerships with schools, universities and media, and permanent spaces of dialogue with communities and stakeholders if biodiversity is to become part of everyday urban common sense rather than an occasional slogan. The comparative cases indicate that where such interfaces exist and are trusted, cities are better able to navigate conflicts, maintain ecological commitments across political cycles and mobilise citizen energy in constructive ways, turning communication from a weak link into a core enabling condition.

(III) A further axis of the blueprint concerns knowledge and monitoring. The analysis has shown that without comparable and accessible data on

species, habitats, ecosystem services and social vulnerability, it is difficult to design targeted interventions, to track progress or to learn from failure. The forward orientation of the blueprint therefore emphasises the need for robust data infrastructures and open knowledge systems that connect municipal departments, research institutions, citizen science platforms and national or European reporting frameworks. In this sense, the investments imagined within the broader NBFC architecture in the digitisation and networking of collections, in shared indicators and in participatory observation can provide the informational backbone that cities require to move from episodic interventions to systematic, evidence informed biodiversity governance.

(IV) Finally, the blueprint points to a cultural and political shift that can best be described through the language of stewardship. Urban biodiversity governance shows its most transformative potential when it is understood as a form of care, care that is both institutional and civic. International agendas increasingly call on cities to act as stewards of the biosphere, recognising that their choices in land use, consumption and investment have consequences that reach far beyond their boundaries. Yet stewardship only becomes real when it is translated into local practices and responsibilities. In practical terms, this means nurturing a culture of shared responsibility, where public administrations, private actors and citizens see themselves as co-custodians of urban and peri-urban ecosystems. It also means giving value to everyday practices of care, from the management of courtyards and community gardens to the decisions made in school grounds, corporate campuses and infrastructural verges. Just as importantly, it requires recognising and supporting the often-invisible work of those who sustain the living fabric of cities, from gardeners to maintenance workers, educators and volunteers, acknowledging that their labour is not peripheral but central to any credible biodiversity transition.

In bringing these strands together, the blueprint condenses a year of empirical investigation and theoretical reflection into a tool for administrations, practitioners, students and researchers. As it is in the mission of NBFC, the aspiration is moving biodiversity research out of a purely academic circuit and into the hands of those who confront, every day, the task of keeping cities living, healthy, fair and ecologically anchored. The analyses, the case narratives and the blueprint make visible how urban biodiversity governance unfolds in concrete contexts, where blockages and openings lie, how local trajectories resonate with

international debates, and how complex evidence can be rendered discussable in policy arenas.

From this perspective, the conclusion is less an endpoint than an opening, it leaves space for further encounters between scientific work, institutional experimentation and civic imagination, so that bringing nature back into cities can gradually take the form of shared and concrete practices rather than remain only a promise.

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Author's short bio

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Monica Bernardi, PhD, is Associate Professor of Urban and Environmental Sociology at the University of Milano-Bicocca. Her research lies at the intersection of cities, sustainability and innovation, with particular attention to the urban transformations generated by the twin ecological and digital transitions. She investigates how these processes redefine forms of urban governance, particularly in the context of smart, sharing and sustainable cities. She has also conducted research on social innovation and urban commons, exploring processes of urban regeneration, collaborative and circular economy practices, and non-profit utility-sharing initiatives such as energy communities, co-housing and community housing, shared urban mobility and urban community farming. She has been Visiting Scholar in Seoul, Boston, Barcelona and Bolzano. She is also an EU Climate Pact Ambassador, engaging in public outreach and science communication on climate, sustainability, and just urban transitions.

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National Biodiversity Future Center / 2

Bringing Nature Back to Cities asks how biodiversity is governed, communicated and lived in contemporary urban settings, and what this reveals about the possibilities and limits of ecological transition. Developed within the Italian National Biodiversity Future Center, in particular its programme on communication, culture of nature and societal impact, the book follows this question through Mediterranean and Southern European cities, where dense fabrics, institutional fragilities and climate pressures collide with growing expectations for greener, healthier and more liveable environments.

Combining documentary analysis, expert interviews and a comparative reading of cases such as Milan, Florence, Genoa, Palermo and Tirana, the volume shows how urban biodiversity is shaped at the intersection of planning systems, political narratives, fiscal constraints and everyday practices of care. It traces the gaps between ambitious strategies and uneven implementation, highlights emerging forms of citizen engagement and environmental communication, and examines how biodiversity is woven into broader agendas of climate resilience, social justice and urban regeneration.

The book's central outcome is a Blueprint that organises these insights into an accessible orientation framework for cities and city makers. Rather than prescribing a single model, it offers a way of recognising structural constraints and realistic levers for change, and of linking local experience to international debate. The book speaks to scholars, students, practitioners and policymakers interested in urban biodiversity, urban governance, environmental sociology and planning, and to all those who are working to make cities more just, more resilient and more richly alive.