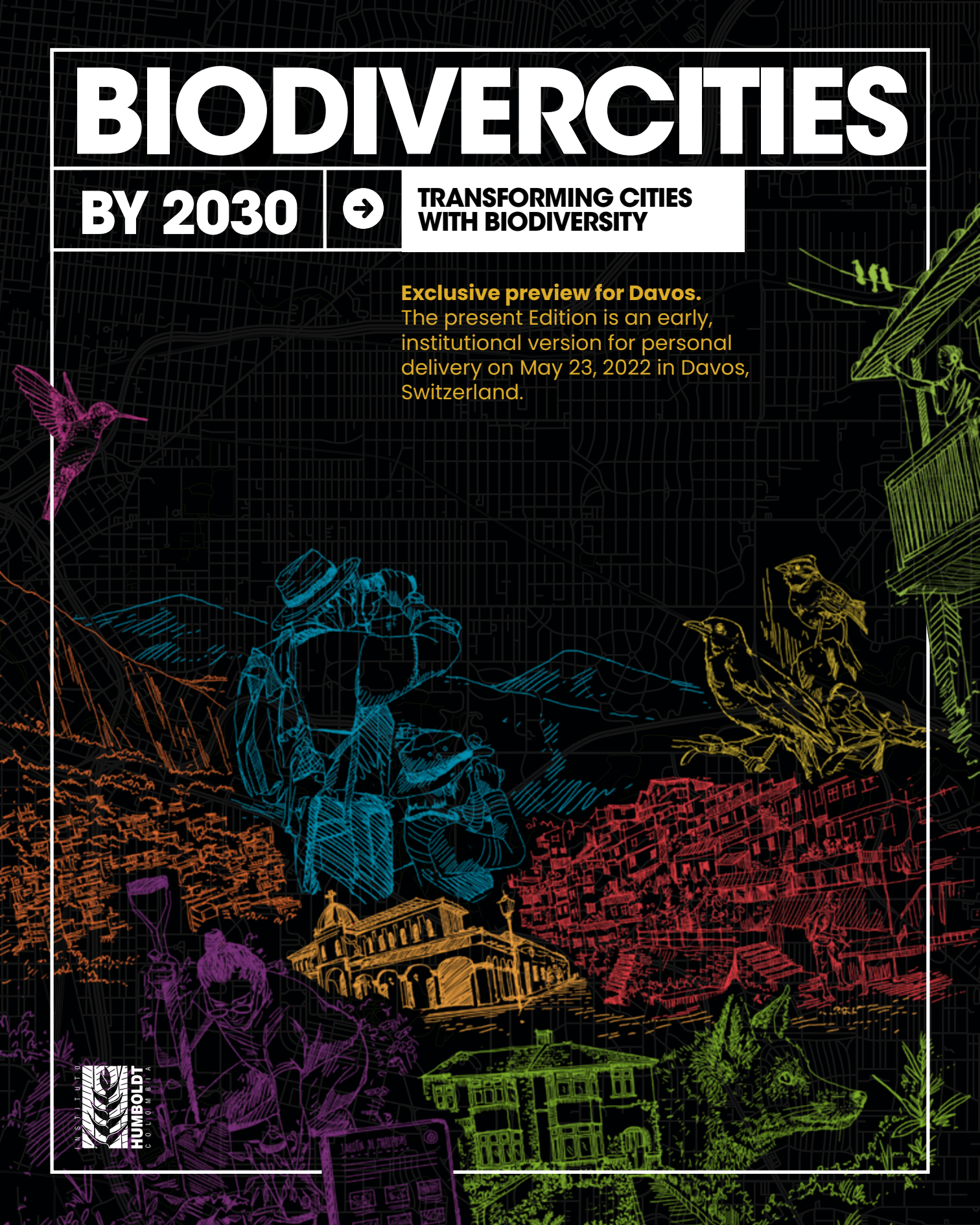
BIODIVERCITIES

BY 2030

TRANSFORMING CITIES WITH BIODIVERSITY

Exclusive preview for Davos.
The present Edition is an early, institutional version for personal delivery on May 23, 2022 in Davos, Switzerland.

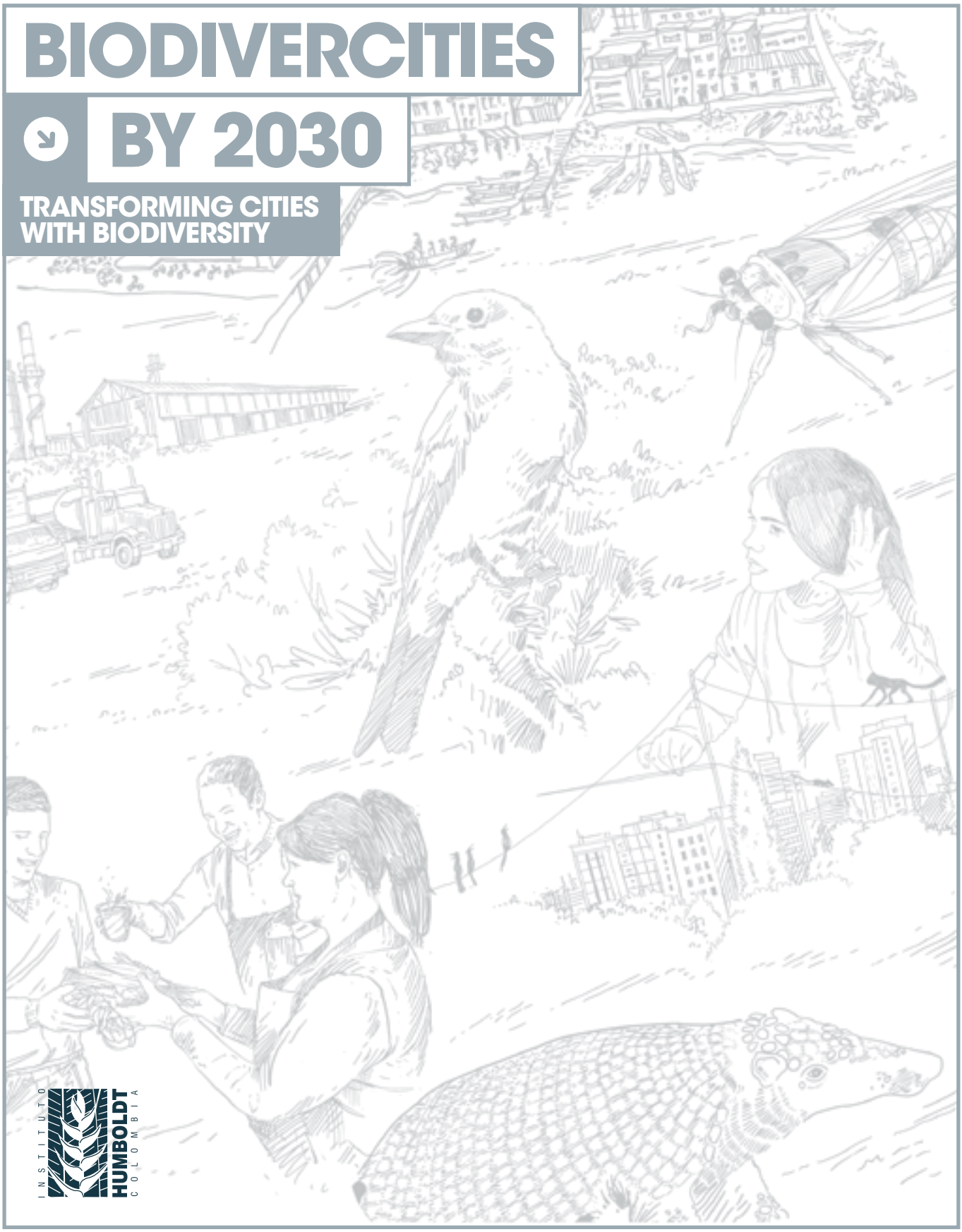


INSTITUTO HUMBOLDT COLOMBIA

BIODIVERCITIES

BY 2030

TRANSFORMING CITIES WITH BIODIVERSITY



INSTITUTO HUMBOLDT COLOMBIA

BIODIVERCITIES BY 2030
TRANSFORMING CITIES WITH BIODIVERSITY

ALEXANDER VON HUMBOLDT BIOLOGICAL RESOURCES RESEARCH INSTITUTE

Edited by: María Angélica Mejía and Juan David Amaya-Espinel.

Editorial assistance:
Érika A. Peñuela Vega

Authors: Alejandro Serrano, Andrea Padilla, Andrés Ibáñez, Carlos Betancur, Carlos David Montoya V., Carlos Eduardo Correa, Carlos Montoya Baquero, Carolina Rodríguez, Daniel Raven-Ellison, Diana Marcela Ruiz Ríos, Édgar Mora, Edward Alfonso Buitrago Torres, Eline van Remortel, Elizabeth Riaño Umbarila, Emily Norford, Fernando Flórez, Germán Andrade, Irene García, Jaime Rovira, Jennifer Lenhart, Jhon Nel Rodríguez, Juan Carlos Caicedo Hernández, Juan Felipe Guhl Samudio, Juan Múnera, Juan Nicolás Galarza Sánchez, Julián Restrepo, León Kapetas, Luis Inostroza, Maéva Dang, Manuel José Jaen Posada, Marcela Noreña, María del Pilar Arroyave, María Stella Sáchica, Marianne Katunaric, Masatoshi Funabashi, Mateo Hernández, Matías Ramírez, Nathaly Rojas, Pablo Lazo Elizondo, Piero Pelizzaro, Rigoberto Lugo, Sandra Castro and Sara María Cabrera.

Editorial Direction .Puntoaparte:
Andrés Barragán and Juan Mikán.
Proofreading:
Nicole Bedoya, John Güechá, Andrés Hernández and Nicolás Sepúlveda.
Translated by: Lina Grisales
Art Direction: Mateo L. Zúñiga, Andrés Álvarez and Felipe Caro Cediel.
Illustration: Guillermo Torres Carreño, Nere Guarrotxena, Sofía Londoño, Andrea Santana, Dylan Quintero
Design: Andrés Álvarez, Felipe Caro Cediel, Inti Alonso and Laura Gutiérrez

Graphic resources: Municipality of Montería, Carlos Montoya Baquero, Charlie Peel, Senderos de Chile Foundation, Amazonian Institute of Scientific Research - Sinchi, Iván Potes Villamil, Julián Restrepo, Leonardo Javier Centeno Castillejo, Luis Inostroza, Maéva Dang, Masatoshi Funabashi, Matías Ramírez, Municipality of Curridabat, Olger Enrique Guzmán, Sebastián Hernán Saiter Villagrán, Secretariat of Environment of Medellín, and OPUS.

Satellite images: Google Earth and IDECA Infraestructura de datos espaciales de Bogotá.

Geographic and demographic information: Municipality of Bogotá, Medellín, Montería and Santa Cruz de Mompós, Chile National Congress Library (*Biblioteca del Congreso Nacional de Chile - BCN*), Los Llanos Road Concession (*Concesión Vial de Los Llanos*), National Administrative Department of Statistics (*Departamento Administrativo Nacional de Estadística Dane*), Metropolitan Regional Government of Santiago (*Gobierno Regional Metropolitano de Santiago*), Amazonian Institute for Scientific Research - Sinchi (*Instituto Amazónico de Investigaciones Científicas - Sinchi*), Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografía e Estatística*), National Statistics and Census Institute Inec - Costa Rica (*Instituto Nacional de Estadística y Censos Inec - Costa Rica*), Medellín, how are we doing? (*Medellín, cómo vamos*), Shenzhen Government Online, and Los Llanos University (*Universidad de los Llanos*).

BiodiverCities by 2030: Transforming Cities with Biodiversity was developed under Contract No. 21-017, signed by the Administrative Department of the Presidency of the Republic of Colombia and the Alexander von Humboldt Biological Resources Research Institute. The latter carries out the conceptual and methodological development and global positioning of the BiodiverCities transformational initiative. BiodiverCities is part of the Public Sector Strategic Management Capacity Strengthening Program, through the line of urban development and Cities System for sustainability, productivity, and quality of life.

BiodiverCities by 2030 team
Alexander von Humboldt Biological Resources Research Institute

Hernando García, *General Director.*
Cristina Gómez Garcia-Reyes, *Advisor to the Director.*
Sandra Perdomo, *Head of Policy and International Affairs.*
Maria Angélica Mejía, *BiodiverCities by 2030 Lead.*
Gabriela Guerrero, *National Commission on BiodiverCities by 2030 Manager.*
Érika A. Peñuela Vega, *Project Assistant*

The present edition is an early, institutional version for personal delivery on May 23, 2022 in Davos, Switzerland.

Printing:
Zetta Comunicadores S.A.

First edition
2022
40 copies
Bogotá D.C.
Alexander von Humboldt Biological Resources Research Institute and Administrative Department of the Presidency of the Republic of Colombia (Dapre).

Suggested complete work citation:
Mejía, M. A., Amaya-Espinel, J. D. (eds.). BiodiverCities by 2030: Transforming Cities with Biodiversity. Bogotá. Alexander von Humboldt Biological Resources Research Institute. 2022.

CATALOGING DATA SHEET:

BiodiverCities by 2030: Transforming Cities with Biodiversity / edited by María Angélica Mejía and Juan David Amaya-Espinel. — Bogota: Alexander von Humboldt Biological Resources Research Institute, 2022.

268 p.; 20 x 25 cm.
Includes bibliographical references, tables, figures, maps, and index.
ISBN printed work: 978-958-5183-48-3
ISBN digital work: 978-958-5183-49-0

1. Urban biodiversity 2. Urban ecosystem services
3. Urban ecology 4. Urban Land use planning
5. Colombia I. Mejía, María Angélica (Ed.)
II. Alexander von Humboldt Biological Resources Research Institute.

CDD: 354.35 Ed. 23
Contribution number: 533
Humboldt Catalog Record: 14972
Cataloging in Publication (CIP) – Alexander von Humboldt Institute Library – Nohora Alvarado

CONTENTS

OPENING STATEMENTS

EXECUTIVE SUMMARY

INTRODUCTION

TRANSFORMATION

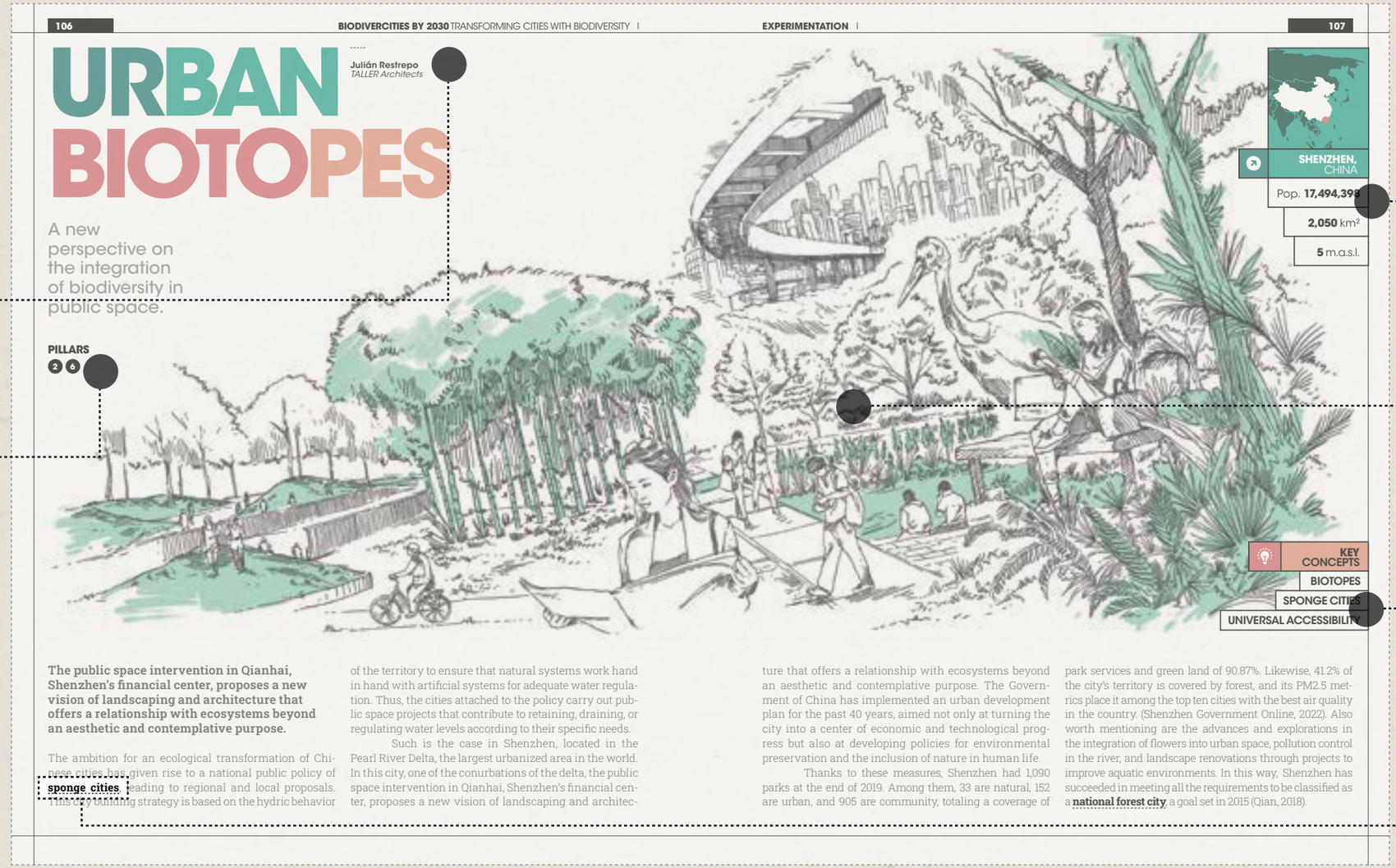
EXPERIMENTATION

OPINION ARTICLES

ANNEX

READING GUIDE
FOR EXPERIMENTATION CASES

The nodal structure of the book presents each experience in a self-contained and independent manner. Hence, the reader has a toolbox in their hands and, thanks to the defined labels, can navigate interconnectedly throughout the work.



1 Main author's data (complete information can be found in the appendix).

2 Thematic pillars attributed to the case study:

1. Urban-regional linkages
2. Biodiversity in the built environment
3. Sustainable economy
4. Governance
5. New values and mindsets
6. Planning (Enabler)
7. Financing (Enabler)
8. Monitoring (Enabler)

3 **Legend for cartographic resources:** map title, thematic source (when applicable), cartographic source and credits.

4 Biogeographical information of the city or region object of the experience: it presents population, the extension of the territory and altitude. The sources of these data are indicated on the legal page of the publication.

5 An illustration that contextualizes the experience and, in other cases, summarizes the research outcome.

6 The key concepts are developed in the glossary (see Appendix).

7 This section summarizes the main findings and lessons learned from the experience and presents the most relevant points for replication.

BIODIVERCITIES: A STRATEGY TO DELIVER BIODIVERSITY PLEDGES ON THE GROUND

Iván Duque Márquez
President of the Republic of Colombia

The race for a nature-positive world is on, and cities play a vital role in it. In the past two years, the COVID-19 pandemic has challenged our assumptions about work, transportation, consumption habits, and city living at large. Many are questioning the current urban design and structure to provide healthy, equitable, and sustainable living and reimagine a more resilient model for the future.

Colombia is the world's most biodiverse country per square meter, and by 2018 Colombian cities were home to more than 76,8% of the national population. Considering the national undertaking of accelerating sustainable and resilient development by 2030, making cities inclusive, safe, and sustainable is a foremost priority for our country.

In line with the climate and biodiversity global commitments, the Government of Colombia has implemented a nature-positive approach to urban development in the last three years: BiodiverCities (BiodiverCiudades). The BiodiverCities strategy was initiated in close dialogue with City Mayors to tap into different opportunities for mainstreaming biodiversity in urban contexts—from the Caribbean, the Andean mountains, to the Amazon, and the Pacific Coast.

We recognize that natural capital is the most valuable strategic asset for our nation's development. Accordingly, several Colombian cities currently benefit from technical assistance and co-finance from the National Government and several regional and international organizations. Including the Inter-American Bank (IDB), the World Research Institute (WRI), the Development Bank of Latin America and the Caribbean (CAF), and UK cooperation in implementing roughly 100 projects that aim to bring biodiversity and nature-based solutions to the center of the urban agenda.

Projects range from urban renewal of cities based on their rivers, mangrove and saltmarsh restoration, construction of botanical gardens, bio-diverse parks, eco-tourism, participatory science, air quality monitoring, urban tree planting, and environmental education.

Engineering this transformation takes wise leadership and visionary foresight above the pressures of the here and now. To this end, the Government of Colombia has partnered with the Alexander von Humboldt Research Institute of Biological Resources and the World Economic Forum to turn the national initiative into a global one, with a significant ambition: BiodiverCities by 2030. This initiative speaks to city governments, businesses, and citizens worldwide and invites us to reimagine urban development with nature and people at its core.

After the first issue in January 2022 on the opportunities of investing in nature-based solutions in cities, the Colombian Government is pleased to present this book, which introduces the foundations of the BiodiverCities vision and offers an overview of meaningful practices, tools, and guiding principles to advance biodiversity in cities. We encourage citizens, city officials, and the whole urban community to navigate through the experiences and lessons from Colombia and the world on how nature is shaping the cities of tomorrow; and how it can be a driver of sustainable urban development.

I want to express our sincere gratitude to all contributors in Colombia and beyond for their support in preparing this issue and, most importantly, for sharing their inspiring views on the opportunities of transforming cities into BiodiverCities.

A GLOBAL NETWORK OF BIODIVERCITIES BY 2030 – WHY AND HOW

Lena Chan
Senior Director, International Biodiversity Conservation Division, National Parks Board
Co-Chair, Global Commission on BiodiverCities by 2030

Mauricio Rodas Espinel
Visiting Scholar, University of Pennsylvania, USA
Co-Chair, Global Commission on BiodiverCities by 2030

Most of us reading this article live in a city, as does 57% of the world's population. Drawn from our personal experience and increasingly supported by well-designed long-term research, it is recognized that frequent interaction with biodiversity is essential for our physical, mental, and psychological wellbeing. We are embedded in nature, and for our survival, we must conserve biodiversity in areas where we live, play, and work – cities.

Healing the urban-rural linkages is critical for making progress on global agendas such as the New Urban Agenda, the Sustainable Development Goals, and the Global Biodiversity Framework, among others. To effectively conserve and restore biodiversity, we need to address the current weak ties between urban and rural areas by implementing a policy strategy and working to mitigate urban sprawls, protect local food systems and raise awareness of the social and economic cost of biodiversity loss.

As biodiversity knows no boundaries, its conservation and restoration must be carried out by everyone through global partnership at all levels. Many areas, widely spread geographically, face the daily existential challenges of biodiversity conservation and climate change, manifested as floods, droughts, rising sea levels, soaring temperatures, etc. Urgent action must be taken before we reach the tipping point.

WHERE DO WE START?

The Global Commission on BiodiverCities by 2030, comprised of a committed team of multidisciplinary expertise, is a joint initiative of the World Economic Forum and the Alexander von Humboldt Institute. Championed by the Government of Colombia, it was established to inspire, motivate and assist city governments, businesses, and people in cities to thrive in harmony with nature by 2030. The Commission published a report titled "BiodiverCities by 2030: Transforming Cities' Relationship with Nature" in January 2022. The Alexander von Humboldt Institute has taken one step further by compiling this handbook.

WHO CAN WE DRAW LESSONS FROM?

Colombia and Singapore are highlighted as two countries that have success stories to share, despite differences in their physical size, culture, geographical features, and history. Both are firmly committed to the biodiversity agenda, as reflected in their numerous biodiversity conservation efforts. Medellín adopted a local action plan on urban biodiversity, "Medellín, a city of life," linking biodiversity and human wellbeing through ecosystem services. Singapore evolved from a Garden City to a City in a Garden in the past 50 years. To counter current existential challenges, Singapore is transforming into a City in Nature through nature's restoration in the city for liveability, sustainability, and wellbeing. This is achieved by applying nature-based solutions for climate, ecological and social resilience.

While the implementation details might differ, the key CREATE principles to adhere to for biodiversity conservation are:

- **C**onserve indigenous natural ecosystems
- **R**estore, rehabilitate and enhance ecosystems
- **E**cologically connect natural areas
- **A**pply science and technology, especially nature-inspired ideas and nature-based solutions
- **T**otally involve everyone
- **E**valuate and monitor biodiversity efforts using tools like the Singapore Index on Cities' Biodiversity, IUCN Urban Nature Index, etc.

The processes of biodiversity conservation must be facilitated by key enablers, this is:

1. Active, comprehensive, and all-inclusive participation by everyone. Active involvement by youth as they must play a prominent role in helping shape the future responsibly.
2. Application of science, technology, and digitalization will help make the journey more efficient.

It is imperative for our survival that we hasten the momentum to convert cities worldwide to become BiodiverCities by 2030 and beyond. We have no other choice. Let's collaborate now to make our cities BiodiverCities!

PREFACE

Hernando García
General Director
Alexander von Humboldt Biological
Resources Research Institute

Ecology, the science of nature's interconnections, teaches us that every plant, fungi, mammal, fish, bird, insect, and bacteria is deeply engaged with each other and with water, gravity, pressure, wind, fire, soils, temperature, and climate. The Earth is made out of interdependences, yet we humans have built political, physical, and disciplinary barriers in an attempt to make sense of our complex world. This paradox of seeking understanding and control while upsetting the balance of the system has led us to the current situation: a compartmentalized planet with siloed subsistence and survival efforts.

Let's take cities as a microcosm of our planet. Cities are living systems connected with forests and oceans, with mountains and valleys. They have intakes, outtakes, and dynamic interactions with their environment and their fundamental parts: nature, the built environment, and social systems. Cities have grown remarkably in the last decades, resulting in more and more people living in landscapes that are regrettably disjointed from nature and mainly dominated by asphalt, glass, bricks, and cement. Understanding the implications of such growth for nature and society became one of the Humboldt Institute's main objectives in 2012. The Institute has since dedicated substantial efforts to analyzing the causes and effects of urbanization in a megadiverse country.

For such a purpose, we have built networks and alliances with local governments, universities, organizations, and the private sector in the last ten years and mobilized expert and practical knowledge through multi-stakeholder dialogues at the global, regional, and national scales. These partnerships and exchanges are represented today in twelve 'urban projects' that include wildlife radio telemetry, ecosystem services mapping, urban bioeconomy, ecosystem-based adaptation, nature-based solutions, and community science.

In 2021, the Institute was appointed as the leading knowledge partner to implement the BiodiverCities initiative, Colombia's strategy to bring nature back to fourteen cities nationwide. This opportunity has positioned the Institute as a lead organization in urban biodiversity. We embrace this accomplishment by recognizing and honoring many other institutions that have laid the groundwork for better biodiversity stewardship by cities and within cities.

As part of the BiodiverCities initiative, we have also consolidated a strong partnership with the World Economic Forum, a significant ally supporting the development of the global ambition of BiodiverCities, known today as the **BiodiverCities by 2030** initiative. The Forum's Nature Action Agenda has galvanized this initiative to greater visibility and impact through a high-level commission of experts, artificial intelligence systems, and crowdsourcing technologies.

The initiative's first year is coming to an end, with crucial milestones like the BiodiverCities by 2030 Insight Report released in January 2022, a report showcasing investment opportunities for increasing nature in cities. And so, the time has come for the second issue -and final output- of this burgeoning first phase: the BiodiverCities by 2030 book.

The book in your hand brings together knowledge and lessons from transformative actions taking place in Colombia, Latin America, and the world. Each of these experiences from very different contexts will provide you with innovative approaches, multiple options, and inspiring opportunities to design, live and enjoy cities in harmony with nature. Today is the time to rethink planetary health from within cities. Today is the time for cities to commit to planetary sustainability. Let's welcome new urban futures that ignite all forms of life. Let's start transforming the planet with BiodiverCities.

EXECUTIVE SUMMARY

18 TRANSFORMATIVE ACTIONS TO DESIGN, LIVE IN AND ENJOY CITIES IN HARMONY WITH NATURE BY 2030

María Angélica Mejía
Juan David Amaya-Espinel
Editors

Global urbanization represents a genuine social and environmental paradox. Cities have become the most important centers of access to services, housing, physical infrastructure, and the development of knowledge and processes of technological and social innovation. However, cities are also responsible for an extensive transformation of the natural ecosystems on which they are settled, as well as biodiversity and their capability to provide services closely linked to the well-being of urban dwellers.

This centrality of cities as hotspots of world population growth and demand for better living conditions worldwide highlights the urgency of understanding how urban areas' economic, social, and ecological functions can work together to benefit the environment and human society alike. Our transition to new growth and sustainable development models will inevitably pose serious challenges. Tackling the latter by reconciling human and ecological dimensions is the most significant contribution cities can make to a **nature-positive** world by 2030.

BiodiverCities arise as an opportunity for humans to live, work and evolve in harmony with their environment. This vision is an action framework in which cities can be comprehensively planned as truly interconnected living socio-ecological systems that ensure ecosystems' integrity and ability to offer human well-being and climate resilience. Thus, BiodiverCities represents a transformative concept of city futures that can avoid environmental degradation of ecosystems and the negative impacts on natural environments and human well-being. This transformative vision of BiodiverCities emphasizes the need for change processes based on a new approach to policy that goes beyond "systems optimization" through top-down technocratic approaches.

When this book project started, we invited all contributors to reflect on the question. *What are the transformations needed to reach* BiodiverCities by 2030*?* With this invitation in mind, in August 2021, over 80 scholars, practitioners, leaders, promoters, and visionary individuals from 44 cities were convened to reflect on five ways[1] in which cities can transform and move towards sustainability by restoring their relationship with nature (see section *Transformation*). This book showcases conceptual approaches, case studies, and op-ed articles addressing why nature in and around cities is crucial to ensuring planetary health.

Contributors analyzed urban natures ranging from Montería and Mompox (riverside cities that functioned as amphibious lands in pre-colonial times) to real estate practices in Milan and Villavicencio. Their analysis included a circular green hotspot in Amsterdam, planetary health diets in Quezon City and Copenhagen, a pan-European toolbox to manage blue environments, a comprehensive methodology to value the benefits of urban trees in Medellín, a food security approach based on green roofs in Rio de Janeiro, and practical applications to advance biodiversity in the public space in the Chinese "sponge-city" of Shenzhen. We organized these contents to guide readers into understanding *why* a system transformation is needed to adopt a nature-positive approach to urban development and *how* it actually happens.

In the following pages, we propose a set of transformative actions grouped in six dimensions to initiate (and navigate through) change toward cities in harmony with nature by 2030. System transformation implies change across all those dimensions. The book also contains vital messages that offer new approaches to promote change and, hopefully, trigger transformative actions. We hope these actions speak to and inspire subnational governments, national authorities, the international community, business, finance, and society in general to imagine the future cities we want to live in -and make them happen.

TRANSFORMATIVE ACTIONS

Values, beliefs, and worldviews

- **Transforming academic disciplines, planning instruments, and perceptions of cities as a threat to biodiversity.** Some emerging concepts that accompany this change of mentality are urban landscape design, re-naturalization, contributions of nature to people, and regeneration (see *The Sweet City, London Natural Park City, The case of Synecoculture*).

- **Promoting cities as hubs of positive interactions between ecological, social, and technological systems.** Recognizing the role of the built environment and technology as mediators of society-nature relations and capitalizing on the opportunities offered by the interaction between biodiversity, infrastructure, and culture that converge in urban areas.

- **Approaching cities as socio-ecological systems constantly shaped by by the interactions between ecosystems, biodiversity, and culture.** Current urban planning paradigms and our general perception of cities overlook the ecology that governs, determines, explains, and makes every city possible and the scale on which it operates (see *Urban Amazon*).

Norms and regulations

- **Transforming productive sectors to harmonize social and economic demands with the functional maintenance of ecosystems and biodiversity.** Cities demand models of multilevel governance, market regulation, bio-intensification, and environmental accounting that ensure maintaining large-scale ecological processes -like water, materials, and energy cycles- and ecological succession.

- **Addressing the human footprint that extends beyond cities.** We need to rethink the metabolic

relationships between cities and regions; and transform norms and regulations that directly address the environmental liabilities that urban sociotechnical regimes such as mobility, water, or electricity generate on a regional scale.

- **Promoting planning processes that overcome the dichotomy between grey and green infrastructure.** The conservation and recovery of green space networks in cities must be planned processes seeking to harmonize urban development goals with societal challenges that depend on the provision of ecosystem services through concepts like Nature-based Solutions or urban forests.

Information and knowledge flows

- **Promoting citizen engagement in generating information on biodiversity and urban ecosystem services and their use in decision-making.** Digital platforms such as eBird and iNaturalist can stimulate participatory projects for monitoring and inventorying biodiversity in urban environments and feeding systems for its evaluation and monitoring.

- **Supporting platforms help spread good ideas and practices in maintaining and recovering biodiversity and ecosystem services between cities.** Collaboration, co-creation, and innovation processes can be supported by generating and exchanging knowledge based on positive links between governmental and academic sectors and local communities.

- **Ensuring that local reports demonstrate the value of maintaining and recovering biodiversity in cities concerning the achievement of key SDGs at the urban level.** We need to develop evaluation systems and indicators that can monitor long-term interactions between drivers, pressures, states, impacts, and responses that describe the relationship between biodiversity and several human dimensions.

Resource flows

- **Developing a new urban economy based on biodiversity and equitable distribution of its benefits.** Biodiversity is much more than the sum of green areas in cities, as these zones profoundly impact urban economies. The implementation of circular bioeconomy models, nature-based economies, and biomimicry will allow cities to increase competitiveness and face several societal challenges related to employment and poverty.

- **Diversifying the supply of financial instruments, incentives, and aids to promote the incorporation of biodiversity in urban planning.** Cities seeking to increase nature's contributions to people's well-being need to develop incentive programs and tax schemes that facilitate public, private, or joint investments around the maintenance and recovery of ecological and social functions of ecosystems and biodiversity.

- **Encouraging the creation of natural capital funds and NbS projects at the municipal level.** An agency or fund to finance NbS projects focused on nature, biodiversity, and ecosystemic adaptation to climate change in cities could explore several direct or indirect forms of financing.

Roles and routines

- **Embracing the Urban Commons as a critical aspect of a BiodiverCity.** Urban Commons include material resources such as parks, community gardens, streets, abandoned buildings, and intangible aspects such as culture, public services, and community bonds (see *BiodiverCities from the Neighborhood*).

- **Promoting experimental spaces implying the creation of platforms for new interactions.** Such is the case of a growing number of Urban Living Labs (or Fablabs), Makerspaces, and "Transition arenas" where stakeholders envision transformations.

- **Instead of doing more, we need to do less.** It is important to let nature reconquer urban spaces—to abandon our fixation on order and the "cleanliness" of green areas. Instead, city managers could try preserving the biomass that allows ecological succession and maintains ecosystem services (such as pollination) that have a regional impact.

Power relations

- **Approaching cities as a space for distributed agency.** Cities are no longer a clean-cut green vs. gray system or a human *against* the non-human matrix. They are now a socio-ecological system where people experiment, connect, share, learn and innovate (see *BiodiverCities from the Neighborhood, London National Park City*).

- **Promoting a shared vision of the future city based on principles of equity and well-being.** Urban regeneration initiatives integrating biodiversity and ecosystem services can benefit from shared visions of the future city and practical efforts that pursue collective goals. They also benefit from community-led networks that push for institutional and behavioral changes around biodiversity conservation values, well-being, sufficiency, and inclusion.

- **Acting decisively to reduce social gaps around the distribution and access to the benefits derived from biodiversity in cities.** Nature's contributions to people (e.g., disaster risk reduction or adaptation to climate change) must be capitalized equally for the entire population, rather than just becoming another inequality factor, especially for the most vulnerable.

TRANSFORMATION

EXPERIMENTATION

OPINION ARTICLES

INTRO DUCTION

UNDERSTANDING BIODIVERCITIES FROM A TRANSFORMATIVE CHANGE APPROACH

Matias Ramírez
University of Sussex, UK

Andrea Padilla
University of Sussex, UK

INTRODUCTION

ARENAS FOR TRANSFORMATION OR SYSTEM OPTIMIZATION?

The redefinition of cities as centers of world population growth worldwide highlights the urgency of understanding how ecological, economic and social functions in urban areas can work together to benefit the environment and human society alike. **BiodiverCities** offer a vision of the city where human beings can live, work and evolve in harmony with their environment. We will argue that this represents a transformative concept of city futures that can avoid environmental degradation of ecosystems and the negative impacts on natural environments and human welfare. Cities are centers of creativity and lifestyle, culture, and learning. They can also be drivers of a new ecological infrastructure in which parks, gardens, open spaces, and water catchment areas thrive and support healthy ecosystems and biodiversity. Examples of these include the work by van der Jagton (2020) and others on "nature-based solutions" (NBS), where green roofs, bioswales, and urban agriculture offer promising ways in which innovative use of nature can help address sustainability challenges in cities.

A central message of this publication is that, especially for cities in the Global South, addressing challenges of sustainable development requires a new approach to policy that goes beyond "optimizing systems" through top-down technocratic approaches. **Transformations** involve radical changes in **socio-technical** and **social-ecological systems** and how these relate. The term "radical" refers to the scope of change rather than its speed (Grin et al., 2010). This is embodied in the sustainable development goals that highlight the link between environmental and social sustainability. Transformations also refer to multi-actor processes that entail interactions between different social groups such as firms, user groups, scientific communities, and social movements.

We draw upon a substantial body of academic literature that discusses how to steer transition dynamics and help create the basis of a new policy approach (Rohracher & Späth, 2017; Sengers et al., 2016; Torrens & Schot, 2017). These are based on three basic principles: **directionality, experimentation, and learning.**

- Transformation is about establishing new *Directions*. This is important because historical studies have shown that most innovations are cumulative and, therefore, can be said to have a direction that is seen as natural or inevitable. For this reason, only certain solutions are looked for and others are ignored. Transformative innovation proposes that not all innovations are positive; some can be highly damaging and create social inequality. Therefore, new directions must be considered, and new development trajectories opened to fulfill societal and environmental goals.
- Early phases of transition are often characterized by *experimentation*. It is not clear which different developmental paths are the best options for society. Experiments can be a mechanism for building niches. These can be important for socio-technical change by challenging existing approaches, setting up new collective priorities, and guiding transformations.
- Experimenting with different options should generate 2nd order *learning*, the process of questioning existing routines, rethinking how problems are defined and what solutions are considered appropriate. This involves reflexivity – the ability of actors to reflect on their practices and assumptions and those of others. It should also stimulate actors to engage with each other to allow 2nd order learning.

This first introduction chapter delivers a valuable contribution that outlines systemic change and sustainability transitions literature. It presents the main concepts, rationales, and values of socio-technical

LATIN AMERICAN HUB

The Latin American Hub of the Transformative Innovation Policy Consortium (TIPC) is a community of practice that brings together organizations based in Latin America in a joint venture to implement methodologies of experimental policy and formative evaluation developed in TIPC. It works with the ideas and methods of transformative innovation policy to build a new approach to science, technology, and innovation policy relevant to addressing significant challenges in the region.

Members undertake transformative experiments whose objective is to advance transformations of socio-technical systems, for example, in energy, transport, and access to clean water and food. These experiments focus on transforming practices within the system by applying a common framework and methodology.

For more information, visit:
https://hubinnovaciontransformativa.net/ (Spanish)

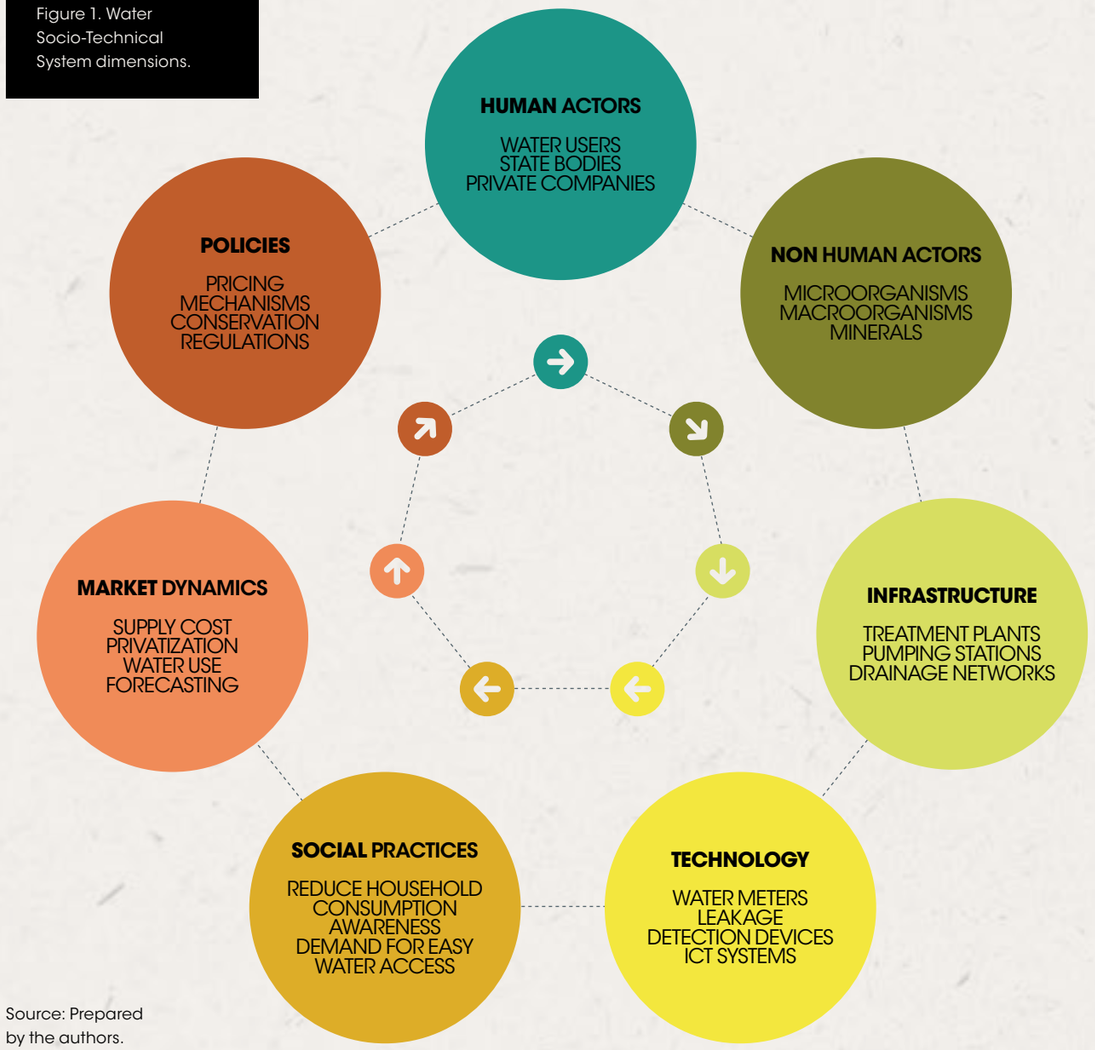
and socio-ecological systems and the connections between them. Next, we discuss the complexity of biodiverse urban transitions and how visions of optimization or transformation can lead to different outcomes, particularly when considering Global South urban dynamics. In addition, it discusses the challenges around the governance of BiodiverCities, which are intrinsically linked to questions over who governs, whose vision of sustainability is prioritized, and the value of promoting urban planning. Finally, we present conclusions about the implications of a transition towards BiodiverCities. As the first introduction for this publication, this chapter, sets out the underlying themes that mark the overall guiding framework for the subsequent publication.

UNLOCKING SYSTEM TRANSFORMATION

WHAT IS A SOCIO-TECHNICAL SYSTEM?

Transitions theory has emphasized the notion of socio-technical systems

Figure 1. Water Socio-Technical System dimensions.



Source: Prepared by the authors.

to understand processes of change. These systems exist in areas that fulfill basic social needs such as energy, mobility, food, education, and healthcare. Each system involves a wide range of human and non-human actors, different regulations and policies, a mix of market dynamics, a collection of scientific and lay knowledge, and a series of technologies and recurrent practices (F. Geels, 2002). An example of socio-technical systems in urban settings is the water system. Cities depend on their water supply quantity, quality, reliability, and affordability for drinking, food production, sanitation services, manufacturing, and industrial activities. A systems approach to managing water resource systems can help urban planners and practitioners by providing a comprehensive picture of the social, environmental, technical, economic, and political dimensions involved. That is, acknowledging the role and interaction between human actors, non-human actors, policies, market dynamics, infrastructure, technologies, and social practices (see Figure 1, for example). Together, these actors and elements illustrate urban water systems as complex systems in which technology, society, and natural components are in constant co-evolution. (See Geels (2005) for a historical example of water supply socio-technical system transition in the Netherlands).

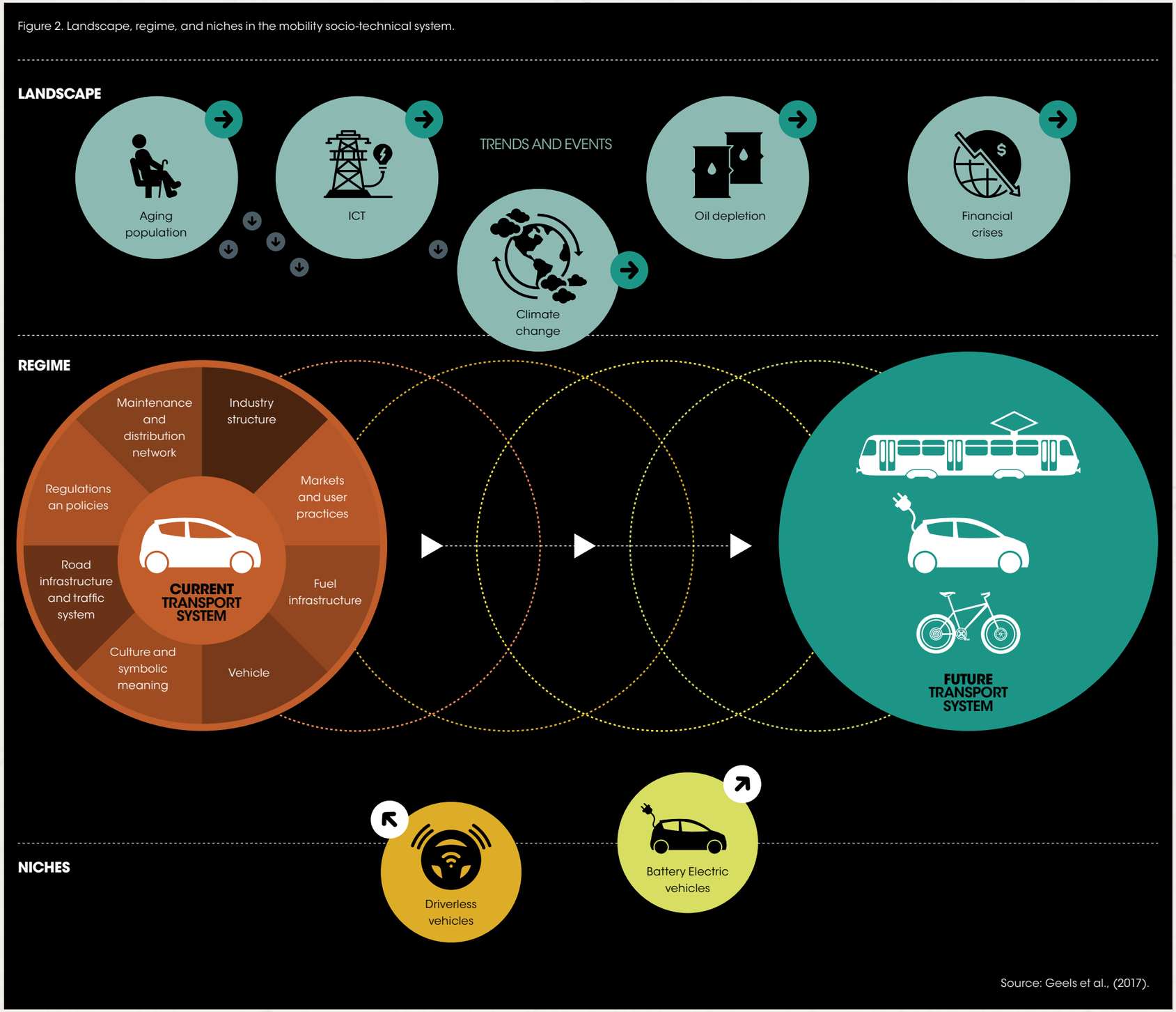
The urban water system has been affected by rapid urbanization rates, population growth, and climate change consequences. Hence, water scarcity, pollution, and high supply costs are increasingly disrupting social, economic, and environmental conditions. Urban planning often fails to deliver appropriate solutions for extreme weather conditions such as heat stress, droughts, or flooding (Güneralp et al., 2015) but assume constant urban extent. Similarly, flawed water disposal mechanisms induce water stress and have negative implications for coastal or river ecosystems in urban and peri-urban areas (Sabater et al., 2018; Wear et al., 2021). Due to increasing pressure on the provision, quality, and cost of water resources, cities are engaging with nature-based solutions that support natural water cycles and increase urban water system resilience. These include alternative innovations such as recycling mechanisms for rain, storm, and wastewater, reconnecting rivers with their floodplains, and supporting urban watersheds that function as catchment basins (Butler et al., 2017). For example, in Italy's Lombardy region, the Gorla Maggiore water park project is an urban wetland development that protects and improves water quality and promotes socioenvironmental co-benefits (Masi et al., 2018). The project includes a sedimentation tank, vertical water flow wetlands, a large pond, green open spaces, cycling, and walking recreational paths. These elements combined prevent flooding, support domestic water treatment, and enable noise reduction and temperature control. Ultimately, the park promotes biodiversity conservation and supports human wellbeing.

UNDERSTANDING REGIMES, NICHES, AND LANDSCAPE

As stated before, complex problems require comprehensive approaches. Transitions theory has developed a now well-recognized approach to describe and provide heuristics for socio-technical system change known as the multi-level perspective (MLP) (F. Geels & Schot, 2007); see figure 2 below for a graphical representation of the mobility system using MLP. This describes the change process in socio-technical systems as arising from interactions in three different and interconnected levels: regimes, niches, and landscape. *Regimes* are dominant configurations expressed in a series of practices, rules, and behaviors that define production and consumption dynamics in a given system. This is similar to that described above, with the dominant preference for car-based mobility. *Niches,* by contrast, are alternative system practices that challenge the incumbent regime by developing shared visions and different socio-technical innovations within a "protected space," in other words, a space where the rules of the incumbent system do not predominate. Non-fossil-based fuel mobility alternatives such as electric cars and scooters and water-resilient innovations such as nature-based solutions have emerged as niche experiments. The landscape also influences *this proces*s, an exogenous environment that pressures the system through trends or shocks (F. Geels & Schot, 2007). For instance, climate change, macro-economic trends, or the COVID-19 pandemic are considered landscape events. Thus, transformation occurs due to external pressures and emerging niches that co-evolve through time and space and create new configurations for existing socio-technical systems.

Depending on the desired vision of systemic change, the interaction between regimes, niches, and landscapes can lead to alternatives of either **system optimization** (Di Maio, 2014) or **system transformation** (R. Byrne et al., 2011; F. Geels & Kemp, 2007). In both cases, technology and innovation play a fundamental role. However, in system optimization, change originates mainly from reacting to specific problems using the practices of existing systems. Policymakers often find this approach more convenient as it is supported by rationales of efficiency, competitiveness, and market-led dynamics. Actions of system optimization are often based on traditional managerial methods such as strategic planning, cost-benefit analysis,

Figure 2. Landscape, regime, and niches in the mobility socio-technical system.



Source: Geels et al., (2017).

and target monitoring. They usually emphasize technical and technological advances as tools that contribute to system change.

By contrast, system transformation emphasizes the need to reconfigure systems and requires a shared vision of change. Such a reconfiguration requires changes in the rules and practices of the existing system. This means working to change system features, such as the nature of markets, infrastructures, and technologies, and some of the values, expectations, and preferences that guide the choices and actions of actors in the system (Geels & Schot, 2007).

WHAT IS A SOCIO-ECOLOGICAL SYSTEM?

The concept of BiodiverCities needs to address transformations in both socio-technical and socio-ecological systems. These are similar concepts regarding their focus on system transformation but differ in terms of the system definition. Socio-ecological systems are composed of two primary domains – social and ecological– that hold several sets of interdependent and dynamic elements in constant interaction (Fischer et al., 2015). These elements are reflected in the economic and socio-cultural institutions that support our communities in the social domain. As seen in figure 3, people can modify how they use and care for natural elements. In the ecological field, they involve biological processes related, for instance, to geological, water, air, and mineral cycles which provide the necessary materials and benefits to support human life –and human lifestyles. As interactions between people and nature increase in their scale and intensity, it becomes clear that the boundaries between human and environmental structures are artificial (Berkes & Folke, 1998). They are all part of the same system and thus can be affected by changes in any of the two primary domains.

IDENTIFYING DIFFERENCES BETWEEN SYSTEM OPTIMIZATION AND SYSTEM TRANSFORMATION

- Are you having a dialogue with traditional actors or involving a broad and diverse set of actors? (Diversity)
- Are you recognizing different opinions, interests, and needs among stakeholders? (Inclusion)
- Are you mimicking a solution developed for a specific setting or adjusting it to your geographical and social context? (Context-based)
- Are you encouraging different actors to meet with each other and create lasting bonds? (Networking)
- Are they co-creating new narratives, visions, and goals for the desired future? (Co-creation)
- Are actors sharing knowledge or ideas and reflecting on the system change process? (Learning)
- Are you promoting development solutions that exhibit links between practices, technologies, and knowledge? (Experimentation)

A vital characteristic of the intertwined relation between social and ecological domains is that they are governed by **feedback loops** (Knoot et al., 2010). According to their potential, loops can be positive or negative to enhance change and support the system's natural dynamism. When ecological systems are disturbed (intervened by humans), it creates an imbalance and forces the system to adapt and self-regulate. For instance, while human-made dams can be intended for irrigation or renewable energy purposes, they also influence migratory movements of several species, as well as changes in temperature, oxygen, and sediment conditions that alter water cycles and riverine wildlife (Mcallister et al., 2001; Wu et al., 2019). It is constant interaction between the social and ecological domains that enables further variation through the exchange of matter, energy, and information that pushes the system away from a state of equilibrium and into one of continuous change.

The socio-ecological analytical framework focuses on the linkages between ecosystems and social institutions. This framework reflects on socio-ecological interactions, feedback loops, tensions, and mutual benefit dynamics across different scales (Berkes & Folke, 1998). For instance, while exceptional ecosystem conditions promote tourism and foster local economic development, overexploitation can degrade the very same landscape qualities that attract most tourists. Similarly, the growth of informal urban settlements —most of which are driven by vulnerable people's desire to improve their livelihood— can lead to economic benefits for those migrating while at the same time creating damaging footprints on urban ecology (Aguilar & Santos, 2011). Research has advanced our understanding of how decision-making can align nature's conditions and attributes with human preferences, values, and needs by exploring the complexity of social and ecological interactions.

Because humans and nature are embedded in the same system, any change in one part of the system's components affects another. Thus, socio-ecological systems are in a constant process of co-evolution. This means that people, economies, and culture depend on (and are shaped by) the biosphere around them and vice versa. Such interdependence occurs across multiple scales that range from an individual level to the local, national, regional, and global levels. For example, within urban settings, green spaces provide habitats with essential characteristics for a wide range of organisms and microorganisms. At the same time, the biodiversity in these urban settings provides core goods and services that city dwellers depend on.

An essential aspect of socio-ecological interactions is the so-called **ecosystem services** (Gómez-Baggethun & Barton, 2013). These are benefits that humans obtain from the ecosystems that support different societies' development and sustainability. They include:

- Provisioning services and goods obtained from ecosystems. For instance, food production in peri-urban farm fields, backyards, community gardens, or water supply for drinking, sewage, or industrial uses.
- Regulation services that provide benefits obtained from ecosystem processes. Urban vegetation in parks often provides climate regulation, water purification, and erosion control.
- Supporting services are those that allow other ecosystems to function, such as nutrient cycles, crop pollination, and enabling living habitats for species.
- Cultural services related to recreational, spiritual, or cognitive activities. Such as ecotourism, outdoor sports, or even using nature as inspiration for artistic or creative purposes.

In urban settings, ecosystem services are fundamental for human health, and humans are less prone to physical and mental diseases by supporting air purification, noise reduction, and temperature cooling. Ecosystem services can also enhance or avoid economic costs. For example, homes near green cover often have higher market value, and those shaded by trees often have lower energy costs (Byrne & Houston, 2020).

SUPPORTING THE "COMMONS"

An important aspect of the discussion of the transformation of cities as sustainable socio-ecological spaces and systems is supporting, building, and managing the "Commons" as an alternative representation of urban areas (Foster, 2011; Foster & Iaione, 2015). Commons are either spaces or natural resources that are finite and non-excludable to rivals, that is, resources that anyone can use but with a limited amount available. When it is in the best interest of each individual to overuse a resource with no regard for others, these are prone to overexploitation or to what Hardin called the "Tragedy of the Commons" (1968). Forestry, pasture, and fisheries are classic examples of these shared resources as they can exhibit clear signs of overexploitation through deforestation, soil erosion, water scarcity, and species extinction. In urban settings, the Tragedy of the Commons becomes apparent in areas such as automobiles congestion rates. In cities such as Moscow, Mumbai, and Bogota, the number of cars exceeds the capacity of urban arterials and leads to some of the world's worst traffic jams (TomTom, 2021) and thus to vehicle emission air pollution (Zhang & Batterman, 2013). According to Hardin, amid the failure of trust in one another and the absence of strong

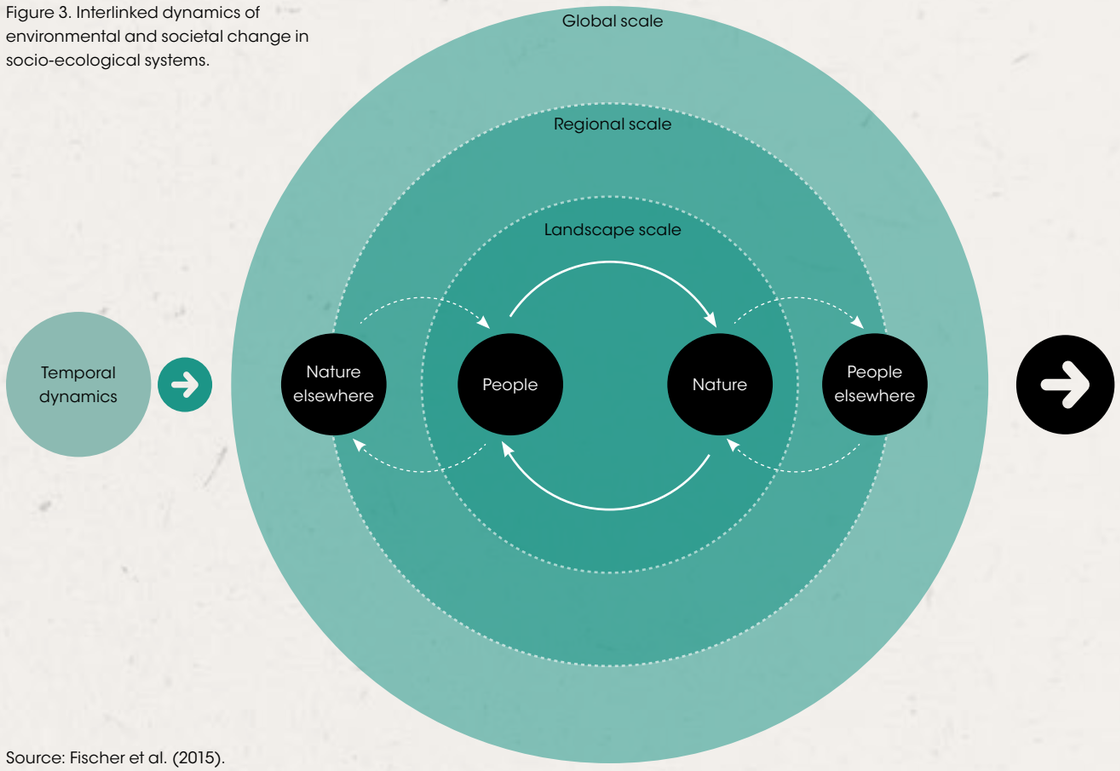


Figure 3. Interlinked dynamics of environmental and societal change in socio-ecological systems.

Source: Fischer et al. (2015).

social institutions to enable cooperation, the tragedy is only solved by the state's intervention that regulates resource usage by fostering long-term preservation or extending the private property to individuals. Therefore, the owners will reap the consequences of over-exploitation and reduce over-exploitation.

As the discussion over BiodiverCities extends, policymakers, activists, and scholars are increasingly embracing the notion of **Urban Commons**. This notion is guided by principles of solidarity, active citizen engagement, inclusion, and social justice (Borch & Kornberger, 2015; Foster, 2011). Urban Commons offers a wide range of resources in the cities that can be made accessible and used by all dwellers, especially those who have difficulty accessing these types of services. Examples of Urban Commons include material resources such as parks, community gardens, streets, and abandoned buildings. They also include intangible aspects such as culture, public services, and community bonds (Hess, 2008).

REIMAGINING CITIES AS HUBS OF BIODIVERSITY AND RESILIENCE

Historically cities have been vibrant centers of political, social, cultural, and economic activities. All around the world, the clustering of these activities contributes to the provision, distribution, and access of numerous essential services around housing, transportation, communication, education, health, sanitation, and other everyday human needs. Similarly, within every urban area, the interaction between people, firms, and governments shapes the formal and informal rules that guide the way dwellers live and how they relate to the services mentioned above. Therefore, the high density of activities and interactions within the same geographical space strengthens interdependence and feedback loops among socio-technical and socio-ecological systems. In turn, this makes urban dynamics more complex.

This complexity emerges partly because, since industrialization, the dynamics of urban services have constantly changed. With the introduction of new technologies also came

changes in user preferences reflected -among others- in higher demands for a wide range of products and services (Dholakia, 2012; Gaile-Sarkane, 2009). This led to significant economic growth and a shared notion of opportunities that attracted people to cities. In the global south, urban development is shaped today by urban expansion and increasing migration of people from rural to urbanized areas. Current urbanization trends indicate that by 2050, 68% of the global population will settle in urban areas. This means an increase of 2.5 billion people in 30 years, nearly 90% of which will be living in Asian and African cities (United Nations, 2019). Cities like Lagos, Nigeria, are struggling to accommodate the needs of an increasing influx of dwellers. The housing deficit is currently estimated at 2.5 million units, which is why there are now over 200 informal settlements, with 66% of the population living in slums (Wallace & Alake, 2019). Not to mention insufficient amenities for mobility and social security.

Additionally, as cities expand, they have also become a focus of environmental concern. Issues such as air pollution, land degradation, water stress, and loss of biodiversity can all be linked (at least to some extent) to urban dynamics (Seto et al., 2011). Automobiles, industries, and construction infrastructure all provide essential services to dwellers. However, in doing so, a contradiction emerges as they also entail higher demands for natural resources, higher energy needs, and higher waste production (Inostroza & Zepp, 2021). This increased pressure on the biophysical environment leads to significant climate change consequences when poorly managed or overlooked. Paradoxically, it is the cities and their dwellers who experience the effects. In Mexico City, air pollution is climbing as the cause of death of its inhabitants (Cromar et al., 2021). In Sao Paulo, water management infrastructure collapsed as the city grew faster than expected, and in 2015 it suffered a significant drought leading to socio-economic tensions (Romero, 2015). Similarly, in Mumbai, the pollution of rivers with industrial materials has increased water scarcity, provoking severe health issues, particularly in the city's slums (Subbaraman et al., 2013; Subbaraman & Murthy, 2015). On many occasions, these damaging consequences affect not only city dwellers but extend to a greater geographical region. Thus, preserving the natural environment and protecting human health and wellbeing are intrinsically intertwined across time and spatial scales.

THE ROLE OF BIODIVERCITIES IN SUSTAINABLE URBAN DEVELOPMENT

While it is true that cities have played a significant role in creating and reproducing many societal challenges, they can also be part of the solution. Urban economic growth and development entail environmental challenges and knowledge production and innovation sources. As more people access education, communication tools, and financial means, they hold greater potential to make critical reflections, discuss imaginaries of future BiodiverCities and build solutions that can contribute to sustainable development pathways. Hence, cities are not passive scenarios where transitions can happen (Bouzarovski & Haarstad, 2018) but rather fundamental actors that can influence the process of transition.

Recent urban agendas have introduced narratives of "regeneration," an idea that draws insights from socio-ecological relations to deliver real-world solutions for urban planning (Raymond et al., 2004). For example, an increasingly diverse set of nature-based solutions aim to protect, restore, or manage natural ecosystems inside and around cities. These actions are discussed by local communities and adapted to their context, so they focus first on understanding the societal needs and then exploring alternatives to address them. Green-blue infrastructures such as green roofs and walls, urban canals, and urban allotments are typical examples of nature-based solutions with some interventions in ecosystems and landscapes (Muller et al., 2010; Tarsitano et al., 2021). However, many communities have also expanded these initiatives to activities with minimal intervention, such as "no-grass mow" seasons to contribute to pollination and protection of marine areas to conserve biodiversity.

New forms of interaction between citizens can also stimulate alternative urban governance. Cities can push forward sustainable solutions by facilitating citizen engagement, encouraging the creation of communities of practice, and supporting existing networks and associations. Thus, cities function as platforms for a diverse group of people –from different backgrounds and with different knowledge– to come together, participate, share ideas and explore their creativity. This can create an atmosphere where it is more likely to build constructive and innovative ways to positively impact urban development (Sutz & Tomasini, 2013). However, as people come together, they can envision different ways to tackle urban challenges. Depending on the imaginaries or expectations of what future BiodiverCities will be like, the change process can lean towards optimization or transformation, representing two entirely different approaches.

URBAN SUSTAINABILITY IN THE GLOBAL SOUTH: CHALLENGES AND OPPORTUNITIES

Urban areas of the global south often face additional and more profound

CREATING A LOCAL COMMUNITY OF PRACTICE FOR ENVIRONMENTAL SUSTAINABILITY

Transition to biodegradable packaging materials

The municipality of Iza, Colombia, is famous for its local deserts. The production of deserts makes a significant contribution to the local economy as it supports small food businesses and constantly attracts tourists. However, as producers used polystyrene for packaging desserts, in 2018, the municipality's success turned into an environmental crisis. Over 4.500 monthly polystyrene packaging exceeded the capacity of waste management landfills.

The landfill crisis motivated local authorities to consider alternative solutions for food packaging. In partnership with Iza Desserts Production Association, they experimented with several packing materials and raised the importance of responsible and sustainable consumption. Since desert production is such a relevant activity for the municipality, the process was highly driven by the participation and interaction of tourists and many local citizens, part of which led to tensions and negotiations. As a result, in 2019, a new policy prohibiting polystyrene food containers in Iza was enacted. Following this example, other municipalities in the region passed similar policies. They are now using compostable containers made from rice fiber or corn cane.

This illustrates an interesting case of bottom-up social innovation. By building a multi-actor, transdisciplinary and local community of practice, producers, consumers, and policymakers were able to co-create a shared vision for transitioning to environmentally sustainable solutions.

Source: "Social Innovation and the polystyrene prohibition policy in Iza" (Marin, 2019)

pressing challenges in poverty and inequality, with fragile institutions and a lower set of financial resources (Dobbs et al., 2018; Olken & Pande, 2012). Many of these cities also face unstable governance due to weak democratic processes and poor administration. Likewise, governmental financial capacity for policy design and implementation tends to be lower. While these challenges apply in different scopes to each city, the most common societal challenges involve insufficient physical infrastructure, inadequate housing, high unemployment rates, inefficient resources management, rising crime rates, illiteracy, and increasing pollution (Datta & Shaban, 2017; Moncada, 2013). Moreover, many cities experience tension between pursuing economic growth while minimizing adverse environmental impact and, at times, social inequality.

Despite these negative external factors of the urbanization process, cities of the global south have also shown strong capacities to innovate and experiment with alternative pathways to urban sustainability. Still, their endogenous capabilities, creativity, and problem-solving orientation are often overlooked (Nagendra et al., 2018). A young population and demand for environmental solutions have encouraged policymakers, businesses, and ordinary citizens to experiment with different ideas and reach creative solutions. The well-known Bus Rapid Transit system originated in Curitiba, Brazil, and has spread to other Global South cities, providing an example of efficiently using limited funds to address a mobility challenge (Rodriguez & Vergel Tovar, 2013). Likewise, low-income households dealing with high pressures due to inequality, poverty, and infrastructure deficits increasingly use frugal innovations. These are often bottom-up, disruptive, and low-cost solutions that minimize the use of materials to address fundamental service provision gaps (Khan, 2016). In Nairobi, Kenya, the lack of an adequate sanitary system has forced dwellers to create decentralized community solutions such as shared on-site sanitation, community or privately owned sanitation in public spaces, portable toilets, and container-based toilets (van Welie et al., 2018). Clearly, there are several opportunities to proactively deal with unsustainability and South cities' vulnerabilities that strengthen resilience-building in emerging urban centers. All without necessarily reproducing the same discourses and solutions that the North has established, thus avoiding path-dependency and lock-in effects.

HOW TO DEFINE THE GOVERNANCE OF BIODIVERCITIES?

Questions of governance of technology and innovation are associated with questions about who science and technology are for, who does it benefit, who benefits, who gets a say, and whose agenda is being followed. When confronting questions of the environment, it is also about asking who benefits from biodiverse initiatives (environmental justice), who

gets access to these services – such as green spaces - and who participates in the distribution of these benefits? In addition, how does one deal with differences of opinion and possible conflicts of interest, and which investments in science and technology are prioritized? This is a topic that, to a large extent, has been ignored within mainstream policies for technology and innovation and by large parts of the academic literature on science, technology, and innovation.

Our specific interest here is to discuss how to materialize new thinking of governance for policy and how new forms of policy governance can act as a spur for transitions in BiodiverCities. The work of Jessops (2016) is relevant here. He argues that the scale and depth of a sustainability transition cannot be top-down and based on technocratic principles or founded on innovation based on technology-push. New approaches to policy governance have emerged to support these approaches. These include, for example, the work on formative evaluation by Molas-Gallart et al. (2021), which seek to support partnerships between policymakers and stakeholders through formative (rather than auditive) assessment principles that encourage mutual learning. A significant change in policy practice is also the principle of policy experimentation to support transformation processes (Schot et al., 2019). Experimentation as a policy governance concept has become increasingly influential in broad policy circles (beyond transformative innovation). Growing recognition of the need to address sustainability challenges in complex environments requires processes of experimentation that encourage learning by a range of actors. This is particularly the case in cities and large urban environments that require integrated systems thinking.

Schot et al. (2019) summarizes five ways in which experimental policy engagements for transformation can take place (see figure 4 below) (see in https://www.tipconsortium.net/resource/transforming-experimentation-experimental-policy-engagements-and-their-transformative-outcomes/).

- **Policymakers can initiate policy instruments and policy processes.** They could include experiments with public dialogues in the context of public participation, explorative planning processes, and policy pilots for climate risk adaptation.
- **Experimental spaces involve creating platforms for new interactions.** This is the case of a growing number of Urban Living Labs or Fablabs and Makerspaces and 'transition arenas' where stakeholders are hosted to envision a transformation.
- **Supporting, connecting, and reviewing societal experiments focuses on supporting already existing (often bottom-up) entrepreneurial experimentation and grassroots initiatives.** According to Schot et al. (2019), such an effort may also entail measuring or evaluating unfolding transformation and identifying specific needs to establish new or support existing intermediaries.
- **Experimental governance culture is promoted as a deliberate strategy or activity to encourage an experimental governance culture.** This may involve promoting disruptive technologies for tackling climate change and other complex societal challenges. This mode of empirical policy engagement may provide the learning required for the emergence of a new culture of governance that embraces and relies on experimentation.

Well-known examples of experimentation in niche urban areas include transdisciplinary approaches to initiate, monitor, and evaluate novel bus-rapid transit systems addressing traffic, air pollution, climate change, and affordability of public-transportation infrastructures (Sengers et al., 2016). In terms of BiodiverCities, there have also been important initiatives on urban food sovereignty (the right to healthy and culturally appropriate food, produced ecologically by using sustainable methods) encouraged by small-scale urban farms. These make locally sourced food and positively affect the absorption of urban waste.

KEY MESSAGES

Relationship transformation of biodiversity and cities. Cities and urban conurbations were originally constructed and designed to further industrial production and economic development. Their design initially paid little attention to social aspects and even less to the ecological damage, they could produce. The reconstruction of cities based on principles of biodiversity requires broader approaches that offer a multidimensional, multi-actor, and context-based vision of development and sustainability.

Biodivercities as socio-ecological systems. Systems of mobility, housing, water, and electricity need to work together and integrate biodiversity within notions of development. Ecologists and biologists can work together with planners, architects, and other social scientists to unravel the complexity of coupled socio-ecological systems and understand the relationships between biodiversity and socio-technical systems.

The importance of transdisciplinary and intersectoral approaches. It is urgent to open the process of knowledge production to transdisciplinary collaboration from non-academic actors such as citizens of local communities. While sustainable, innovative ideas emerge in nature-based solutions, those ideas that effectively reach cross-sector and cross-actor partnerships will most likely open spaces for alternative directionalities and encourage positive links between urban, peri-urban, and rural settings.

The meeting point between cities and biodiversity. For Just city transitions based on principles of biodiversity to emerge, it is essential that "the commons" and urban collaborative governance are strengthened. Moreover, social organizations and social movements can play a central role in generating new ways of developing conservation practices and restoration of nature through experimentation and collective learning.

The shared vision of biodiversity. Urban regeneration initiatives integrating biodiversity and ecosystem services can benefit from shared visions of the future city and practical efforts towards collective goals. They also benefit from community-led networks that push for institutional and behavioral changes around biodiversity conservation values, wellbeing, sufficiency, and inclusion.

Figure 4. Modes of experimental engagements.

MODES OF EXPERIMENTAL POLICY ENGAGEMENT	MODE 1: POLICY DESIGN ELEMENTS	MODE 2: POLICY INSTRUMENT AND POLICY PROCESS EXPERIMENTS	MODE 3: CREATING EXPERIMENTAL SPACES	MODE 4: SUPPORTING, CONNECTING AND EVALUATING SOCIETAL EXPERIMENTS	MODE 5: EXPERIMENTAL GOVERNANCE CULTURE
Role of experimentation in policy	Assists in the formulation, calibration and justification of policy instruments	Setting up of specific experimental policy interventions in the form of new policy instruments or policy processes tried out temporally or in a small scale.	Creates dedicated environments and a constituency for experimentation, where the normal conditions (e.g. regarding permits, taxation) are relaxed	Articulates existing experiments carried out by multiple actors, facilitates learning from and between experiments, and supports the development of networks,	Creates flexible and proactive governance arrangements, including open-ended goals, allowing decentralised and experimental interventions by multiple actors.
Actors involved	Policymakers, and recipients of the policy treatment	Policymakers and policy analysts, stakeholders involved in the experiments	Lead users, entrepreneurs, technology advocates, designers, civil society actors, policymakers	Networks implicated in experiments, intermediaries and policymakers	As others, but with aim of broadening participation to actors normally expluded from policy process.
Approaches	Randomised Control Trial, Behavioural Experiments	Experimenting with new formats in established policy instruments / processes (programmes, subsidies, regulation)	Urban living Labs, policy labs, walk-shops, transition arenas.	Intermediary organisations and platforms, workshops, online resources.	Strategies and iniciatives to promote experimental culture; rewarding reflexivity and learning.

Source: Schot et al. (2019).

FROM URBAN BIODIVERSITY TO BIODIVERCITIES
RECONCILING SOCIETY AND NATURE IN CITIES

Germán I. Andrade
Universidad EAN

This chapter narrates the transformation of the link between society and nature in urban spaces. It starts historically with recognizing the city as a threat to biodiversity and moves on to understand the importance of managing these built environments for human well-being and the close relationship with the regional perspective. In this journey, it becomes evident how the primitive views of intrinsic values of nature and the notions of management focused on human threats gave way to the consideration that the quality of life of urban communities depends on those spaces that contain biodiversity and provide ecosystem services.

With a changing conceptual approach to nature and city, the creation of protected areas in urban environments, the planning of ecological connectors, and the management of specific elements of biodiversity advanced. In parallel, schools of urban ecology documented nature and urban biodiversity, understanding them first as the exceptional species and natural spaces that occur in a gradient from the wild and then as spaces that emerge from design in urban interventions.

Thus, concepts such as urban landscape, design and renaturalization, co-production of contributions from nature to people, governance, and environmental justice emerged in urban environments. BiodiverCity emerges in this context as a conciliatory concept of some of these paradigms, as well as an opportunity for reconciliation between nature and the city, in the pressing context of global change.

THE CITY AND BIODIVERSITY

The city emerges and grows as a phenomenon of negation of what is natural, and civilization is also a concept that expands in parallel with urban expansion. Thus, what is urban has historically developed at a conceptual and practical level as the opposite and primary threat to conserving biodiversity perceived as abstract and remote. Today, however, elements are being sought to build a new relationship -which here is called conciliation - based on a historical view of the concepts and practices that converge in what is urban, especially when, amid a global environmental crisis, most humans live in cities (United Nations, 2014).

Conciliation must be understood in the context of evolving the very ideas of nature as well as the approaches for its conservation, which have been linked to changing the concept of biodiversity and its relationship with society (Mace, 2014). Thus, there has been a shift from the idea of biodiversity being untouchable, with an exclusively intrinsic valuation in which humans are presented only as a threat, to a conception of biodiversity as a source of benefits for people as well as an essential part of a system of nature and people interacting in a coupled manner.

Thus, in the growing global urbanization, the idea of the biodiverse city, as we know it today, has taken root. However, the biodiverse city is one in which this concept is transformed into a melting pot of interactions between human beings and other living beings in the built habitat. The city, in this sense, is not unnatural but has a new identity, in which the concept of the human in nature and nature in the human changes in a reciprocal manner.

Urban biodiversity as a concept is an open and evolving category. With this notion, we do not intend to describe only the wildlife that is distant or adjacent to the city, but the wildlife that persists there without human agency and, in turn, what happens there deliberately through management. In other words, it is a category of agency that must be understood with a transdisciplinary view that deals with several knowledge systems of knowledge that interact. From this basis, a conciliatory concept such as BiodiverCity has emerged.

WHAT IS URBAN AS A THREAT

The narratives that emerged in the modern idea of conservation in the mid-20th century led to the adoption of the Convention on Biological Diversity (CBD). As the first global legal agreement, the CBD captured the prevailing conservation ideas at the time, emphasizing the need to preserve the values of nature that persist "despite of people" and the threats their activities generate to it (cf. Mace, 2014). In this early formulations of conservation biology (Soulé & Wilcox, 1980), it is evident that urban spaces are implicitly conceived as a destructive factor of those considered natural. Such a position becomes apparent when it is suggested that, unlike areas that are considered natural, cities retain very few natural elements.

Thus, the initial strategies for biodiversity conservation in the face of the urban environment were aimed at isolating what is considered artificial from what is natural, creating physical or legal boundaries for this purpose. However, this vision, which only finds what is human as part of the problem, was evidently a barrier to the appropriation and social valuation for those life forms that coexist with humans in cities.

In this context of separating what is natural from what is urban, those wild spaces that persisted in proximity to the city appear exceptional. Wild nature as a landscape adjacent to the city is presented in protected areas in cases such as the Avila in Caracas or the Eastern Hills in Bogota (Mejía, 2016). The images of the large fauna of Nairobi National Park against the backdrop of the city are also evidence of this. The

city highlights the character of these spaces, which would otherwise maintain their own identity.

The city-nature tension in this vision of what is urban as a threat is also manifested in the occurrence of protected areas that are trapped within the urban fabric. Perhaps the most notable cases in this sense are the Table Mountain National Park, surrounded by the urban fabric of the city of El Cabo, or the Tijuca National Park as an island in the middle of the city of Rio de Janeiro (Mejía, 2016). Likewise, regional metropolitan natural park Cerro El Volador, as a protected area in the middle of the urban fabric of Medellín, presents us with a new nature as a green island in the middle of the city. The recognition of protected urban areas as "protected areas located on the edge of large population centers" (Trzyna et al., 2014) by the International Union for Conservation of Nature (IUCN) accelerated this integration of protected areas with urban life.

DEPENDENCE AND INTERDEPENDENCE

An important step towards constructing a new concept of urban biodiversity was the Millennium Ecosystem Assessment (MEA, 2005), which proposes understanding the relationship between biodiversity and society from its human benefits through the concept of ecosystem services. This paved the way for the initiative to manage urban ecosystem services (TEEB, 2011), one of the first approaches to address the relationship between the city, human well-being, and biodiversity, including the definition of guidelines for its management.

The dependence on nature of what is urban became evident as a predominantly long-distance relationship, due to the usually remote location of the water sources of numerous aqueducts, especially in mountainous cities. This dependence becomes very notorious, for example, in cities located on the dry slopes of the Andes, where water comes from ecological systems situated at great distances. Such is the case of Trujillo, Lima, La Paz, or Santiago, whose need for nature is also threatened by global climate change.

In line with the development of conservation sciences, elements began to slowly appear within urban spaces that made it possible to maintain or recover ecological connectivity and, with it, the flow of biodiversity and its ecosystem services. Landscape ecology thus appeared in the urban context.

The conceptual and practical arrival of concepts such as ecological structure and ecological networks to maintain or recover biological connectivity stands out (Bennett, 2003). This vision followed the first global impulses on the possible role that biological nodes and corridors can play in connectivity at the landscape scale, a perspective that could not remain alien to conservation efforts in urban environments. These concepts were later integrated (Andrade et al., 2013).

However, the urban landscape matrix continues to receive almost no persistent attention in terms of landscape ecology. Therefore, the connectivity required for the persistence and flow of biodiversity and its ecosystem services within urban spaces is still an unresolved issue. Various conflicting social, economic and political interests converge and are assumed to be at odds with each other.

Beyond these nodes and connectors, urban growth goes beyond the managed city and manifests itself as a regional phenomenon. Forman (2008) speaks of urban regions, where the built matrix dominates the landscape. It is an expression of what Zepp et al. (2021) propose as the "end of the city" as an enclave, which has led to what is urban being considered a regional and global phenomenon. Luis Inostroza makes this explicit in this same book on the importance of this link in the very emergence of the concept of BiodiverCity.

Beyond the protected areas and the connecting elements that relate biodiversity to the city in adjacency or at a distance, the interdependence between urban areas and nature takes on greater importance when analyzing the biodiversity that occurs amid these built environments and its true relationship with those who live there. It is not only present in urban protected areas but as a variety of green structures associated with purely urban typologies. For many citizens, this urban greenery represents the opportunity to experience what is perceived as natural and makes up for the lack of a sense of nature.

URBAN ECOSYSTEM SERVICES

Over time, cities began to consider that they not only consume ecosystem services provided at a distance but also produce them. Gómez-Baggethun & Barton (2013) propose a typology for some of these so-called urban ecosystem services (UES). Thus, cleaner air, meso or microclimatic regulation, reduced risk of natural disasters, or the very presence of wildlife in the urban environment, which is positively valued, constitute a narrative of reconciliation amid the city's ongoing divorce from nature.

Inostroza et al. (2014) propose the concept and indicator of "technomass," which arises from the interaction of urban ecology, metabolic studies, and urban planning. Their approach understands the city as an ecosystem where matter accumulates and energy flows. It tends to design forms of social control of urban development that guide the structural and functional evolution of the city. In this way, it would be possible to improve the quality of urban life and mitigate its growing

environmental problems. In this line of thought, the balance of biomass and technomass would determine the future of a city. Therefore, talking about urban ecosystem services implies recognizing the existence of benefits co-produced precisely due to the interaction between society and nature, according to IPBES (Díaz et al., 2015).

The concept of UES cannot be approached similarly in cities that function as enclaves in wilderness areas and those amid landscapes profoundly transformed by agribusiness. The central issue is not only the existence of spaces that provide flows of benefits to society but also the way these are valued, which is neither unique nor uniform.

Some urban conformations, in fact, confront the concept of UES since nature manifests itself as a set of benefits and disservices. The presence of pathogens or predators in urban environments, for example, is a subject of study in urban ecology and sociology. Similarly, the contradictory valuation of urban wetlands is a notorious case when they collect sewage and untreated water in cities and at the same time provide spaces in which nature recreates itself. An interesting case is Nairobi, where water purification areas have become highly valued for bird watching.

The disservices become more evident in environments lacking public services, where the positive valuation of urban biodiversity conflicts with issues such as cultural diversity, lack of urban sanitation, insecurity, and the lack of evidence for the nature benefits for the people´s well-being. For example, a less recognized disservice of nature in an urban environment in the public perception is the relationship between wildlife and risk in aerial operations. The above is just one of several situations in which some manifestations of biodiversity, which tend to be valued in generic terms, may be undesired.

URBAN BIODIVERSITY AS A POLITICAL OBJECT

Biodiversity in urban environments has emerged as a presence and as a purpose and political object of territorial planning. A large part of the environmental citizens' movements has emerged in the cities around the spaces of nature that are recognized. These are new citizenships (Kowarick, 1991), ready to defend these environments in the political arena. These social struggles have led, for example, to the creation of urban protected areas (Quimbayo, 2012) or the protection of wetlands in a city like Bogotá (Galindo, 2003).

Thus, the first urban biodiversity management policies were aligned with the levels of separation-integration between society and nature posited by Mace (2014) and now recreated in the collective social imagination. This more diverse and complex way of understanding urban biodiversity has, of course, direct implications for its management. Some elements acquire relevance from the citizen's perspective, even with contradictions. This is the case of invasive exotic species or predators within the urban habitat, as well as the staunch defense of green spaces with preservation arguments that do not recognize the fact that these are the product of human interaction with nature, as occurs with the urban wetlands of Bogota (Van der Hammen, 2003). Examples of this complex valuation are creating urban habitat for wild species, the diversification of flora managed in the city, or the urban trees themselves, which usually arouse empathy and suspicion when they need to be managed.

In this sense, tropical cities have the potential to contribute not only species through horticulture but also typologies of spaces and forms of management. Urban greenery amid housing presents an interesting evolution in "young cities." Although the recent origin of their inhabitants is rural, this attribute does not persist due to the tremendous economic value that urban space is acquiring. Green spaces become community spaces and places to meet where there is feedback on social acceptance.

With the advent of a complete concept of biodiversity as spaces and species, the equation changes: we no longer speak only of dependence but of interdependence. It is not the benefits of nature for people, but the benefits of people for nature. Thus, urban biodiversity management goes beyond the disciplinary agendas derived from conservation sciences and becomes an object for social entrepreneurship in areas such as architectural design, gardening, urban vegetable gardens, landscaping, tree planting, eco-efficient vertical gardens, and green roofs.

EVOLUTION OF URBAN ECOLOGY

The evolution of the concept of biodiverse cities has been taking place under other notions that come from disciplines such as urban ecology. The re-creation of the city's identity in its relationship with nature has been primarily driven by this discipline, which emerges with historical roots and differentiated emphases.

However, just as there is no single discipline of ecology (Drouin, 1991), neither is there a single urban ecology. The paradigms under construction emerge imbued with unique and special cases because the differences between the knowledge and practice of biodiversity in the world are still vast. Particularly relevant in this context is the integration proposed by Dramstad et al. (1996) of the principles of landscape ecology (applied to wild or rural spaces), landscape architecture (used as a complement to urban planning), and

land-use planning that, with their distinct professional strands, have not yet met harmoniously.

Most of the world's schools of urban ecology have their origins in Europe and North America, in the absence of an obvious systematization of their evolution in the rest of the world. The first root that can be identified is the large urban park designed for human benefit, whose inspiration in North America was Olmsted (1822-1903) based on the "ecological approach to understanding the city" of the Chicago School. This initiative takes an analogical view of social systems as ecological systems that enable "the set of relationships between city dwellers and their living environment" (Joseph & Grafmeyer, 1990).

In urban planning, some precedents are more relevant today. Le Corbusier, for example, proposed networks of urban green spaces similar to what today we would call green infrastructure "for the recreation of the body and spirit. Thus, the design of large urban parks came to life in cities such as Bogota, Santiago, Mexico City, etc. In fact, it is interesting how the concept of the human benefit came to these spaces first, and later that of biodiversity, contrary to the recent conceptual construct of biodiversity-services and human well-being.

The systemic ecology approach, focusing mainly on urban metabolism and describing the organizational functions of nature, also allowed for a new interpretation of the city. In this case, ecology has been used as an instrument to explore the analogy of the city as an ecosystem through the flows of energy, materials, and metabolism. We talk about the machine city, the entropic city, and the city interpreted through the paradigm of ecology (Camargo, 2005).

The identity of what is natural in the city, a manifestation of the wildlife in the urban intervals of unbuilt or abandoned spaces, acquires an identity of its own for Clément (2004)[1] . With this proposal, the urban landscape is widely developed as a space for integrating conservation. Clergeau's (2007) in his "urban landscape ecology" brings a conservation biology approach to the functioning of the urban landscape, seeking to overcome the vision of the city as irreconcilable with the principles of ecology. This author concludes with the approach of a green mesh (maillage vert) that applies the concepts of connectivity to the city. In the same vein, Wu Jiango (2014) develops a school of applied research on the city as a multi-scale phenomenon, pointing out the challenges of constructing urban settlements that effectively address sustainability and global environmental change (Grimm et al., 2008).

Nonetheless, landscape and aesthetic approaches, and the contribution of the humanities, which are fundamental in the practice of what is urban, there is still a distance in the construction of knowledge about the relationship between society and nature in the city. The perspective of Patricia Johanson's projects, for example, invites us to link art and survival, proposing the design of the built with the forms and functions present in nature (Kelley, 2006). Therefore, the evolution of urban ecology is not only an academic matter but a process that has been accompanying new forms and purposes for its management. (Details for the diversity of approaches to address the relationship between nature and society in Figure 1).

BIODIVERCITY AS A SPACE FOR RECONCILIATION

The new attributes and recognized dimensions of urban biodiversity are now driving new paradigms in city management. Thus, urban landscape

Figure 1. Approaches and purposes describing shifts and variations in the addressing the relationship between nature and society in cities around the world.

Source: Own elaboration

	SOCIETY-NATURE RELATIONSHIP	PERCEPTION OF BIODIVERSITY	PREDOMINANT APPROACH	PRACTICAL STRATEGIES
THREAT CITY	Opposing and based on urbanization as a threat to nature.	Abstract, untouchable, and remote from the cities.	Ecology in the city.	Declaration and management of peri-urban protected areas.
BENEFITTING CITY	Utilitarian and based on capitalizing on goods and services provided by nature.	Source of ecosystem services that provide well-being.	Ecology in the city.	Declaration and management of peri-urban protected areas.
SOCIO-ECOLOGICAL SYSTEM CITY	Systemic and based on cities as coupled social and ecological systems.	Factor of resilience and cities' adaptive capacity.	Ecology in the city.	Ecosystem-based adaptation. Nature-based solutions.
BIODIVERCITY	Functional and based on social and ecological transitions to urban sustainability.	Central determinant of human development, innovation and social equity.	Ecology in the city.	Transformative ecology. Transition to socio-technical regimes.

design now involves the need to preserve, conserve, restore and sustainably use biodiversity, an approach that will be fundamental to sustainably transforming the territory.

Some emerging concepts that accompany this change of mentality are urban landscape design, renaturalization, contributions of nature to people, and regeneration. The compilation of experiences around the concept of urban nature (Mejía, 2016) constitutes a step on which to develop the conciliatory concept of BiodiverCities, which has the potential to encompass a new way of seeing what is urban with a different purpose. Thus, in a BiodiverCity, urban biodiversity is linked to the purpose of understanding, conserving, or improving it.

The new concepts mentioned above also call for a multidisciplinary approach. Ecological structures and networks become not only the space for the practice of conservation sciences but also the scenario par excellence for a multi-scale and interdisciplinary encounter in which the "pieces" of a new landscape can be "assembled" (Andrade et al., 2013).

A representative example of the evolving concepts of urban biodiversity and the emergence of the BiodiverCity is given around water spaces, not only in the landscape management of "waterfronts," where urban design and landscaping converge (Franco, 2011) but also in the search for a city that harmonizes with the hydrological cycle, creating new balances between what is natural or naturalized and what is artificial. These water spaces integrate aquatic species, protected areas, the blue network, and sustainable urban drainage. The urban river emerges as that place where past management engages and invites us to recreate the new future.

At the core of the concept of BiodiverCity is the need to bring about a transformative change that can promote deep and lasting transformations. Therefore, beyond conceptualization and the recounting of examples, this proposal's challenge lies in its social practice, including public policies. In the BiodiverCity, interactions between humans combine learning and innovation, that is, reflection on the human experience and the imagination of better futures. Thus, the city is no longer just a threat, a green network, and a gray matrix, but a socioecological system in which human activity is the agency of new processes.

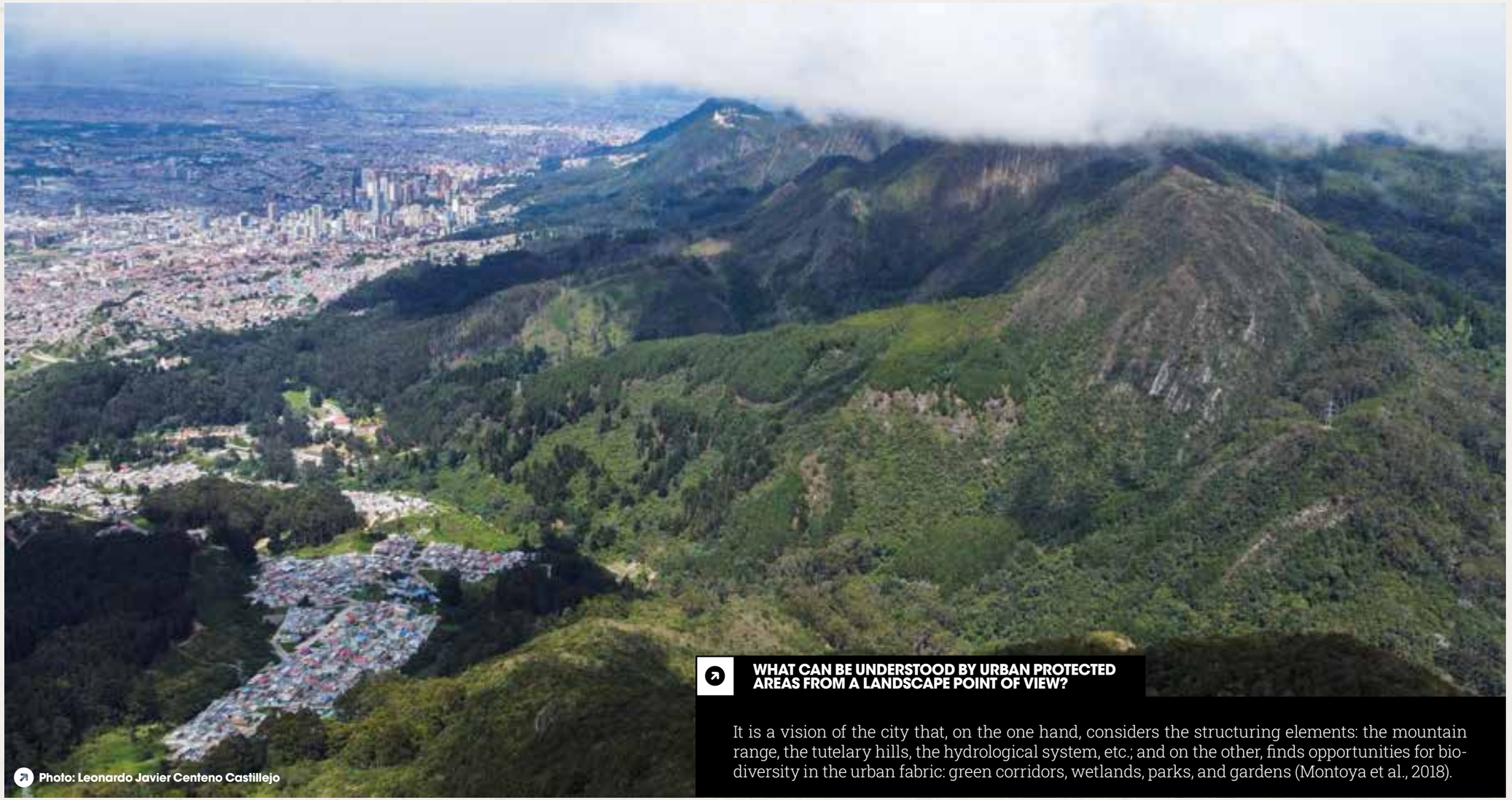


Photo: Leonardo Javier Centeno Castillejo

WHAT CAN BE UNDERSTOOD BY URBAN PROTECTED AREAS FROM A LANDSCAPE POINT OF VIEW?

It is a vision of the city that, on the one hand, considers the structuring elements: the mountain range, the tutelary hills, the hydrological system, etc.; and on the other, finds opportunities for biodiversity in the urban fabric: green corridors, wetlands, parks, and gardens (Montoya et al., 2018).

KEY MESSAGES

Conciliating city and nature. Civilization and city are concepts that have grown parallel but antagonistic to what is considered natural. The disciplines that address these concepts in practice have persisted in approaching them from the perspective of a relationship mediated by threat. Today we are looking for elements to build a new relationship based on the close link that truly unites city, biodiversity, and human well-being.

Transforming the vision of what is natural in the city. What is urban has moved from primordial visions of a threat to biodiversity to the recognition that the quality of life in cities depends on spaces that at local or regional scales contain biodiversity and provide ecosystem services.

An emerging concept. The BiodiverCity emerges as a conciliatory concept resulting from the main paradigms that have defined the way in which human beings have related to nature in the framework of urban areas. The BiodiverCity is an opportunity for reconciliation between nature and the city, of great relevance in the pressing context of today's global environmental change.

BiodiverCity as an opportunity for transformation. Given the expansive growth of urbanization on a global scale, it is urgent to bring about a profound and persistent change in the unsustainable tendencies of this process. In this context, the city is no longer just a threat to biodiversity or a dichotomous green network or gray matrix system. It is a socio-ecological system in which human activity is the agency of new processes that combine learning and innovation.

INTRODUCTION

EXPERIMENTATION

OPINION ARTICLES

TRANS FORMATION

BIODIVERCITY AND REGION: A UNITARY SYSTEM
THE PARADIGM SHIFT IN 21ST CENTURY URBAN DEVELOPMENT

Luis Inostroza[ab]
[a] *Ruhr University Bochum, Institute of Geography, Germany*
[b] *Universidad Autónoma de Chile, Chile*

INTRODUCTION

The conception of the regional urban system and urban development management requires a fundamental paradigm shift in the 21st century. In the last hundred years, society has undergone profound changes in its ways of life and the way it relates to the natural environment and biodiversity. In addition, the high complexity of urban systems has rendered obsolete the paradigms, concepts, and knowledge that have described and explained them. Therefore, today, urban development trajectories and spatiotemporal behavior and what they mean for people's well-being cannot be justified under past paradigms, especially those that understand the city as a system isolated from its environment, autonomous, and governed by its own laws.

In the emblematic book Cities in Evolution, Patrick Geddes, a founder of urban planning, said at the beginning of the 20th century that "it takes a region to make a city." Geddes was the first to draw attention to two aspects. The first aspect is that time is a fundamental component of the structure of cities; therefore, cities evolve not only in space but also in time and even "conurbate." This term describes how cities extend and merge spatially over time. The second aspect is to consider the region as the primary socio-ecological system encompassing the urban system as a whole and a fundamental component of the urban structure: region and city are a unitary system.

On the contrary, the reductionist and objectified vision of urban planning and urbanism of the 20th century sees and understands the city as an object isolated from the regional environment deprived of ecology. This view is still valid, for example, in Professor Michael Batty's book "*The New Urban Science*," which addresses fundamental urban research topics, such as transportation, land use, and population, among others. Batty's urban characterization is sophisticated and quantitative, making it an outstanding contribution to urban scientific knowledge. However, there is not a single reference to the ecology of urban systems. It seems as if the urban phenomenon emerged on a blank canvas, an empty landscape without ecology and biodiversity in which the city appears and develops following its own socially determined laws.

The disciplines traditionally dedicated to studying and analyzing cities, which today continue to determine urban development management, persist in omitting the ecology that governs, defines, explains, and makes every city possible. This omission will prevent progress toward ecologically sensitive development that considers biodiversity a fundamental component of integrated urban development.

THE CITY-NATURE DICHOTOMY, A PARADIGM THAT FOSTERS ECOLOGICAL DEGRADATION

The city concept has been historically dichotomous, opposed to the natural, and separated from nature by foundational acts. Such as those implemented by the Greeks and Romans, who drew a clear line dividing the dominated world -that is, the sphere of the civilized and the scope of human rationality- from the rest -that is, the wild and untamed world and the uncertainty of a threatening, intimidating, unknown and aggressive nature. The urban environment then constituted a place of certainty in which solid walls excluded natural forces and the surrounding biodiversity.

Thus, for example, within the medieval mythology associated with forests and wetlands, ominous signs - such as witches, spells, curses, and diseases - always appear; that is, the evils attributed to those natural environments that medieval civilization had systematically destroyed. This destruction process inherited from a threatening conception of nature still continues, although the reasons are more pragmatic and economic today. The change we have observed in the environmental awareness of Western civilization has not yet reached urban development. In the vast majority of the world's cities, the latter is still anchored in obsolete concepts - essentially aesthetic, pragmatic, and economic - that do not make room for new paradigms that truly incorporate ecological processes and biodiversity as supports for the well-being of their local populations.

BIODIVERCITY AND REGION AS ONE UNIFIED SYSTEM

Everything materially necessary for a city to function -including water, food, and the materials needed for infrastructure- comes from outside the urban limits, in many cases from distant latitudes. From a metabolic point of view, which considers the inflows and outflows of matter and energy, the city and the region form a unitary and indivisible system (Kennedy et al., 2007; Baccini and Brunner, 2012). That is, without a region, there is no city.

Until the industrial revolution, most of the inputs that supported urban life came from surrounding areas. Land use location models, such as Von Thünen's, considered the city as the center of a system of concentric rings in which agricultural, forestry, and other activities were located following an order that obeyed the commercial valuation of their respective products. Thus, the production of the most expensive goods was found in the rings closest to the urban center, reducing transportation costs to deal with the higher land costs of such locations.

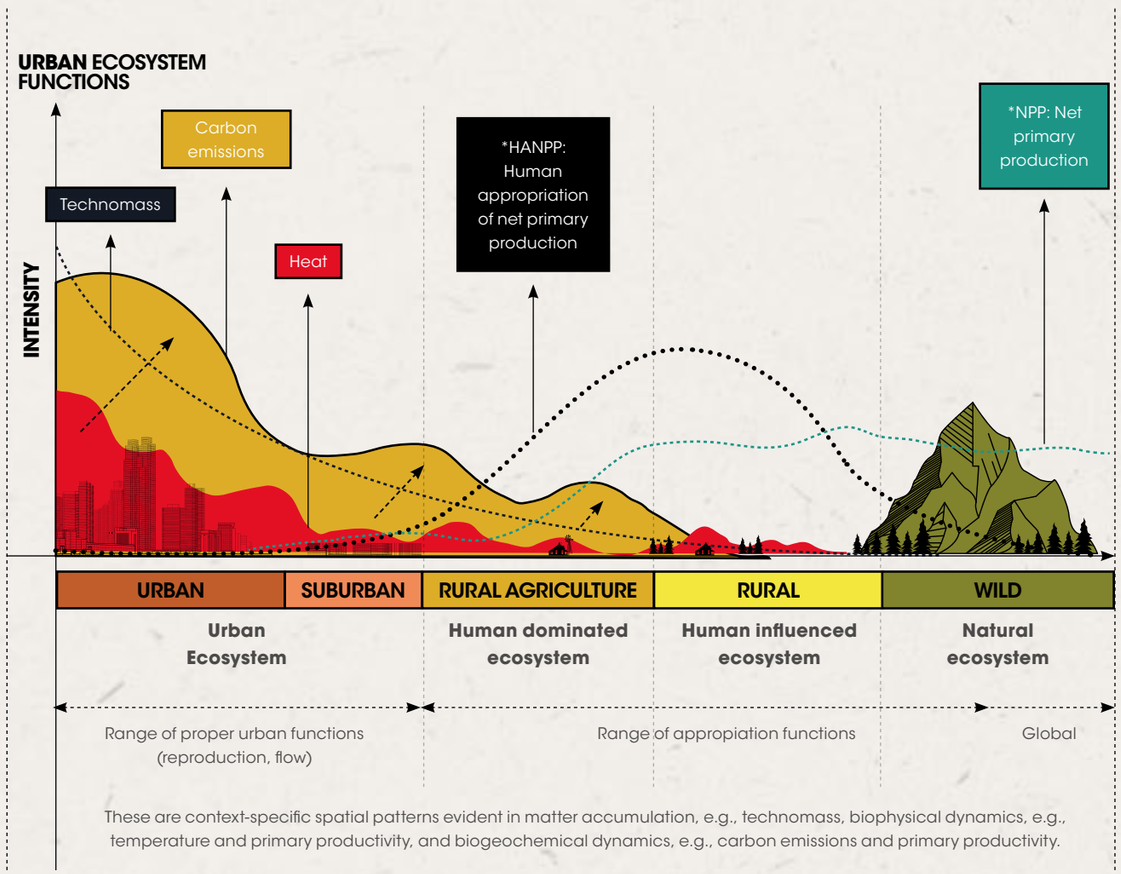
Likewise, archaeological evidence shows that proto-urban systems

-such as Ur, Babylon, or Çatalhöyük- were surrounded by agricultural areas that supplied food and construction materials. In other words, the trade of goods from distant places was a luxury and was concentrated on small items of very high value. Thus, the region explained the phenomenology of each city (Mumford, 1956; Bairoch, 1988).

From the point of view of biodiversity, the unitary system has been maintained despite industrialization. City-biodiversity relationships have become more complex but are still strongly determined by spatial interactions at local and regional scales. These interactions are visible in patterns of change in ecosystem functions and metabolic behavior across the urban-regional system. In particular, processes such as accumulation of matter - e.g., technomass, a concept that points to all matter that has been transformed by human labor per unit area and time - biophysical dynamics - e.g., temperature and primary productivity - and biogeochemical dynamics - e.g., carbon emissions and primary productivity - are determining local ecological processes but generating context-specific spatial patterns at the regional level (Figure 1).

Urban development that promotes biodivercities must necessarily incorporate regional and peri-urban ecosystems into its spatial structure while recognizing and respecting their ecosystem functions. This makes it possible to maintain and increase the flow of ecosystem services that these ecosystems provide to local populations.

Figure 1. Patterns of change in ecosystem functions and metabolic behavior across the urban-regional system*.
Source: Prepared by the author.



These are context-specific spatial patterns evident in matter accumulation, e.g., technomass, biophysical dynamics, e.g., temperature and primary productivity, and biogeochemical dynamics, e.g., carbon emissions and primary productivity.

FUNDAMENTAL BIOPHYSICAL INTERACTIONS, CITY-REGION

The primary resource that every city consumes is air, followed by water. Both materials come from outside the urban boundaries to be processed physicochemically through a series of complex transformations related to specific urban functions. Generally, when air and water leave the urban limits, they present lower levels of quality due to the presence of pollutants, unwanted nutrients, and other elements that, if not adequately treated, can affect regional ecosystems. It is widely recognized in urban science and practice that the urban benefits enjoyed by city dwellers ultimately have adverse effects on air and water that extend beyond urban boundaries.

Another product of urban metabolism that affects the urban-regional system is heat. Heat comes from both the structure and functioning of the city. The thermal patterns present in cities are complex and exceptionally heterogeneous, even though they obey regularities present in the vast majority of the world's cities (Lemoine Rodríguez et al., 2022). A clear example of this is the concept of urban heat islands, which indicates that the temperature inside any city will be between 2 and 6 degrees higher than the temperature of the surrounding region (Oke et al., 2017). Thus, the greatest challenge of the hotter urban climate is related to climate change, which will increase exposure to heat waves and affect the well-being of urban populations. This urban heat will also directly affect ecosystems and biodiversity, both within cities and in the urban-regional context (Figure 2).

BIODIVERCITY AND ECOLOGICAL PROCESSES

Ecology characterizes ecosystems through four fundamental ecological processes. First is the water cycle, which moves or accumulates in soil - in rivers or lakes - or the air - in air humidity and evapotranspiration from vegetation. Then comes the material cycle, which includes fundamental elements such as carbon and oxygen in addition to nutrients such as phosphorus and nitrogen. Third, comes the energy cycle, which is fundamentally captured by vegetation -primary producers- and introduced into the food webs of any ecosystem -the food chain. And last is ecological succession, which is the change in the composition and structure of the species present in an ecosystem over time.

For urban ecology, urban systems are the particular habitat of human beings that, to materialize, require the transformation of the earth's surface, which leads to a series of fundamental changes in the four ecological processes underlying all ecosystems. For example, the alteration resulting from the sealing of the soil by pavements and built structures adds many new materials coming from distant places, sometimes thousands of kilometers away (Inostroza and Zepp, 2021). These materials have different bio-geochemical behaviors and allochthonous elements that can eventually alter the health of ecosystems, such as heavy metals introduced by the wear of infrastructure in environments free of them that threaten local populations of fragile species, such as amphibians.

On the other hand, a city has between 2,500 and 9,000 tons of accumulated anthropogenic materials on average. This volume increases to close to 70,000 tons in city centers such as Bogotá, reaching 500,000 tons in New York. This enormous body of material in urban systems is constantly growing and constitutes one of the most significant challenges for biodivercities. Why?

When observing the material behavior of ecosystems like forests and corals, there is a rule in terms of the ecosystem's physical structure growth: the total sum of the biomass of the primary producers, such as plants and trees. Growth stops when the ecosystem reaches its climax. At this point, material productivity - the amount of biomass an ecosystem produces per unit of time - and respiration stop increasing and the physical structure of the ecosystem stabilizes. The stabilization of productivity and respiration allows the size of the ecosystem to remain stable over time. This closed material cycle is an ecological behavior that ensures ecosystems' long-term health and resilience and from which urban systems must learn.

ECOLOGICAL PROCESSES IN A BIODIVERCITY

A city seeking to move towards a biodivercity should promote the maintenance and recovery of ecosystems such as soil, urban forests, wetlands, rivers, green areas, and green infrastructure in general. These ecosystems contribute to the sustainability of urban life through the provision of ecosystem services, such as rainwater infiltration and flood risk reduction, local climate regulation and control, recreation, and particulate matter absorption, among others (Costanza et al., 2017). Without such ecosystem services, urban life would not be possible.

That is why these ecosystems need to be managed with ecological criteria. A biodivercity must pay special attention that the management of the four fundamental ecological processes of any ecosystem ensures ecosystem resilience. Including first, a water cycle that maintains the air and soil moisture levels and ecological flow required by wet ecosystems; second, a material cycle that ensures that critical nutrients, such as nitrogen and phosphorus, are at adequate levels for the entire food web. Third, a cycle of energy from the sun that is adequately distributed at each trophic level; and fourth, a process of ecological succession as a mechanism that determines a species composition of urban ecosystems that is ecologically tuned with the species composition at the regional scale.

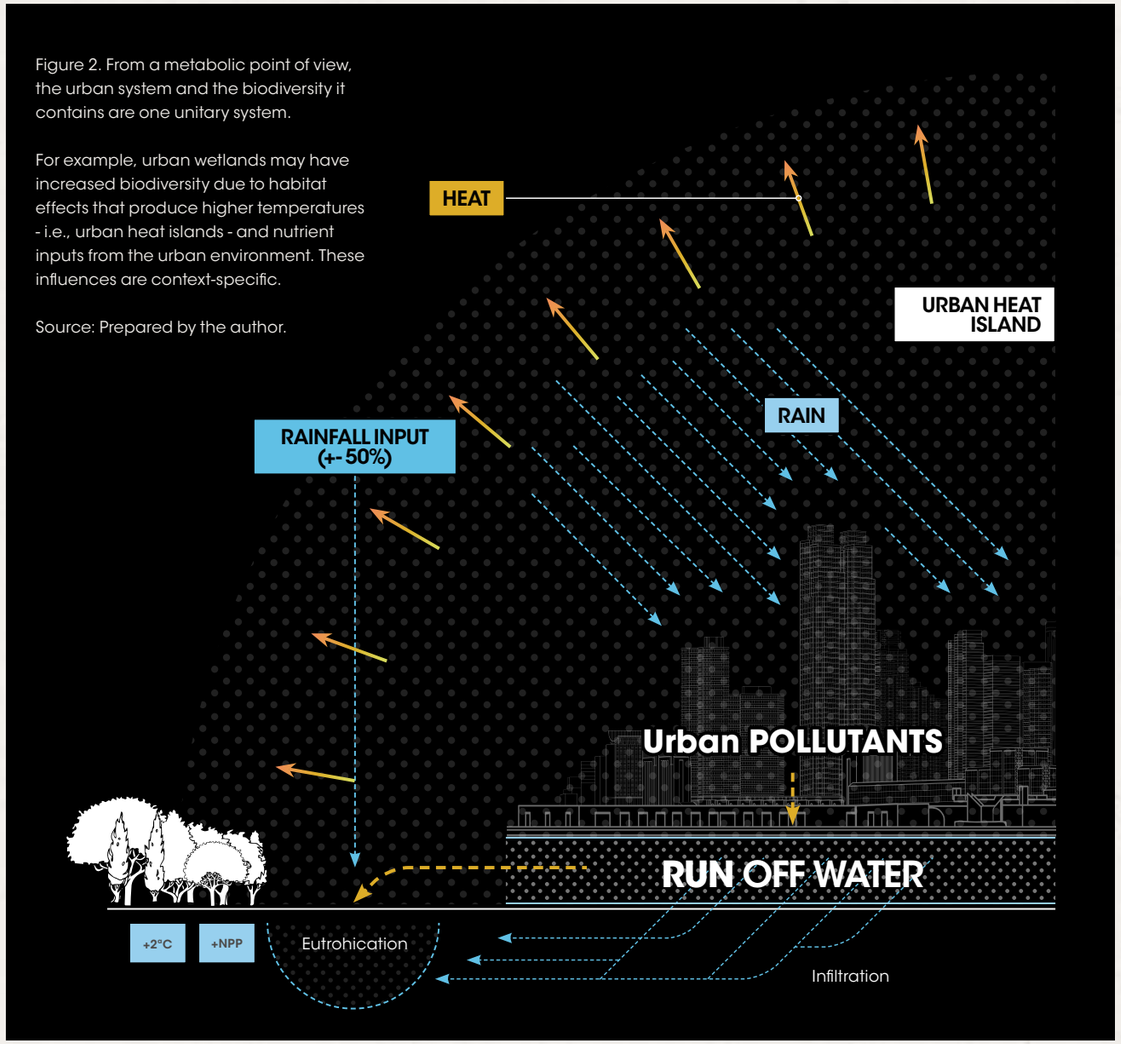


Figure 2. From a metabolic point of view, the urban system and the biodiversity it contains are one unitary system.

For example, urban wetlands may have increased biodiversity due to habitat effects that produce higher temperatures - i.e., urban heat islands - and nutrient inputs from the urban environment. These influences are context-specific.

Source: Prepared by the author.

BIODIVERSITY ISLANDS AND BASINS

Spatial interactions between a region's biodiversity and urban systems are complex and depend on each species and taxonomic group. It is usual that different organisms require different environments for reproduction and survival and possess differential displacement capacities. Thus, the interior of urban areas can offer vital habitat and nutritional possibilities for those species flexible enough to cope with the pressures and stresses of the urban environment. In addition, the reduced presence of predators creates favorable conditions for colonization by opportunistic species. In general, within urban systems, green areas, urban parks, rivers, wetlands, and coastal edges are places that diverse living organisms use, either as islands or as ecological connectors, allowing them to move within urban areas or the regional environmental system.

Islands are highly biodiverse urban spaces not ecologically well connected to the more extensive regional system. These islands are not well integrated with the flows of biodiversity that move and interact at the regional scale. In the latter, each species has differential ranges of movement that can be greater or lesser depending on their motor skills or the degree of fragmentation of the landscape. On the other hand, elements, such as river basins and coastal edges, generally operate as connectors

integrating the biodiversity found in the cities with that present in the larger regional ecosystem due to their linear-directional condition.

In the urban-regional context, biodiversity-city interactions can be understood through the concept of basins. A biodiversity basin is the area of movement and habitat larger than the urban area where species exist. A biodiversity basin is always specific and will vary in size, shape and spatial extent depending on the size, mobility, reproductive, and feeding habits of the species in question[1]. Thus, a biodivercity should promote an intra-extra-urban system of biodiversity basins that allow the movement, interaction, and reproduction of as many local species as possible.

LESS IS MORE: TRANSFORMATIVE CHANGE IN THE CONTEXT OF URBAN-REGIONAL DEVELOPMENT AND MANAGEMENT

Transforming urban-regional systems into biodivercities requires a transformative change in the paradigm of urban development and management. Adequate management of the four ecological processes of any ecosystem must consider the urban-regional system as a large ecosystem and not concentrate on arbitrary administrative limits defined as boundaries. To incorporate truly ecological considerations, it is also necessary to transform the merely aesthetic and cosmetic conviction that predominates in urban planning and design and that only understands its social and economic implications. The ecology of the city, in the city, and for the city (Wu, 2014) is an essential scientific foundation that can provide rationale and empirical evidence to enable urban planning to achieve a biodivercity's goals.

Likewise, a change in the paradigm that governs how green infrastructures are managed and handled within cities is required. Today, aspects such as species composition and biomass management are mainly based on aesthetic criteria. While large lawns are periodically mowed, and fallen leaves are constantly removed, any symptoms of colonization by other local species are immediately controlled, even with nineteenth-century pruning practices. This is ecologically blind management that neutralizes the colonization processes of local species and the formation of specific ecosystem communities that may change in their taxonomic composition due to ecological succession.

Current practices do not allow urban green areas to become ecologically attuned to regional biodiversity or to become nodes in a more extensive ecological network.

To change this trend and prevent its effects, instead of doing more, we must do less. We must let nature and its processes reconquer the spaces that we can free of pavements and infrastructures so that local species can arrive and compete following their own dynamics. We must abandon the unhealthy attitude of aesthetic maintenance of green areas and parks in which the grass is periodically cut and all the biomass extracted. This prevents the ecological succession essential to maintain ecosystem services -as vital as pollination- that possess spatial dynamics of regional scope.

A green infrastructure with less human intervention is potentially healthier and, therefore, will be in a position to provide more benefits than only aesthetics. A wilder nature free from human control is the aesthetic and ecological paradigm of a biodivercity that coexists with the fundamental processes of its ecosystems in tune with regional-scale environmental cycles.

CONTEMPORARY URBAN DESIGN, ECOLOGY, OR COSMETICS?

Over the last few decades, several urban projects have appeared claiming ecological principles. In many cases, such principles have been treated superficially without proper environmental assessment tools constructed using the scientific method. And therefore, such projects have not been able to deliver the promised benefits. An example of this merely cosmetic ecological management is the Houtan Park in Shanghai, China, which intended to clean up more than 600,000 gallons of polluted water from the Huangpu River and increase plant and animal biodiversity. The author visited the park in 2016, and it is closed with no public access allowed. During that visit, the deterioration of vegetation and fish deaths were observed.

URBAN DEVELOPMENT, ECOLOGICAL DETERIORATION, AND URBAN-REGIONAL PLANNING: THE CASE OF LATIN AMERICA

Although urbanization trajectories faced by Latin American cities are heterogeneous, diverse, and complex -as are their ecosystems from Mexico to Patagonia- it is possible to identify four particular characteristics of their urbanization processes.

1. **Rapid urban expansion.** Urban expansion processes are brisk and with high land consumption rates -which can reach 20 m² per minute- and take place in the absence of comprehensive urban planning that respects or enhances ecosystems and their benefits (Inostroza et al., 2013).
2. **Size and urban structure.** Capital cities in Latin America have a high primacy over the respective configuration of the urban system, as capital cities concentrate most of the population within a relatively demographically weak remaining urban system (UN Habitat, 2012). This primacy affects biodiversity in densely urbanized territories, their regional ecological connectivity, and, therefore, the flows of ecosystem services generated from it.
3. **Informal urban development.** A large part of urban development in Latin America is informal (Inostroza 2016, 2017; Inostroza and Tábbita, 2016) and is markedly located in vulnerable areas that constitute relevant, fragile, and highly biodiverse urban ecosystems. Informal urban development in Latin American cities is a problem of inequality that encompasses social and gender asymmetries in access to urban land. In turn, it is affecting the most fragile ecosystems.
4. **High biodiversity under threat.** The biodiversity present in urban and peri-urban ecosystems is high and relevant. It is strongly threatened by the lack of adequate intra-extra urban ecological connectivity, which adds to the increased fragmentation of urban ecosystems in Latin America and is a fundamental challenge for sustainable urban management (Inostroza et al., 2013). In spatial terms, biodiversity also responds to a center-periphery pattern.

As a result of these trends, forests and peri-urban wetlands in Latin America are permanently threatened by urban development that views them as available land and does not incorporate the benefits they provide to local populations into their valuation structure. An example of this is Chile's urban and peri-urban wetlands, which have suffered systematic fragmentation and habitat reduction (Rojas et al., 2015; Arriagada et al., 2019; Muñoz Lobos et al., 2020). This is the case of the Tres Puentes urban wetland in Punta Arenas, which provides habitat for more than 70 nesting birds -including the endangered Ruddy-headed goose, a species in danger of extinction- concentrated in 65 hectares. This wetland is threatened by the urbanization process promoted by the State with the construction of road infrastructures that induce fragmentation, habitat reduction, and, consequently, loss of biodiversity (Kusch et al., 2008; Inostroza, 2009).

The need to modernize regulatory frameworks with 21st-century ecological criteria that allow better management of urban-regional ecosystems is a pending task in much of the world. In Europe and China, significant efforts are being made to improve the institutional framework for urban-regional planning by including concepts such as ecosystem services (Zepp and Inostroza, 2021; Zepp et al., 2021). In Latin America, it is evident that planning and land use systems are generally weak in their ecological components. They are challenged by the scarcity of resources for investment in environmental infrastructure and the lack of qualified human resources for analyzing and managing urban-regional environmental relationships. There is a high sectarianism degree in Latin American territorial planning systems with fragmented competencies in a range of authorities and institutions that often have complex and atomized governance traditions. This generates significant uncertainties regarding the positive and negative ecological impacts of new urban developments, their effect on regional ecosystems, and the delivery of ecosystem services.

Urban planning and management in Latin America are examples of the global need to implement specific urban development policies that address their impacts on urban ecosystems' ecological structure and consider the populations' vulnerability in their vicinity (Inostroza, 2017). It is also necessary to advance in the materialization of urban-regional ecological connectivities that, although they may be considered in existing planning instruments, in many cases have not been implemented (Vasquez et al., 2016).

KEY MESSAGES

➔ **City, an obsolete concept.** A change is needed in the approach to the city as a system isolated from its environment, autonomous, and governed by its own laws. The current paradigm omits the ecology that governs, determines, explains, and makes every city possible, as well as the scale (regional and global) on which it operates.

➔ **Without a region, there is no city.** Everything materially necessary for a city to function comes from outside the urban limits. This implies the maintenance and recovery of urban forests, wetlands, rivers, green areas, and infrastructure in general at a regional scale. Without such ecosystems and their ecosystem services, urban life would not be possible.

➔ **Four processes that every biodivercity must maintain.** The development of biodivercities should be focused on maintaining four fundamental ecological processes to increase their resilience to global environmental change: i) water cycle, ii) material cycle, iii) energy cycle, and iv) ecological succession processes. One way to achieve this is by implementing nature-based solutions that enable ecological connectivity of the urban-regional system as a whole, going beyond the emphasis on strictly intra-urban connectivity.

➔ **How could biodivercities be characterized?** In the urban-regional context, biodiversity-city interactions can be understood through the concept of basins. A biodiversity basin is the area of movement and habitat, always more extensive than the urban area where certain species exist.

➔ **Instead of doing more, we need to do less.** It is necessary to change the way green infrastructures are managed within cities, based mainly on aesthetic criteria. It is important to let nature reconquer urban spaces, abandoning the fixation on order and the "cleanliness" of green areas. On the contrary, we must conserve the biomass that allows ecological succession and maintain ecosystem services, as vital as pollination, that have spatial dynamics of regional scope.

➔ A flock of common kestrels flying over the Tres Puentes wetland in Punta Arenas, Patagonia, Chile. Photo: Luis Inostroza.

➔ Flamingos in a Patagonian steppe lagoon. Photo: Sebastián Saiter.

The biodiversity of urban wetlands can occasionally exceed that of non-urban wetlands.

BIODIVERSITY THRIVES IN THE BUILT ENVIRONMENT

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

Diana Marcela Ruiz Ríos
Alexander von Humboldt Institute.

Andrés Ibáñez
National University of Colombia

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

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

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

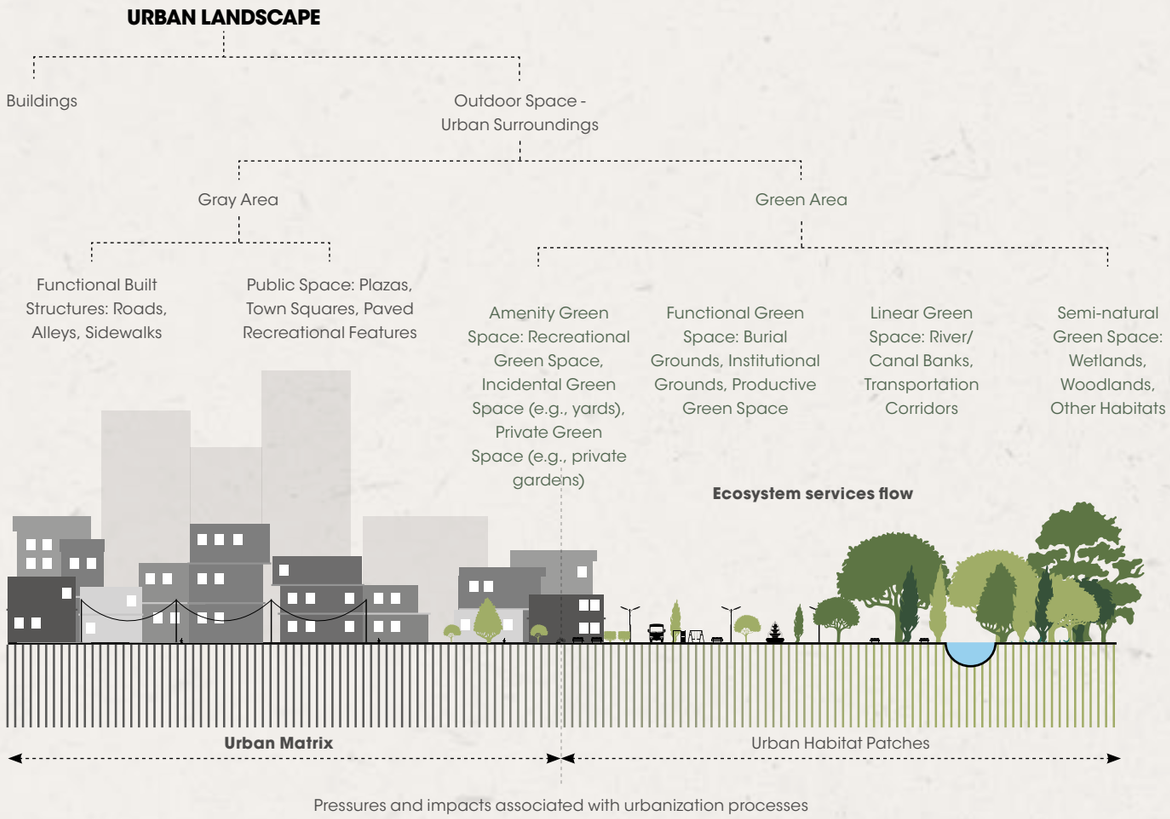
From the relational perspective between citizens and their immediate environment, coordinated and innovative actions are also required to link people, places, meanings, visions, and ecosystems. In this perspective, city spaces should be understood as a web of narratives, meanings, stories, and cultural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

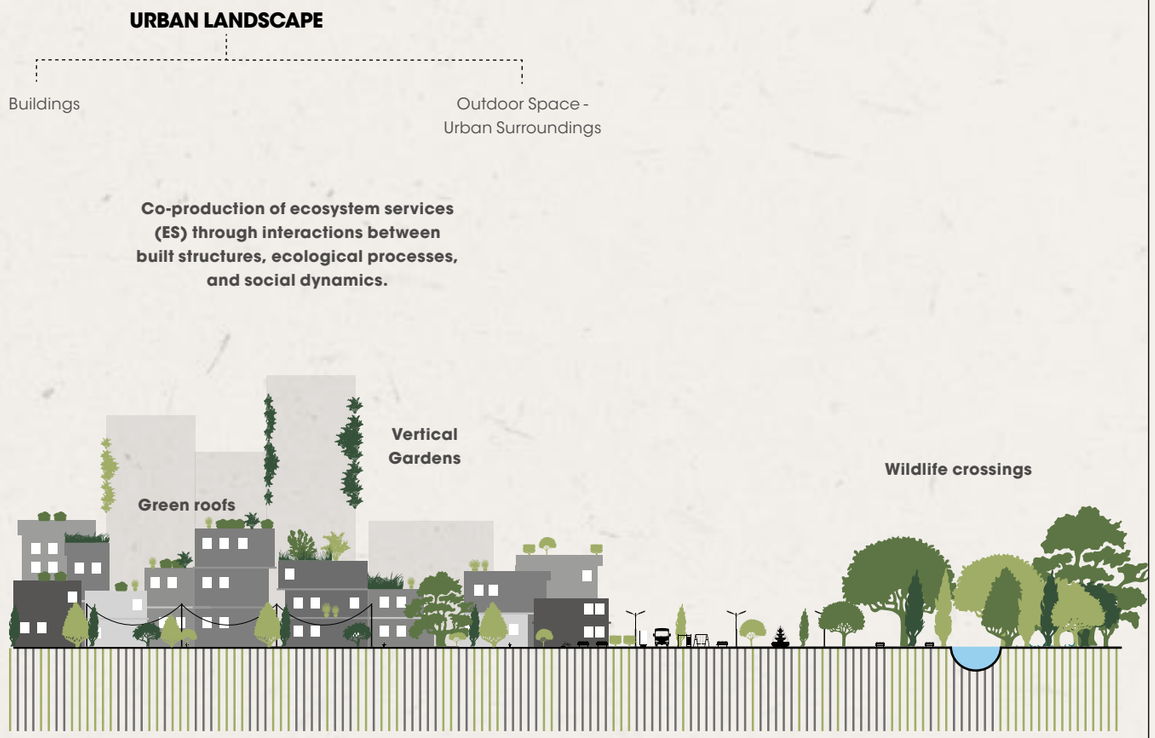
Under this systemic and relational conception of cities, the interactions and interdependencies between social-cultural-economic-governance, climatic-biophysical-ecological, and technological-infrastructure dimensions determine urban patterns and processes, and thus the generation and access to nature's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

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

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

Source: Prepared by the authors.





1. FROM THE HUMAN CITY TO THE METAHUMAN CITY

WHAT DOES A PARROT WANT?

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

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

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

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

Patrick Blanc
Centre National de la Recherche Scientifique (CNRS)

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

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

ATTRIBUTES OF THE METAHUMAN CITY

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

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

2. FROM THE GREEN CITY TO THE WILD CITY

HOW MANY SQUARE KILOMETERS DOES A BEE MEASURE?

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

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

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

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

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

ATTRIBUTES OF THE WILD CITY

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

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

3. FROM THE COMPLETE CITY TO THE (UN) FINISHED CITY

DID THEY ACTUALLY START WHEN THEY THOUGHT IT WAS THEIR END?

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

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

ATTRIBUTES OF THE (UN)FINISHED CITY

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

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

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

4. FROM THE SEGMENTED CITY TO THE OVERLAPPING CITY

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

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

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

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

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

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

Nigel P. Dunnet
University of Sheffield

ATTRIBUTES OF THE OVERLAPPING CITY

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

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

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

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

USING THE CLOCK OR THE PARROTS SONG?

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

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

ATTRIBUTES OF THE BIO-PERFORMATIVE CITY

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

Figure 2. Cities typologies that describe the relationship between values, demands and capacities of local communities with different ecological conditions. Opportunities to face characteristic social challenges based on the cities biodiversity are presented.

DENSIFIED MOUNTAIN CITY CLOSE TO STRATEGIC ECOSYSTEMS FOR WATER SUPPLY

INFILTRATION/RETENTION

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

COASTAL CITY RIVER DELTA

FLOW ATTENUATION

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

PIEDMONT OR RIVERSIDE CITY

FLOW ATTENUATION

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

COASTAL CITY

COASTAL EROSION

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

HOT AND HARDENED CITY (CONSOLIDATED)

EVAPOTRANSPIRATION, MICROCLIMATE REGULATION/ HEAT ISLANDS

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

Source: Prepared by the authors.

beings into urban planning and design processes.

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

6. FROM THE ORNAMENTAL CITY TO THE BIOMIMETIC CITY

HOW LONG HAS IT BEEN WORKING WELL?

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

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

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

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

ATTRIBUTES OF THE BIOMIMETIC CITY

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

TOWARDS POSSIBLE FUTURES

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

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

In this sense, some authors have proposed conceptual and methodological frameworks, such as nature-based thinking (Randrup et al., 2020; Maller, 2021), which suggest transcending the use of nature as an isolated solution to specific urban challenges to think and act in order to build regenerative and biophilic cities that provide spaces for biodiversity and ecological processes. This effectively integrates cultural diversity and the particular way in which local communities relate to nature. This perspective is relevant in the construction of the six proposed visions, especially for megadiverse countries, in which biological and cultural capital constitute a fundamental opportunity to integrate values, respond to social demands and use the capacities of communities that relate in different ways with each other. nature. For example, in figure 2 this perspective shows a typology of cities in which converge different ecological conditions, societal challenges, but also opportunities to face them based on biodiversity. This types includes from cities located at high altitudes in mountains or along riverside or coastal areas, to those with high building desities.

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

KEY MESSAGES

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

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

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

Julián Briz, Isabel de Felipe and Teresa Briz
Polytechnic University of Madrid

TOWARDS THE FINANCING OF THE BIODIVERCITY

Investment mechanisms for incorporating biodiversity in urban planning

Lugo Rigoberto
Consultant on urban planning and financing issues

Lazo Elizondo Pablo
World Resources Institute (WRI)

The world's cities will become a key element in reversing the effects of climate change, as well as the damage to ecosystems and, consequently, their capacity to provide human well-being. This is what the conceptualization of biodivercities and their implementation is aimed at. Since the creation of the United Nations Environment Program (UNEP) in 1972, there has been significant institutional growth to promote environmental protection - climate change, preservation of ecosystems, environmental governance and "green" finance,[1] which has led to environmental problems becoming a priority on the global agenda. A key in this process has been encouraging investment strategies and policies, both public and private, to strengthen natural capital[2].

Within this framework, the phenomenon of urban expansion acquires great importance due to its recognized impacts on nature (WEF et al., 2022), its contribution to greenhouse gas (GHG) emissions, and the high risk of human and material damage that can stem from the resulting degradation of ecosystems. This situation requires urgent action, given that, as the United Nations[3] points out, 55% of the world's people live in cities today, and this proportion will increase to 68% by 2050. It is, therefore, a priority to accelerate climate mitigation and adaptation in cities, based on the preservation and restoration of their ecosystems and biodiversity, seen as a way to effectively address these challenges (WEF et al., 2022). It is a matter of adapting urban planning to environmental criteria and orienting investments towards natural capital. This is the reason for the scope that financing acquires, within the framework of the biodivercity concept, as a model for sustainable urban development.

In this sense, "Nature-based solutions" (NbS) are a key element that has emerged in actions to protect, sustainably manage and restore natural or modified ecosystems around cities while at the same time being useful to enhance their benefits for human well-being. The biodivercity thus emerges as a concept around which investment should be prioritized through these types of solutions. The aim is to have greater possibilities to organize the urban territory, respond to the climate emergency and reduce its impact on biodiversity.

Designing and defining financing mechanisms to develop NbS projects in cities is already underway. However, these mechanisms must be accompanied by a public policy, which requires articulating several elements to promote their effectiveness. An important issue is guaranteeing the financing of investments, which can be a complex bottleneck in the case of LAC.[4] Despite this, the potential for investment in NbS projects exceeds US$500 billion, generating more than 50 million jobs (WEF & Alexander von Humboldt Biological Resources Research Institute, 2022). In this sense, the operationalization of the biodivercity concept can provide an impetus to make these investments more viable. Thus, it is necessary to expand the financing of these actions, as well as the design and adoption of novel financial instruments, so that together with the traditional ones - public budgets, multilateral or local loans - they can guarantee "green" investments in those cities that seek a transition towards sustainability. All this is based on the protection, restoration, and sustainable use of their ecosystems and biodiversity.

This chapter presents possible mechanisms that can facilitate this financing, mainly focused on the case of LAC countries. Thus, it points out alternatives for NbS funding, both public and private, focused on strengthening the commitment made by biodivercities and their consequent

TYPES OF NBS FOR PRIORITY INVESTMENT OBJECTIVES IN LATIN AMERICA AND THE CARIBBEAN (LAC).

In a recent study by the Inter-American Development Bank (IDB) and the World Resources Institute (WRI), primary, secondary and tertiary investment objectives and up to three of the NbS implemented in 156 different projects were classified and analyzed across 129 broader initiatives in LAC. This made it possible to qualitatively establish the degree of applicability of each NbS option in relation to the priority challenges that different sectors may be facing. As a result, a relationship of NbS types was established against the most important investment objectives, especially those related to water quantity and quality, urban flooding, coastal erosion and flooding, landslide risk, and river flooding. The main types of solutions identified are related to the protection and recovery of different types of ecosystems and the development of agroforestry and silvopasture processes, good agricultural practices, bioretention systems, artificial wetlands, and urban parks, among others.

Source: Ozment, S. et al., 2021.

benefits in urban planning and management in the region. In addition, the information presented seeks to contribute in the creation of public policies that make viable the articulation of projects, the confluence of funds, and the efficient execution of other related public policies.

GENERAL CONTEXT AND THE VALUE OF BIOLOGICAL DIVERSITY

The financing of projects that link biodiversity and the city, mainly supported by NbS, must consider that what is urban refers not only to that which is built. It must also recognize that biological diversity has an important capital value in these spaces, as it provides ecosystem services that are fundamental for the well-being of citizens. In other words, biological diversity is an asset equivalent to land surplus value.

These natural assets that should be valued within the concept of biodivercity are diverse and operate at different scales. They can be represented by protected areas, green zones, rivers, canals, wetlands, coastal areas, including flora and fauna found in these spaces, as well as water sources and food and energy supply areas, among others.

TYPOLOGIES OF INVESTMENTS IN NATURAL CAPITAL AND URBAN BIODIVERSITY

The investments that arise in this context are of different types in terms of components and technologies. Regarding the former, they correspond to the conservation or the partial or total recovery of ecosystems and green infrastructures. Regarding the latter, they cover two different areas: NbS and hybrid solutions (gray, combined with NbS).[5] These have great potential for contributing to sustainability and generating socio-environmental benefits.

In most cases, these NbS or combined investments correspond to public assets and should, therefore, be defined and operated mainly from that sector. However, there are some cases in which they are public assets or assets transferred to private parties. As far as possible, they should be provided by private parties or through agreements between the State and private or community entrepreneurs, through concessions or public-private partnerships (PPPs).

Urban-regional biodiversity is usually incorporated in this context through territorial planning and management instruments, which identify and define as determinants the different types of elements that are considered to provide fundamental ecosystem services. In the case of a country such as Colombia, for example, this occurs precisely with the Land Management Plans, under the figure of the *main ecological structure*. This instrument has three connotations of interest: (i) it can be a mandatory action framework for public environmental management and indicative of the private sector; (ii) it has a long-term validity; and (iii) the mandate is the responsibility of the State (whether at the municipal, regional or national level).

INVESTMENT OPPORTUNITIES IN BIODIVERCITIES

According to Funds Society, for the World Economic Forum, more than half of the world's GDP is directly dependent on nature's goods and services. This means that a reduction in natural capital, resulting from the loss of biodiversity and the deterioration of renewable reserves, poses a real risk to companies, their profits, and investors. This has been confirmed by recent research,[6] which shows that the positive impacts of investments in nature outweigh the costs that the economy would have to bear for the losses caused by the deterioration of ecosystems.

Biodiversity investments thus face two significant challenges. On the one hand, to adopt, as much as possible, NbS, for which financing mechanisms must be promoted, but targeted in a specific way. On the other hand, recognizing that these are medium- and long-term projects due to the very essence of the problems to be addressed. It is essential to point out that international experience shows that the way to promote NbS as the driving force of biodivercities requires the efforts of governments, international organizations, and multilateral financing agencies to channel resources toward a new generation of urban green infrastructure that includes NbS.

FINANCING THE BIODIVERCITY: EXPERIENCES AND CHALLENGES

The financing of biodiversity management in projects to promote biodivercities based on NbS requires environmental policies and actions at global, national, regional, and local levels. These take the form of four main instruments: (i) planning; (ii) command and control; (iii) economics; and (iv) education, information, research, and citizen participation. The first refers to development plans, watershed plans, waste management plans, and land use plans, among others, which, as mentioned above, exist in practically all LAC countries. The second is a matter of regulation and establishes specific standards or limits that economic agents must comply with.[7] The third is based on using economic or market incentives to generate behavioral changes in agents. Finally, the fourth seeks to train, educate and inform society about relevant aspects of the environment.

FINANCIAL SOLUTIONS FOR BIODIVERCITIES

Financial capital - or, more generically, finance - is an enabling asset because it enables the exchange of funds between legal entities or natural persons over time and makes investment for capital formation viable. When the object of financing is natural capital, it is often referred to as "green" finances or financing.

A *financing solution for biodiversity*[8] (BIOFIN - UNDP, 2018) is a financing mechanism, tool, option, and strategy (or some economic instruments) that facilitates financial flows for conservation, sustainable use, and equitable sharing of ecosystem benefits (see Box 2).

It is worth mentioning three aspects that can influence financing and investment in natural capital and NbS in a context of transformations such as those proposed by the biodivercities:

1. There is a current imbalance between public or private funding for investments in activities that are harmful to ecosystems and biodiversity - fossil fuels, agriculture, fisheries, mining, and infrastructure, among others - versus activities that enhance natural assets and promote sustainable use (Dasgupta, 2021).
2. In the case of private financing, the main concern is the uncertainty of the profitability of these investments, as they have a longer time to generate income flows. This reduces the attractiveness of projects by affecting the liquidity of these assets.
3. Conservation and restoration projects are generally inadequate in size for private investment.

Although the situation in this regard has improved, traditionally, financial markets do not adequately value biodiversity outcomes and avoid investing in NbS. This makes it necessary to establish incentives that particularly motivate institutional investors to consider the value of biodiversity assets, both in making funding decisions and in the process stimulating markets to channel investment from various stakeholders. Evidence from developments in the broader climate finance landscape indicates that this may be achievable, thanks to the considerable reduction in risk exposure and growing evidence of the valorization of environmental assets as drivers of cities with better quality of life (WEF & Alexander von Humboldt, 2022).

The Cambridge Institute for Sustainability Leadership [CISL] (2021) recently published the manual and framework for identifying financial risks related to nature, allowing financial institutions to start integrating this issue into the main financial models, risk frameworks, and portfolio strategies. In any case, it is necessary to create the conditions and technical capacities in each country to structure projects that promote transformations in biodivercities at the feasibility level ("ready for investment"), in addition to policies that incorporate these projects into environmental planning.

FINANCIAL SOLUTIONS FOR BIODIVERSITY

Financial solutions for biodiversity are based on a combination of elements, including one or more financial instruments, sources of funding, key actors or intermediaries, beneficiaries or key stakeholders, and the desired financial outcome. The main elements of a financial solution are:

- Sources of financing on which the solution is based.
- The main agent or intermediaries in charge of managing the implementation of the solution.
- Instruments or mechanisms used to mobilize, raise, manage and disburse the corresponding financing, with strictly financial instruments such as bonds, shares, or tax and regulatory reforms.
- The desired financial results, including those related to: (i) avoiding future expenses; (ii) providing measures that improve cost-effectiveness and efficiency in budget execution, achieve synergies, align incentives and favor a more equitable distribution of resources; (iii) generating revenues; and (iv) realigning expenditures.
- Beneficiaries or stakeholders, i.e., the principal recipients who receive the funding or are the targets of the instrument.

Source: UNDP (2018).

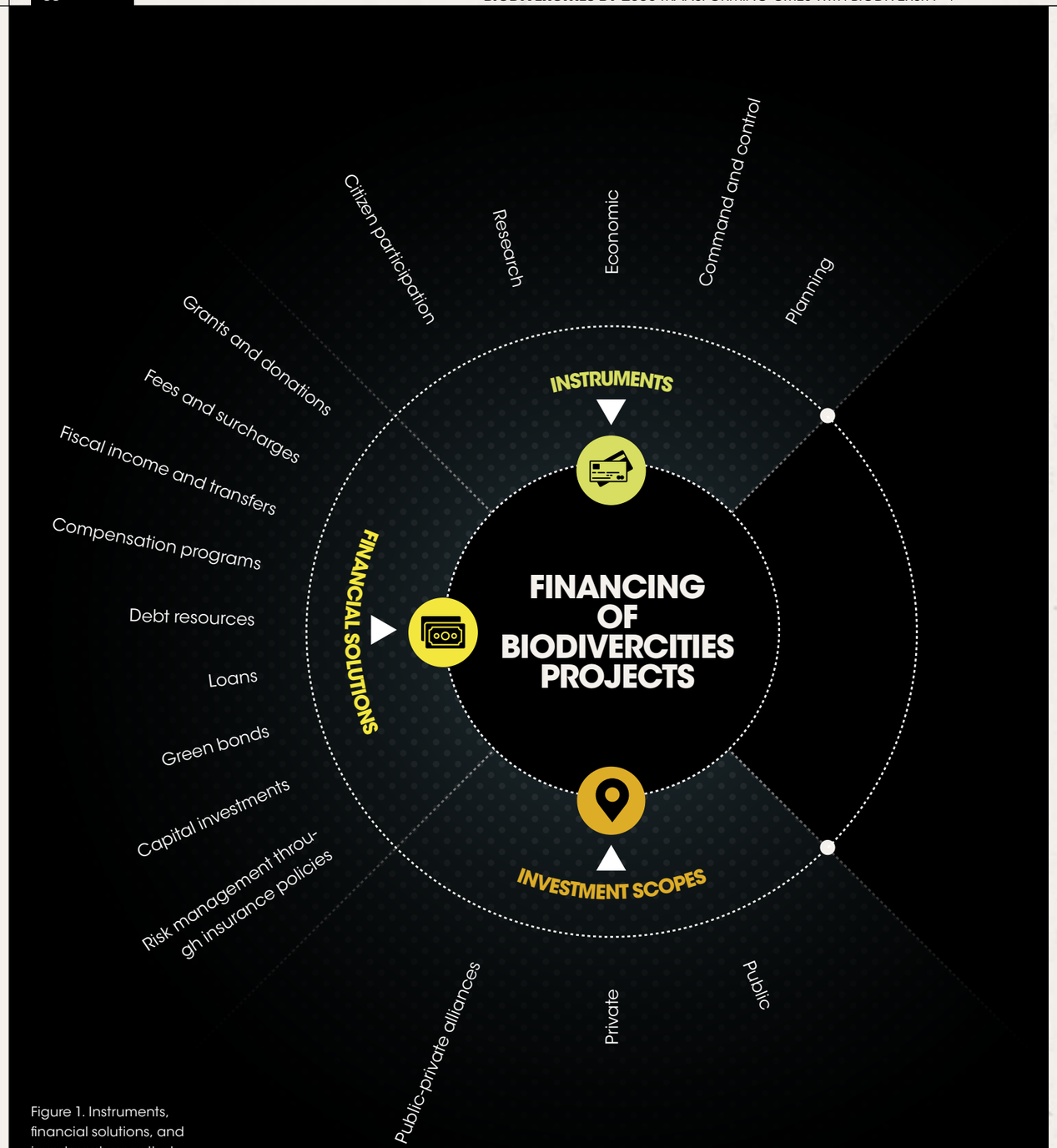


Figure 1. Instruments, financial solutions, and investment areas that define the financing of projects such as NbS that make the development of Biodivercities viable.

Specifically, their "bankability"[9] and "scalability"[10] should be sought to facilitate financing.

NbS Funding Experiences

Investments that drive the transformations proposed by bio-green cities can be made by combining traditional interventions and NbS, especially in infrastructure. Recent experiences in the implementation and financing of these NbS demonstrate that they are a way to boost green infrastructure, in many cases in more cost-effective conditions. In addition, these NbS interventions allow recognizing a wide variety of instruments that are implemented in the projects' financial solutions (Ozment et al., 2021).

The main NbS financing instruments identified in that context (according to Ozment et al., 2021) are:

- Grants and donations: these are the primary source of funding for NbS. They usually come from public entities or international or local foundations.
- Economic instruments: funds from fees and surcharges from public service providers, tax revenues, fiscal transfers, or revenues from compensation programs. These instruments bring together national and territorial public sources.
- Return-based instruments: debt resources, i.e., local or international loans from commercial or multilateral banks, green bonds issued by local or national governments, and equity investments such as private or public investment funds.[11]
- Risk management instruments: innovative scheme to mitigate project risk through insurance policies.
- Multi-source strategies: potential financing from a combination of grant sources; matching funds and tax revenues or surcharges from specific public service providers; multilateral loans; and private investment, among others.
- Private financing: financing by public and private companies that are associated with the benefits derived from these investments.

Public financial instruments for the biodivercity

In general, national or subnational governments allocate resources for financing and investing in biodiversity and green infrastructure. They do so through: (i) direct investments from the public budget, whose sources may be general revenues, debt, taxes, fees, or earmarked fiscal contributions; (ii) the creation of environmental incentives and regulations; and (iii) public-private partnership schemes, concessions, and other joint participation mechanisms.

In addition, public finance also has access to debt sources, such as multilateral credits, through green financing lines, and to the capital market, through green bonds. Likewise, the world's green finance is supported bilaterally or multilaterally by both developed countries and multilateral development banks or agencies (Swann et al., 2021).

Private financing

The international community recognizes that public funds alone are not, and will not be, sufficient to ensure that current trends in biosphere degradation slow down. For this reason, as in the public sector, private investments have access to instruments such as green bonds, sustainability-linked loans, private equity funds in support of biodiversity, environmental impact bonds, and other insurance products for activities that enable the conservation, restoration, and sustainable use of nature.

This market is expected to see an increase in the issuance of green bonds, social bonds, sustainable bonds, blue bonds, and all bonds of a similar nature related to sustainable development spending by national or subnational governments and the private sector.

STRATEGIC CONSIDERATIONS FOR THE FINANCING OF BIODIVERCITIES

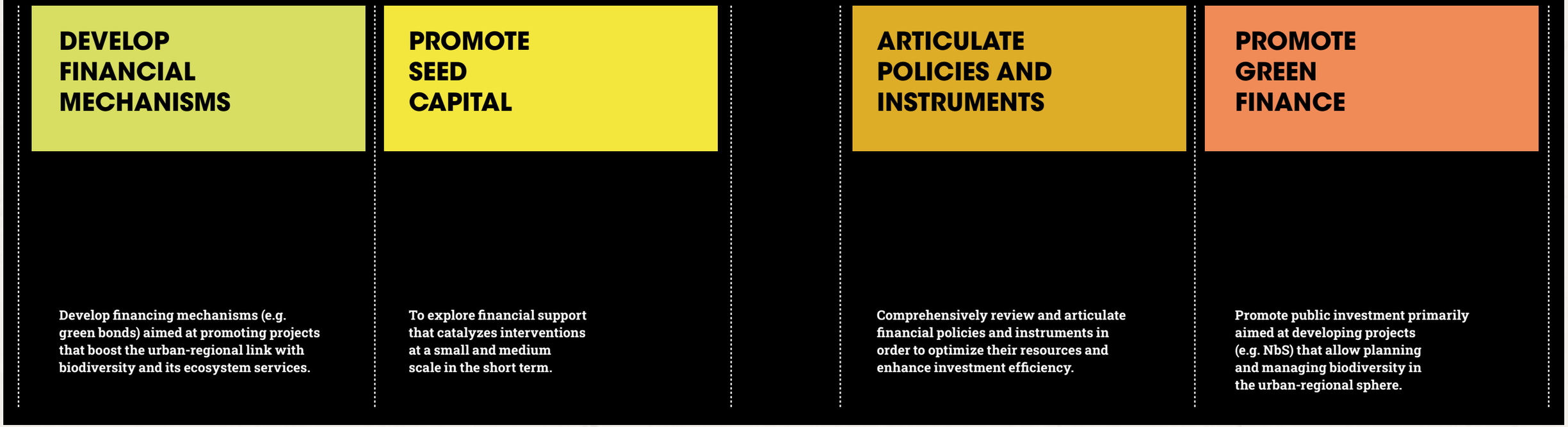
The biodivercities initiative is an appropriate and timely global response to ensure sustainable urban-regional development, as it takes into account the challenges and opportunities provided by biodiversity as a cornerstone within urban planning processes. The reintegration of local ecosystems in these processes, mainly with green infrastructure, will lead to improved quality of life in cities.

In the short and medium-term, the formulation and financing of these programs should be guided by strategies that minimize structural obstacles and difficulties. As an initial approach, the following are some ideas that seek to promote the financing of the projects proposed by the biodivercities (Figure 2):

STRATEGY 1. DEVELOP A GREEN BOND PACKAGE TO FINANCE ECOLOGICAL NETWORKS AND GREEN INFRASTRUCTURE AS AN ARTICULATING AXIS

Provide a secure financial mechanism at the national and regional level that allows the sustainability of ecological networks and green in-

Figure 2. Strategies to promote the financing of projects that can make Biodivercities more dynamic and viable.



frastructure as the articulating axis of the biodivercity projects, guaranteeing the connection of the elements of urban-regional development with the biodiversity of the cities and their ecosystemic services in a comprehensive manner. This will facilitate the formulation and structuring of subprojects and their financing. These green infrastructure networks could be strengthened in areas where precedents of green bonds for air pollution control, environmental education, and NbS, among others, already exist.

STRATEGY 2. EXPLORE THE CREATION OF A CATALYTIC FUND FOR BIODIVERCITIES

It can be achieved through a partnership between the three levels of government and multilateral agencies to obtain a financial base and provide capital for projects within the initiative. This may include results-based financial support such as green conservation bonds, watershed restoration, or water quality improvements. Such a strategy could facilitate financing for small- to medium-scale interventions.

STRATEGY 3. ARTICULATION BETWEEN ENVIRONMENTAL MANAGEMENT POLICIES AND INSTRUMENTS

It is essential to properly articulate environmental management policies and instruments and financing schemes following new trends in financial markets, private investment, tax revenue possibilities, and international cooperation modalities. In this regard, a comprehensive review of all environmental policy instruments, particularly those related to biodiversity, should be carried out. The use of existing environmental fiscal resources should be optimized, and mechanisms should be redesigned to improve the efficiency of public spending.

STRATEGY 4. PROMOTION OF GREEN FINANCE

The budgetary and financing instruments available for public investment should be, as a priority, oriented towards biodiversity projects and should be advanced mainly at the urban-regional level, specifically through NbS projects with a medium-term vision. Likewise, greater public budget allocations at different scales should be earmarked for NbS projects, whose bankability has been previously demonstrated not only in direct economic benefits but also through the monetization of natural capital assets.

The strategies presented seek to propose an urban planning model that considers natural capital assets a cornerstone for a socially just and economically viable urban transformation based on the protection, restoration, and sustainable use of ecosystems and biodiversity related to urban centers. The approach to the necessary changes in the regulatory framework, public policy, and financial institutions seek precisely to reorient the financing process in order to reflect the real cost of nature and its importance for the future of cities.

What follows are a series of recommendations and the key messages that emerge from the perspectives, tools and financing instruments to catalyze biodivecities.

- To make the biodivercity viable, it is necessary to define and implement public policies that favor the preservation and recovery of biodiversity in cities.
- Regulatory environments and institutional arrangements must be created - at municipal, regional and national levels - that favor investments in these projects and state and/or private financing. These are vital elements to consolidate the public policy of a biodivercity.
- To guarantee the biodivercity in Latin America and the Caribbean, it is essential to articulate environmental management policies and instruments and financing schemes according to new trends in financial markets, private investment, tax revenue possibilities, and international cooperation modalities.
- The strengthening of green finance, the diversification of financial instruments and local and international aid, and market access facilities should be part of the plan for the construction of the biodivercity.

KEY MESSAGES

- **Create innovative municipal budgets focused on incentivizing green infrastructure and Nature-based Solutions.** Explore this through channeling and integrating funds from different government sources, green infrastructure projects, and, specifically, NbS.
- **Encourage the creation of natural capital funds and NbS projects at the municipal level.** Define and consolidate an implementing agency to finance NbS projects focused on nature, biodiversity, and ecosystemic adaptation to climate change in cities. This fund could explore various direct or indirect forms of financing.