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EDITED BY
Simone Mora,
Massachusetts Institute of Technology,
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REVIEWED BY
Sara Lenzi,
University of Deusto, Spain
Eugenio Rivas-Herencia,
University of Malaga, Spain

*CORRESPONDENCE
Iñigo Garcia Odiaga
✉ i.garcia@ehu.eus

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Mixed eco-neighborhood: Matsaria as a model of post-industrial transformation

Iñigo Garcia Odiaga[1]*, Nekane Azpiazu Lejardi[1] and Francisca Gual Ors[2]

[1]Architecture Department, Basque Country University, Donostia, Spain, [2]Architectural Representation Department, Polytechnic University of Catalonia, Barcelona, Spain

The research shows how a disused industrial fabric can be transformed to adapt to emerging urgencies. As urban environments evolve, the regeneration of abandoned areas becomes an opportunity to rethink traditional urban planning models. In contrast to the city structured in specialized bodies, the study analyzes a more flexible and dynamic model, where spaces allow to assume changes, and thus function in a resilient manner. Through an inductive methodology based on the analysis of significant case studies, such as The New Urban Fabrik: Torrent Estadella eco-industrial park, it concludes in a decalogue of strategies applicable in urban centers, which delves into the reuse of buildings and hybridization of uses, as well as the implementation of solutions focused from a more-than-human vision in public space to promote multi-species cohabitation. These guidelines arise from common patterns detected in successful processes of urban and industrial regeneration, demonstrating their capacity for transformation in non-specialized structures. The result of the research, is the image of a new urban model in the post-industrial area Matsaria of Eibar, which is obtained through the implementation of the guidelines of the decalogue. The intervention shows its transformation towards a sustainable hybrid infrastructure based on post-natural ecological design. The study highlights the conversion capacity of urban fabrics that became obsolete due to the zonification of uses, and how they can be converted into inclusive and versatile spaces that ensure greater integration between economic, social and cultural activities. The decalogue not only serves as a practical guide for interventions in similar industrial environments, but also opens the way for reflection on its possible application in any urban fabric, inspiring a new vision for the city model of the future based on the capacity for constant adaptation.

KEYWORDS

industrial fabric, hybrid buildings, urban industry, revitalization, postnatural design, urban ecology, multi-species coexistence

1 Introduction

The firm belief in the absolute power of the machine radically conditioned the architecture and urbanism of modernity. The mechanical power of industry, the creative power of mass production, or the transformative capacity of factories, elevated the machine to the paradigm of a new era, as states Reyner Banham, british architectural critic and theorist, in his book *Theory and Design in the First Machine Age* (Banham, 1960).

The great dogmas of faith of the modern movement found their starting point in the logics of industry. The rationality of industrial architectures, arising exclusively from the functional optimization of factory production processes, seduced the architects of the early twentieth century, leading architecture and urban planning to the dead end of functionalism.

The International Congress of Modern Architecture (CIAM) (Mumford, 2000), established in 1928, served as an intellectual laboratory for the modern movement, aiming to reshape society through universal principles of urbanism. Among its most influential contributions was. The Athens Charter, formulated during CIAM's IV congress in 193 aboard the Patris II, navigating the route from Marseille to Athens and back. This manifesto advocated for the functional segregation of urban spaces, organizing cities based on key activities such as living, leisure and work. Rooted in the logic of population distribution, this approach elevated mobility, particularly the automobile, as a central element in maintaining the efficiency of the modern city. Through its various congresses until its dissolution in 1959, CIAM played a pivotal role in shaping the 20th century urban planning.

This functional segregation annihilated in a certain way the life of exchange and relationship of the city, its mixture and hybridization of uses, and with it the life of the neighborhood, provoking an urbanism far from the human scale, dehumanized and also denaturalized, as Fritz Lang denounced in his work Metropolis, a film that aims to depict through science fiction the vivid embodiment of society, delving into the human and social content. A megacity of enormous proportions, highly industrialized, and spatially and socially organized through a system of superimposed and strictly compartmentalized strata: an elite of owners and thinkers, headed by Joh Fredersen, lives on the surface, in a city of tall skyscrapers, with all kinds of luxuries; at the other extreme, the workers, who have no names, only numbers, live precariously in a subway ghetto where sunlight never reaches; below the metropolis, although belonging to it, is the industrial heart of the city, where the workers work to exhaustion to ensure the functioning of the machinery that makes the existence of the metropolis possible.

The city, that invention to improve people's lives, is thus transformed into a specialized machine that expels human and natural life from its area of influence. The machine and industry are thus elevated to the iconic image of a system based on resource extraction, unlimited consumption and exponential pollution of territories and ecosystems, putting the natural balance and biodiversity in crisis. The concern about urban growth and its consequences was later echoed in the famous Meadows report of 1972, which anticipated perspectives on a planet on the path to devastation and marked a turning point in early environmental awareness. Presented by Dennis Meadows, this report was the first major study commissioned by the Club of Rome, a group dedicated to researching environmental issues. Widely disseminated, it was the first document to reflect the severity of the ecological crisis affecting the planet, raising significant concerns about sustainability and the long-term viability of existing urban and economic models.

After the various crises suffered, environmental, social and economic, one could think of recycling those industrial areas now relocated and that due to urban growth occupy central places in today's cities. Those manufacturing districts in which machines devised by human reason could dominate nature, reflect the essence of the term Anthropocene, introduced by Paul Crutzen in 2000. Crutzen, a Nobel Prize-winning chemist, used the term to highlight the profound environmental consequences of human activities, such as the sixth mass extinction and climate change. It underscores how inventions, particularly the mass production of goods and construction of cities, have reshaped the geophysical properties of the planet, making human intervention a dominant force in Earth's history. The industrial icons can now be urban islands of diversity, hybridization and miscegenation. New places for new ecologies, interspecies eco-neighborhoods as this article advocates.

How could architectural practice be redirected towards a climate-positive and socially just planet? The answer involves fundamental changes in the financing and organization of all types of buildings, in order to implement a form of management in which ecological and social values are a priority (Loorbach et al., 2024, p. 45). For a city to function as a tree, any type of specialization must be eliminated. Trees, as opposed to cities, do not have specialized organs. Their vital functions are distributed over the entire extension of the organism, allowing flexibility and adaptability. This modular structure allows them to survive for centuries and adjust to fluctuating circumstances (Mancuso, 2024, p. 76–77). However, the urban system continues to function through a specialized structure that does not provide for the necessary flexibility. Industrial zones act as specialized organs of an urban body, designed to maximize efficiency by grouping similar activities, but have serious disadvantages when factories close and change their development strategy. The specialized model lacks versatility and makes it difficult to reconvert for new uses, contributing to urban decay. Adopting plant-nature approaches, rather than concentrating specific functions in separate zones, cities should encourage functional diversity within the same areas. Integrating residential, commercial and industrial uses promotes resilience, and enables cities to become more resilient and sustainable systems.

The starting point is to build urban environments that, like trees, are capable of evolving in response to the challenges and changes of the current polycrisis, rather than relying on specialized bodies that will inevitably become obsolete over time. Nature, threatened by the pressures of industrial development and pollution, seems to be the only entity with the capacity to mitigate human-generated environmental damage. This duality that places it both as a threat and as a solution (Picon, 2024, p. 160–161), makes it a remedy to act on polluted sites such as former industrial zones. Why do we persist in selecting untouched, pristine, and valuable areas to leave our mark? Why not redirect our efforts towards restoring degraded spaces or revitalizing neglected heritage sites? (AAVV, 2024, p. 65).

This study responds to the growing concerns about the impact of human activity on the planet, particularly through urbanization and industrialization, which have drastically altered Earth's physical and environmental structure. It explores how cities, once symbols of humanity's control over nature, can evolve into spaces of diversity, hybridization, and new forms of ecological coexistence, reflecting the idea of the post-organic city. The research highlights the potential for creating urban environments that embrace sustainable living and coexistence between species. Looking ahead, it calls for further exploration of these urban ecosystems and their ability to foster more harmonious relationships between human settlements and the natural world.

2 Materials and methods

This study formulates and implements a new non-specialized urban theory in the disused industrial areas of Matsaria in Eibar—located in the Basque Country, Northern Spain—for its revitalization, with the purpose of strengthening the urban ecosystem, implementing

a multi-species justice perspective in an environment previously characterized by its great anthropocentric and extractivist activity. The term multi-species refers to the relationships with non-human othernesses, acknowledging the importance of integrating diverse species beyond human concerns (Castro, 2023, p. 36). By fostering such relations, we aim to create a more inclusive and sustainable environment where both human and non-human actors coexist and thrive.

The research employs an inductive methodology based on the analysis of several case studies to identify and extract strategies applicable in degraded urban industrial areas, such as Matsaria, the object of study of this research. To structure the research, a design-based analysis approach was adopted. The research has been confined to two specific areas, in order to set clear boundaries and concentrate the study on analizing management models for eco-industrial environments and ow urban proposals integrate new natures within city limits. These characteristics define the scope of the investigation, ensuring a focused and manageable approach (Muratovski, 2016, p. 50).

- The first area addresses the hybridization of uses, the reuse of existing structures and regeneration, analyzing management models for the creation of eco-industrial environments that integrate production and the circular economy, revitalizing public spaces and the urban fabric.
- The second area focuses on urban ecology, analyzing how the proposals studied manage to incorporate new natures in the urban limits.

This procedure has made it possible to identify essential patterns and concepts, driving the development and design of solutions capable of transforming urban remnants into hybrid neighborhoods capable of promoting a new urban ecology. The implementation of the studied approaches manages to blur the boundary between the city and nature, in its contact with the slopes of the mountains that characterize the place.

To achieve these objectives, the research is mainly based on the analysis of the case study *The New Urban Fabrik: Torrent Estadella eco-industrial park*, commissioned by the Barcelona City Council in 2015 to Eduard Balcells and Honorata Grzesikowska. The proposal emphasizes the necessity of repurposing industrial urban fragments to integrate them with their surrounding environments, converting existing urban barriers into extensions of metropolitan park networks. It is a centrally located urban fragment that, as a specialized organ of the city, has historically lacked effective continuity with its surroundings.

One of the potentialities of the proposal lies in choosing an industrial piece with a neighborhood scale, allowing a sufficient extension of the area to be intervened, but without exceeding the nearby fabric that guarantees the feeling of belonging and the links with the resulting community. To this end, sustainable production systems, urban agriculture, social self-sufficiency and the neighborhood's network of commerce and local economy play a key role. As a result of this case study, the need arises to consider the importance of non-specialized productive fabrics in our cities.

To enhace the rigor and robustness of this study, additional complementary cases have been analyzed alongside the main case, providing a basis for comparison and refining the results.

- *Parco Dora*, Torino, Italy. Latz + Partner.
- *Zollverein Park*, Essen, Germany. Planergruppe Oberhausen.
- *Industrial Area Reset*, Avilés, Spain. Ecosistema Urbano.
- *Landschaftspark Duisburg Nord*, Duisburg, Germany. Latz + Partner.
- *Scalo Farini*, Milan, Italy. OMA.
- *Vallée de la Chimie*, Lyon, France. OMA and B1ASE.

The study, employing a dual-area approach, resulted in the formulation of a set of 10 strategies designed to stimulate the revitalization of underutilized urban fabrics. These strategies are projected for application in Matsaria to assess their effectiveness. Matsaria, an area characterized by intensive industrial use, was selected as a case study for the implementation of the new urban model due to its potential for programmatic hybridization and the development of new activities within natural environment.

The result of the research is the image of the interspecies industrial eco-neighborhood of Matsaria, which emerges from the synergy of both lines of development. It demonstrates how the boundaries between city and nature can be blurred from a more-than-human perspective and by applying project tools based on the reuse and recycling of obsolete industrial fabrics.

2.1 Case studies

The main case study on which the research is based is *The New Urban Fabrik: Torrent Estadella Eco-Industrial Park*. This project, a preliminary study for the MPGM (Modification of the General Municipal Urban Development Plan) in the Torrent Estadella area of the Sant Andreu district in Barcelona, was prepared in 2014 by the architectural firm of Eduard Balcells and the urban planner Honorata Grzesikowska for the City Council of Barcelona and had the collaboration of Factors de Paisatge—Manuel Colominas in the field of agronomist and landscape consultant.

The research derived from this project has provided a solid foundation for understanding and developing approaches applicable to similar contexts, given its significance in urban renewal and environmental restructuring.

In addition to the analysis of the aforementioned case study, other examples have been investigated with the aim of reinforcing the points raised and deepening the frame of reference. Broadening this vision has made it possible to compare different contexts and situations, and to identify different strategies that have broadened the scope of the research (Table 1).

2.1.1 Analysis of reuse and hybridization of uses

The case study highlights the potential of the Torrent Estadella industrial area to develop into a green economy hub within Barcelona. This potential is supported by several urban factors: its strategic central location near the future La Sagrera High-Speed Railway Station, its proximity to dense and established neighborhoods, well-defined geographical boundaries, and strong vehicular accessibility due to its nearness to the Ronda Litoral.

The approach of *The New Urban Fabrik* refers to the architectural types that emerged in the successive industrial revolutions. While the First Industrial Revolution left a legacy of urban factory buildings, integrated into the consolidated fabric of cities, the Second Industrial

TABLE 1 Comparative table of the research case studies, the strengths of each project and the reason for their choice.

	Case study	Location	Team	Project strengths	Reason for choice
Main case study	*The New Urban Fabrik: Torrent Estadella eco-industrial park*	Barcelona, Spain	Eduard Balcells and Honorata Grzesikowska	Development of a green economy hub through industrial rehabilitation and energy efficiency	Sustainable urban industry model
Additional case studies	*Industrial Area Reset*	Avilés, Spain	Ecosistema Urbano	Reuse of industrial heritage as urban landmarks and multifunctional urban spaces	Industrial memory integration
	Vallée de la Chimie	Lyon, France	OMA and BASE	Gradual regeneration based on the natural appropriation of space by flora and fauna	Long-term adaptive planning
	Scalo Farini	Milano, Italy	OMA	Creation of a green corridor and conversion of an industrial facility into technology research center	Industry-to-urban transition
	Parco Dora	Torino, Italy	Latz + Partner	Use of phytoremediation to decontaminate industrial soils and promote ecological restoration	Environmental regeneration model
	Landschaftspark Duisburg Nord	Duisburg, Germany	Latz + Partner	Transformation of metropolitan infrastructure into ecological filters for air and water	Climate adaptation strategy
	Zollverein Park	Essen, Germany	Plannergruppe Oberhausen	Evolutionary landscape approach for renewable energy production and soil regeneration.	Industrial ecology innovation

Revolution was characterized by the emergence of suburban pieces in peripheral areas. The authors advocate a Third Industrial Revolution, which is currently taking shape through a new urban industry centered on renewable energies, communication networks and the promotion of a green economy based on sustainability (Figure 1).

As Jeremy Rifkin outlines, this Third Industrial Revolution is based on five key strategies aimed at transforming the energy and economic landscape. These include a transition towards renewable energy sources, the adaptation of buildings to function as decentralized energy producers, and the implementation of advanced storage technologies such as hydrogen. Additionally, the restructuring of power grids into interconnected, decentralized networks would allow energy to be shared efficiently across regions, much like data is distributed via the Internet. Finally, the shift towards electric and fuel-cell-powered transport systems would integrate seamlessly into this smart energy infrastructure, fostering a more sustainable and interconnected urban environment (Rifkin, 2011, p. 45).

Torrent Estadella attracts sustainable construction and renovation industries, clean energy production or design with recycled and recyclable materials. It opts for a dual strategy: the rehabilitation of existing buildings and the construction of new parts with high standards of energy efficiency. The ultimate goal is to close as many cycles as possible within the new urban eco-industrial park, so that the by-products and waste produced can be used within the same area (Figure 2).

After a mapping of the current activity in the area, a color-coded inventory and photographs of all existing structures were created, revealing that the predominant feature in the Torrent Estadella area is inactivity, with nearly 25% of the industrial premises remaining vacant (Balcells and Grzesikowska, 2014, p. 163). The industrial plots are of very different sizes, which allows for a wide variety of possible solutions and programs. In addition, the research shows that 66% of the buildings have a single floor, so they form a suburban fabric that requires some densification to integrate into the context of the city.

To this end, the proposal defines a *silo building* model, a new compact factory building in which industry is stacked high (Figure 2). Balcells and Grzesikowska's proposal opts for a Vierendeel-type beam structure with spans of 32 meters, leaving floors with open spaces free of pillars. The very geometry of the beams acts as a support for the passage of the necessary infrastructures and installations. The clear heights of the spaces allow the appearance of mezzanines, and the roofs are used for urban gardens with hydroponic systems. The compactness and density of the components result in the availability of soil suitable for greening.

This same casuistry of high-rise factories is defined by Nina Rappaport in *Preserving the Modernist Vertical Urban Factory* (Rappaport, 2016, p. 153), where she defines the concept of the Vertical Urban Factory as a multi-story industrial building located within the city. According to Rappaport, these factories do not necessarily have to be tall but must incorporate verticality into their production processes. They can function either as "integrated" factories, where a single company occupies the entire building, or as "layered" factories, in which multiple manufacturers operate within the same structure. The production workflow in these spaces can be organized from top to bottom or vice versa, optimizing the use of vertical space for industrial activities.

Another aspect of the project is to seek a figure that, from the planning, enables these conversion processes, modifying the maximum heights currently allowed for industrial uses. To achieve this, the authors of the project suggest the introduction of a new zoning category, "22u." In this classification, "22" represents the existing industrial zoning, while "u" denotes its transformation into a new urban form. This new zoning category aims to promote more compact and urban building typologies that integrate better into Barcelona's urban fabric, while simultaneously freeing up space for uban renaturalization (Balcells and Grzesikowska, 2014, p. 176).

In terms of management, one of the main challenges of the project is the creation of *T.E.M.A* (Torrent Estadella Manufacturing Alliance), a non-profit corporation in charge of revitalizing the area and its industrial activity as an essential public asset. It would act as manager, promoter and representative, and would guarantee collaboration between neighborhood associations, companies, workers, multidisciplinary experts and public administrations, especially the Barcelona City Council. In this way, the green reconnection of the

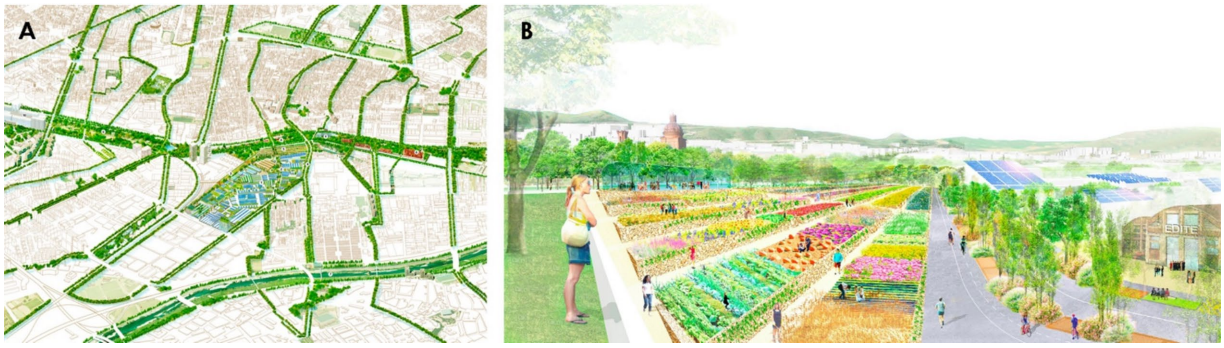

FIGURE 1
General arrangement and stitching of Torrent Estadella with the city through green infrastructures **(A)** and *The Farm of Sant Andreu* **(B)**. ©The New Urban Fabrik.

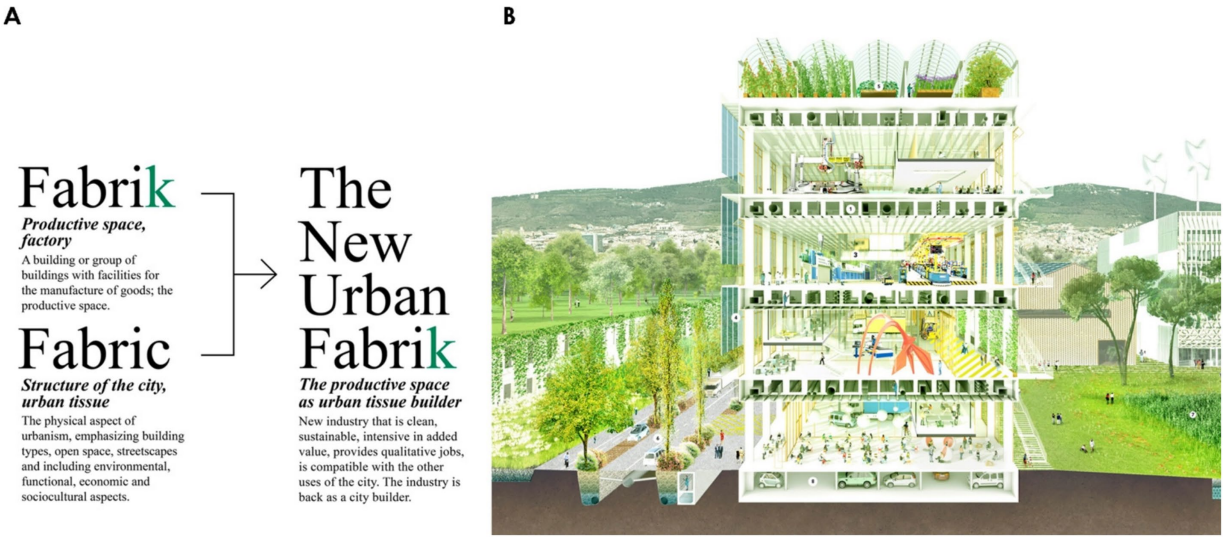

FIGURE 2
Justification of the term *The New Urban Fabrik*, based on the productive spaces and urban structure of the city **(A)** and proposed hybrid building of the *silo building* model **(B)**. ©The New Urban Fabrik.

industrial area of Torrent Estadella is accompanied by a management body that guarantees the regeneration of industrial assets, income generation, community participation, qualified job training and the defense of public policies favorable to all of this. It aims to balance the interests of various stakeholders, ensure transparency in decision-making, and establish a system of financial sustainability to guarantee the long-term viability of the proposal.

However, to avoid being a specialized body within the whole metropolitan area of Barcelona, it is necessary to inform citizens about this new urban industry so that they really recognize it as a fundamental part of the city. The solution is the creation of *BCNMade*, a corporation and a website that would be responsible for promoting it, with search engines and maps available to the public where they can consult and learn about the network of local and sustainable eco-cluster products.

Another built example that can reinforce the reuse strategy enunciated in the urban study of Torrent Estadella is the *Parco Dora* project in Turin (Figure 3). In this case, an adaptive repurposing strategy to carry out the urban regeneration of the abandoned industrial areas of the city is highlighted, the proposal gives value to the industrial pre-existences, avoiding their demolition and turning them into new landmarks of the planning of the area. It reinforces the character and the value of the memory of each of the five areas: Ingest, Vitali, Mortara, Michelin and Valdocco, greening them and integrating them into the urban park as a whole.

One of the most characteristic elements to exemplify the reuse is the former *Ferriere Fiat* steel plant in Vitali. The roof of three of the original aisles is removed, leaving only the vestige of its pillars, structuring the public space. However, in the *Capannone di Strippaggio*, the building used to extract the steel ingots from the molds where they were produced, it was decided to preserve the structure and the roof, transforming it into a large urban loggia. The result is a flexible and multipurpose public space that, although open, is sufficiently protected and delimited to allow for multiple activities and events.

In relation to the scale of the existing industrial pieces, a key factor in the urban regeneration strategy is their link to the urban context and the city, the dialogue with what surrounds it and the capacity to create public space around it. The case of Torrent Estadella exemplifies an urban fragment that is located in a city that has mutated and that today differs from what it was at the time of construction of the industrial vestiges. The temporary disconnection of the industrial ruins with the context requires a treatment of the boundaries and extending the buildings into the public space. The strategies of naturalization and greening of spaces, through the creation of vegetal filters, offer a framework that favors mediation between both realities. This leads to the final key element: transforming the factory into a generator of environmental resilience, providing values that can serve as a model for the neighborhood and the city's transition process. The integration of vegetation, serving as CO2 sink and mitigating urban heat islands, is crucial not only for making the building passive, as a production center and a comprehensive rehabilitation model, but also for representing a fundamental shift in how citizens perceive and assume responsibility for their city's environmental future (Sánchez-Montañés and Castilla, 2020, p. 13).

FIGURE 3
Area Reset Industrial Project in Avilés by Ecosistema Urbano ©Ecosistema Urbano **(A)**, *Parco Dora* in Torino by Latz + Partner ©Heidemarie Niemann **(B)** and *Zollverein Park* in Essen by Planergruppe Oberhausen ©claudiadreysse.de **(C)**.

In this line, the *Zollverein Park* project in Essen is a clear example of the importance of the passage of time in regeneration strategies and of the mediating role between industrial parts, users and public spaces in greening strategies (Figure 3). The former Zollverein mine ceased to operate in 1993 and, due to the lack of maintenance of the facilities, fauna and flora freely colonized the site, until it became a UNESCO World Heritage Site in 2001. After several management proposals by Rem Koolhaas and Agence TER, the competition held in 2005 resulted in an interdisciplinary proposal based on long-term strategies.

The project needed a solid approach that would give it a unique character, but at the same time allow it to adapt and be flexible to the changes brought about by the passage of time. The park was opened that same year, applying a principle of gradual development, which is activated gradually and adaptively. Some pieces have been reconverted into a cultural center, while others are the object of ephemeral artistic interventions. Multiple pieces of furniture and different plant treatments are scattered throughout the area, allowing users to colonize them according to their needs.

Another case study of closer proximity is the assignment given in 2008 by *Arcelor Mittal* to the firm Ecosistema Urbano to develop an urban regeneration of the coal processing facility in Avilés (Figure 3). *Industrial Area Reset* is divided into two phases, a first phase for the creation of a green corridor and the reorganization of the industrial spaces, and a second phase, after the dismantling of the facilities, which proposes a river park and the conversion of a historic building into a technological research center.

2.1.2 Analysis of environmental and ecological solutions

In terms of environmental management for the conversion of an industrial area into an ecological neighborhood, Torrent Estadella has become an innovative space that looks to the future from the perspective of resilience. The project is based on the simultaneous integration of green and blue infrastructure, to promote the biodiversity, as well as sustainable water management. The new district proposes a new innovative model reconfiguring the interaction between urban structure and nature.

The project is situated in a privileged location; close to the city's new central station, and opposite the historic center of the Sant Andreu District with its regional train station, as well as the future Sagrera Linear Park, which will be the largest urban park in the city. Therefore, the main objective is to reconnect the district with the surrounding green areas through green axes and productive urban parks. The main axis of the district, Torrent Estadella street becomes what the proposal calls Rambla Verde, a new concept of renaturalized urban axis, which aims to recover the original meaning of rambla as riera, characteristic intermittent streams of the Mediterranean coast that only carry water during rainy periods, but are fundamental agents

of the water cycle and climate management. The rieras structured the first urban order of the Barcelona plain, linking mountains, rivers and the sea, which over time have become the principal urban axes of today. The Green Ramblas aim to recover the functioning of these ancient hydrological paths, so that the city of Barcelona can adapt to climate change and be able to respond to episodes of torrential rains. To this end, the design combines *Water Sensitive Urban Design* solutions, a land planning and engineering design approach that integrates the urban water cycle, including stormwater, groundwater, and wastewater management and water supply, into urban design to minimize environmental degradation and enhance aesthetic and recreational appeal, which allows the integration of hydrological and ecological processes, so that the city is able to manage the water cycle *in situ* (Figure 4).

These Green Ramblas are part of a green infrastructure that aims to foster spaces for new ecologies and production models, providing locally grown food and clean water from filtered wastewater. This extensive green system that floods the district is constituted by three types of elements: *The Stream Street*, *The Filtering Rambla* and *The Farm of Sant Andreu*.

The Stream Street, is applied both in the street Torrent Estadella, as well as in other secondary axes. In these, the construction of continuous gravel channels is proposed in the surfaces that form parking and planting areas to simulate the functioning of the streams in a way that helps to regulate the water cycle. The parking surfaces are covered with a corten steel mesh that supports the load of vehicles, and allows water to quickly filter through this mesh and be stored in the gravel channel below, and then circulate by gravity to the adjacent areas, where it can be slowly absorbed by the roots of plants and trees. In this way, rainwater is immediately retained and reused on site, instead of being mixed with wastewater, stored for some time in huge subway reservoirs to prevent flooding, and finally treated in distant, already overloaded conventional wastewater treatment plants. The design of these new shafts enhaces the ecological functioning of the stream.

The Filtering Rambla type artery is focused on purifying the wastewater generated by the industries in the area, and is considered as a vegetal wastewater treatment plant. It is proposed to transform the train tracks, which are scheduled to be dismantled soon, into a system of filtering basins, consisting of gravel beds that will allow the growth of macrophyte plants, forming a wild meadow. The industrial water collected by gravity is pumped to the upper part of *The Filtering Rambla*, where it undergoes treatment to separate the solid parts and eliminate pathogenic germs. After being treated, the water needs to be cleaned, and this process is carried out in the course of the filtering ponds, known as "vertical flow systems," where the water remains for 1 or 2 weeks, and is prepared to infiltrate the aquifer, as well as being used to irrigate vegetated areas or clean streets. The system uses several basins, mostly fed alternately by rotation or tank loading. The water flows freely by natural gravity between the different basins. In this way, the wastewater cycle is closed *in situ*, reducing the need to transfer the water to distant treatment plants and increasing the biodiversity of the site.

Along the boundary between the site and the Sagrera Linear Park, a new 2 hectare park is proposed where new models of urban agriculture will be adopted in the city. *The Farm of Sant Andreu* aims to be a productive space where people can actively participate, and serve as a social meeting point beyond offering local food to citizens.

The new paradigm of the city presented by *The New Urban Fabrik* project is characterized by its innovative, sustainable and biodiverse condition, reconfiguring the interaction between the existing urban infrastructure and nature. The project transforms and refurbishes the city into a resilient space capable of responding to present challenges.

The strategies present in the project, from the use of vegetated areas to suture a disintegrating urban fabric and partially remediate soil contamination to the transformation of industrial remains, can be identified in projects such as the Duisburg North Park in the city of Duisburg (Germany) (Figure 5). The land previously occupied by the Thyssen factory has been converted into a 200-hectare park that aspires to be more than a replica of idealized nature. Green areas and plantings contribute to soil decontamination through phytoremediation (Picon, 2024, p. 170), and vegetation has been allowed to develop naturally and spontaneously. In this case study, they also play with the role that water originally played; they convert the canal, which was previously used to transport waste from the iron and steel process, into a course that supplies clean water to various ponds and gardens.

Similarly, *Scalo Farini* in Milano (Italy) is a 2019 OMA planning proposal to redevelop two disused rail corridors on the city's peripheries (Figure 5). It exemplifies a regeneration strategy that leverages the scale of metropolitan infrastructure as ecological filters. *Parco Farini*, to the north, is proposed as a green corridor, while *Parco San Cristoforo*, to the south, becomes a blue zone. The green lung is responsible for purifying the air of toxic particles from the city, while

FIGURE 4
Green boulevards based on *Water Sensitive Urban Design*: *The Stream Street* **(A)** and *The Filtering Rambla* **(B).** ©The New Urban Fabrik.

regulating hot air. The blue corridor focuses on the groundwater system, cleaning it through a filter basin and a phytoremediation basin. Two new zones act together to provide clean air and water, mitigating the effects of climate change and pollution.

However, the same OMA studio has been developing the *Vallée de la Chimie* development project on the outskirts of Lyon (France) since 2014 (Figure 5). The territory is located in a strategic location between Lyon and Saint-Etienne, which, due to new innovation and development activities, has undergone several deindustrialization processes. Fragmented by an extensive network of infrastructures, the valley consists of an isolated set of industrial areas with severely polluted soils, disconnected from both the urban fabric and natural systems. The new planning proposes an evolutionary process, considering the landscape as an evolutionary resource that can contribute to the production of renewable energies or to the processes of treatment and regeneration of the soils. Through remodeling, it aims to establish new reference points for the territory's users, to introduce new principles of industrial metabolism.

3 Results

3.1 Guidelines for an urban fabric without specialized bodies

Recently developed case studies have allowed the definition of general guidelines that can be applied in specific contexts where the abandoned industrial fabric represents an opportunity for the development of new districts where land can be optimized using urban renewal processes.

The present research aims to use these guidelines in the specific context of Matsaria in Eibar, as it is an environment that has an important potential to become a self-sufficient mixed neighborhood, based on ecological resilience strategies.

Applying the approaches derived from the analysis opens the door to new imaginaries for disused industrial areas. The guidelines resulting from the integration of mixed-use development and urban ecology allow the transformation of the city by responding to present challenges and taking into consideration the landscape and the ecosystem of the site. The proposed approaches, grounded in urban theory, ensure a model inspired by plant metabolism, as lack of rigid specialization and the presence of numerous functional elements allow the plant organism to adapt, transform, and evolve. These characteristics are essential for establishing a new model of industrial reuse, capable of self-management in a manner similar to an autotrophic organism, from production to waste management.

The strategies obtained and tested in the research are summarized in the following decalogue (Figure 6).

3.1.1 Rehabilitation of abandoned industrial areas. Material recycling and heritage conservation as a guarantee of preservation of the collective memory

Contemporary architecture is faced with the challenge of sustainable development after having realized the limitation of resources and the need to optimize them. Often, the idea of sustainability is associated with the complex technification of buildings at a high economic cost, focusing efforts on a series of conditioning factors such as installations or the sophistication of construction solutions. However, the approach leaves in second place the logic of the project itself, in which the effort is to understand the value of what has already been built. Structures that have already amortized the energy cost of their initial construction and whose reuse can be understood as a sustainable resource. The intervention and rehabilitation projects of industrial buildings in disuse, built for heavy uses, and with large spans, allow better than other typologies their reloading with new uses capable of reactivating neighborhoods and urban life.

On the other hand, industrial buildings have a heritage value to conserve and preserve for different reasons, whether for their structure and construction system, for their architectural and artistic characteristics or for their material value implicit in their capacity for recycling and reuse. However, another of its characteristic aspects is the weight of memory and the deep-rootedness of the workers of the different industries. The feeling of belonging, linked to the memory of the neighborhood's productive past, is one of the key tools for achieving social cohesion of the new community in urban regeneration processes.

- Rehabilitate existing buildings, avoiding demolition and reducing waste generated in the process.
- Amortize the footprint of something built to optimize its useful life cycle and reduce its ecological impact.
- Regenerate obsolete urban fabrics and reconnect them with the immediate urban context.
- Introduce new programs in existing industrial parts as a guarantee of conservation and preservation.
- Use project intervention strategies that enhance the qualities of industrial containers.
- Insert cultural and exhibition programs linked to the industrial past of the pieces.

3.1.2 Reconnect the city as a global system from the neighborhood unit

The modern movement idealized an urban system based on the rationality of functionalism. A logic that segregated the city by uses, weaving between these functional units a dense network of road and rail infrastructures for the sake of greater connectivity and logistical benefit for the productive areas. Those infrastructures are today revealed as boundary elements, which sectorize the city, and prevent pedestrian urban connection, imposing themselves on the urban structure as insurmountable barriers. These barriers also generate marginal areas on their edges, unarticulated and unstructured free spaces.

Resolving these difficult points becomes a strategic decision, since with their implementation, the territories located on both sides of the old barrier are activated.

- Projecting public space for the soft mobility of people, connecting them with each other to give continuity to walking and cycling routes. Thus establishing an extensive network of paths through open spaces that allow the flow of citizens.
- To orient the relationship of urban public spaces towards the natural environment in order to guarantee the continuity of the territory and facilitate people's access to the natural environment and its biodiversity.
- Strengthen public transport nodes as new areas of centrality. Public transport stations, often with disorganized and poorly

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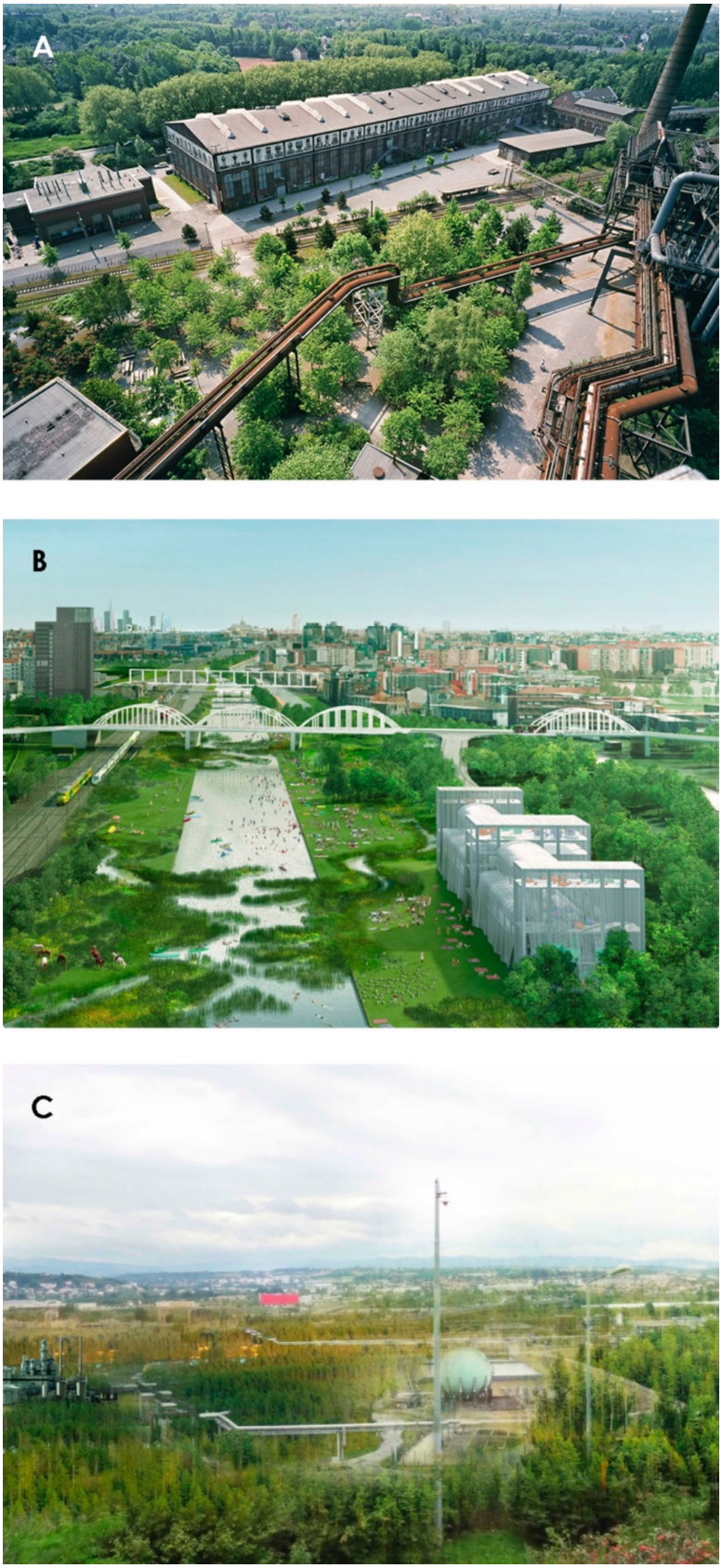

FIGURE 5
Landschaftspark Duisburg Nord by Latz + Partner ©Michael Latz **(A)**, *Scalo Farini* of OMA **(B)** and *Vallée de la Chimie* of OMA and BASE ©Baseland **(C)**.

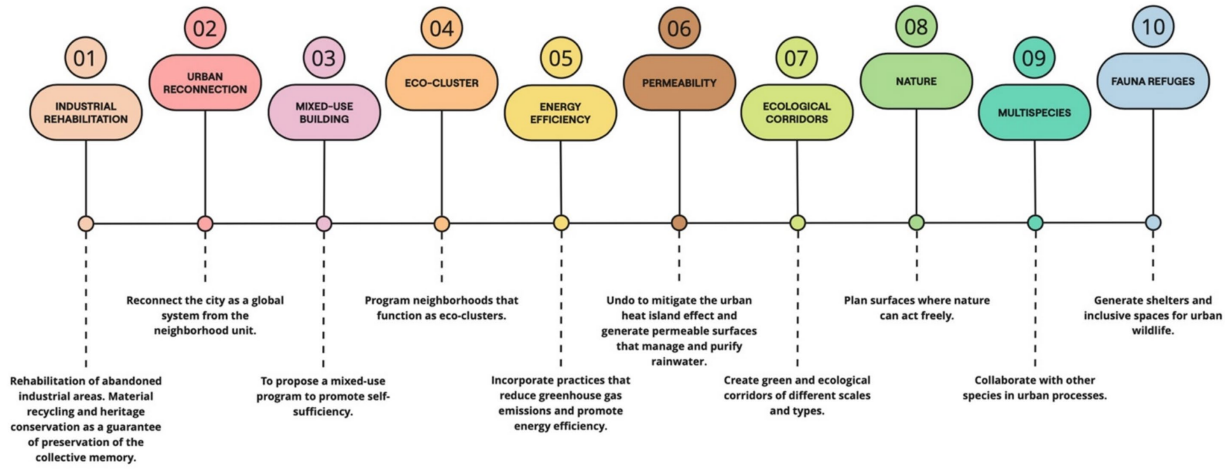

FIGURE 6
Diagram of the decalogue of the 10 strategies obtained and tested in the research.

used environments, should be transformed into spaces of centrality for the 21st century and be the places with the highest density of activities and mix of residential and productive uses that take advantage of their connectivity.

3.1.3 To propose a mixed-use program to promote self-sufficiency

The diverse city, without specialization, guarantees the success of urban regeneration processes, allowing multiple programs to coexist in the same context. However, the mix of uses (residential, productive, commercial, public and care) should not be thought of each of the elements to be intervened in isolation. The ability to generate self-sufficient neighborhoods directed to the city without organs, also involves project approaches based on the hybridization of uses in the same building, something that is especially encouraged in the industrial parts due to their large scale.

- Enhance the flexibility of the existing parts, with open floor plans and structures designed for high overloads.
- Design without eliminating the condition of infrastructures capable of accommodating diverse uses in the future.
- Giving new life to roofs, incorporating productive programs and sustainable energy source systems, creating buildings capable of self-sufficiency.

3.1.4 Program neighborhoods that function as eco-clusters

Consolidate the transformation of obsolete fabrics into post-industrial neighborhoods that function as eco-clusters, integrating communities with the capacity to produce sustainably, engage in urban agriculture, obtain social self-sufficiency and weave a network of commerce and local economy.

- Promote local self-sufficiency with a coexistence of residential programs and uses that close the productive cycle.
- Integrate renewable technologies and recycling systems to generate energy and manage resources in a sustainable manner.
- Create spaces for local trade, collaboration among producers and community participation.

3.1.5 Incorporate practices that reduce greenhouse gas emissions and promote energy efficiency

In order for the urban centers or industrial fabrics to be reactivated to operate based on a circular metabolism model, it is necessary to establish practices that encourage the transition to the use of clean technology and the adoption of renewable energy sources. Promoting local food produced in the buildings themselves or in the city's public space is a key strategy for eliminating emissions associated with food transport and distribution.

- Reuse buildings to reduce the impact of the construction industry.
- Install solar and wind energy systems in urban infrastructures.
- Strengthen urban and peri-urban agriculture.

3.1.6 Undo to mitigate the urban heat island effect and generate permeable surfaces that manage and purify rainwater

The incessant artificialization of soils has led to urban centers having to face the problems generated by the urban heat island effect and water management. Faced with these realities, the only feasible solution is to restore these surfaces to their original state, to recover water functions, agronomic functions and carbon sequestration functions. To undo so that the land can once again support biodiversity, and so that soils can once again support all forms of life whose evolution and reproduction cycles take place there.

- Undo unnecessary artificialization in paving.
- Increase permeability in soils.
- Implement Water Sensitive Urban Design (WSUD).

3.1.7 Create green and ecological corridors of different scales and types

Green corridors promote the integration of nature into the built environment and provide shelter for different species, as well as helping to regulate temperature and improve air quality. These spaces reinforce biodiversity by linking ecosystems that may be divided. It is necessary to be aware of the species to be benefited, since the design

can vary between physically connected green corridors—for large animals that need continuity to move around—or fragmented green corridors—for small creatures such as insects or birds.

- Plant trees and create urban forests.
- Promote green roofs or facades with plant elements.
- Install shelters for birds, insects and small mammals.

3.1.8 Plan surfaces where nature can act freely

Allowing urban surfaces for spontaneous vegetation to grow is primordial, and a necessary action for urban ecology. We must let nature act, allowing plants to grow on their own, and for this the design must be directed towards permeable supports where wild vegetation can develop, allowing any species that wants to establish its roots to grow.

- Identify areas interconnectedwith other green spaces.
- Restore the soil to make it suitable for plant growth.
- Integrate vertical structures that allow wild growth.

3.1.9 Collaborate with other species in urban processes

Urban space should foster interspecies interactions that promote biological diversity. These make it possible for humans, plants and animals to coexist in harmony, benefiting from each other, as to exist is always to coexist, to exist in relation or even as a relation (Alonso, 2024, p. 27). Plants collaborate in the decontamination of soils and clean the air that other species breathe, just as fauna helps control pests.

- Planting plant species that contribute to phytoremediation.
- Create habitats for species that regulate pests.
- Encourage coexistence between species: plant fruit trees that feed the urban fauna.

3.1.10 Generate shelters and inclusive spaces for urban wildlife

Green surfaces make it possible for the city to be a refuge for other forms of life that are more-than-human; therefore, it is necessary to reflect on the built environment in order to design more inclusive environments that promote multi-species cohabitation. It is necessary to strengthen relationships with other beings by integrating them into architectural design.

- Promote green, porous and cavity surfaces.
- Transform barren facades into new types of habitats and nesting sites for insects, birds and bats.
- Facilitate spaces where they can find food and water.

3.2 The new urban model

3.2.1 Background

Eibar is probably the paradigm of an industrial city in Gipuzkoa due to its long manufacturing tradition, especially in the machine tool industry, which is why it is known as the "*villa armera,*" which translates from Spanish as "village of weapons," in allusion to the manufacture of weapons parts in the various machine tool industries. Its location within a narrow valley has led to the appearance of a distinctive typology of vertical buildings and workshops integrated into the urban fabric to take advantage of the limited available land. This is a clear example of the transfer of industry to peripheral industrial estates, beyond the established urban core, due to the need to adapt to the demands and logistics of modern transportation.

The specific area where the research is focused, has developed as manufacturing infrastructures expanded, seeking depressions in the slopes as suitable settlement areas. The area around Jardiñeta, Ibargain and Matsaria streets consists of multiple abandoned and disused industrial sites. Despite their spatial proximity, they are currently disconnected from each other and from the rest of the surrounding consolidated urban fabric. Discontinuities are generated by the boundary of the Euskotren railway line and the unevenness of the existing roads in contact with the city. However, the slopes that surround the area and its proximity to the National 634 road, offer an opportunity for expanding green infrastructure toward the new Matsaria eco-neighborhood.

The entire proposed complex has become obsolete and requires a transformation to accommodate new uses and city models, leaving a perfectly reusable ruin capable of having new lives (Figure 7). The *Vertical Urban Factory* think tank, founded by Nina Rappaport, investigates how to reintegrate industry into cities. It offers consultancies on the reuse of former industrial spaces and the design of new places for urban production. Since 2008, she has conducted research, seminars, books and exhibitions on urban manufacturing, and currently focuses on hybrid urban factories, which combine light industry with other urban uses.

In this sense, it opens a door to test strategies understanding the existing industrial pieces in the area as infrastructures capable of functioning from top to bottom and bottom to top (Rappaport, 2015). Buildings and workshops that once had industries such as *Arizaga, Basterrica y Compañía, B.O.J.S.A., Antonio Narbaiza* or *Nicolás Correa SRC*, among others, now enable their reconversion into a mix of residential, productive, public and care uses, integrating multi-species contexts.

The process of mapping the current state of the industrial area of Matsaria allows us to identify the different existing buildings, making a distinction between those that are consolidated and those that are in a state of abandonment.

3.2.1.1 Consolidated residential uses

The area has 21 residential blocks of high-rise buildings, 4 of which are residential towers of GF + 12. At present, the plot located at 5 Bittor Sarasketa Street (for tertiary use) is in the construction phase of public housing to house 19 public housing units, promoted by the Basque Government.

3.2.1.2 Consolidated facilities

As for public facilities and endowments, in the area there are several pavilions of the railway network outside the Euskotren station, a municipal parking lot, a religious facility that houses the parish of San Agustín and an educational facility used as a kindergarten.

3.2.1.3 Industrial in use

Of the different industrial plots, some are in a good state of preservation and are currently in use: *B.O.J.S.A Barrenetxea, Olañeta*

y Juaristi, Antonio Narbaiza, Pablo Soroa (inventoried as industrial heritage) and the industrial pavilions of Matsaria 2.

3.2.1.4 Abandoned and disused industrial site

The rest of the industrial fabric is abandoned, except for some small workshops or residual warehouses that are still in use in some of the buildings. In all of them, it is possible to bet on their renovation, following the decalogue of strategies included in this research.

In relation to the planning figures of the area, the General Urban Development Plan (GUDP) in force in Eibar proposes the demolition of all the existing buildings in the industrial area 207 Matsaria. A Special Plan is foreseen to develop a new zoning for the entire area, which has a surface area of 48,375 m^2, assuming the cost of relocation and relocation of all existing housing and activities as the urbanization cost.

However, the process of revising the GUDP is currently underway, as its validity period ended in 2016 due to its failure to adapt to contemporary economic, social, and environmental challenges. The revision process and the drafting of the future document are subject to a participatory program in which associative entities and the general public of Eibar have been involved since 2020. Notably, the foundational work plans of the participatory program do not take the new planning into account, but instead focus on all existing buildings in the area, an approach that aimed at strengthening the ongoing post-industrial eco-cluster project in Matsaria.

3.2.2 Urban reconnection and hybridization of uses: a new eco-neighborhood model for Matsaria

The new eco-neighborhood of Matsaria establishes a post-industrial transformation model based on the rehabilitation of existing buildings, activating them under load with the introduction of a mixed-use program. The strategy opts for a sustainable system of optimizing resources and increasing the useful life, challenging urban planning approaches that favor demolition. The clustering of diverse activities and functions in the same urban area is a solution that generates hybrid structures that avoid zoning and specialization, as well as the appearance of obsolete monofunctional fabrics such as the one currently represented by Matsaria.

In the 1980s, Steven Holl was already announcing the problems of the proliferation of single-function buildings on the periphery of the city, highlighting the limitations of such strctures. He argued that isolated, single function buildings, typical of suburban areas, become less common as one moves into the city center, where the proximity and interconnectedness of buildings lead to the intersection of functions, suggesting that urban relationships can be organized in a way that aligns different programmatic functions, fostering greater integration and multifunctionality within urban spaces (Holl, 1988, p. 11).

Matsaria applies a city model that implies a process of urban regeneration and reconnection with the consolidated fabric, giving value to the existing industrial vestiges. It combines complementary uses that go beyond the architectural scale, promoting the integration of public space through porosity. Javier Mozas refers to the origin of these first urban approaches in the *a* + *t* magazine series on hybrid buildings, pointing out that the concept of hybrid buildings originated in the late 19th century, when densely populated cities began to accept the unavoidable blending of functions. These mixed-use structures mainly developed in the city center, where the centrality of the area played a key role in their emergence. Hybrid buildings are most effective in dense urban settings, where different functions are seamlessly integrated and interwoven (Mozas, 2009, p. 4).

The proposal creates a new central point in the neighborhood, where the relationships between the existing pieces and their users have the public space as a meeting point (Figure 8). In addition to the rest of the pieces in contact, the Pablo Soroa building, currently in use and inventoried as a heritage site, takes on special prominence in the new heart of the neighborhood. At the level of sustainable mobility, it

FIGURE 7
Current state of the factories in the district of Matsaria, Eibar. Ignacio Zubillaga Arms Factory (1961) **(A)**, Solaun, Rubio and Ormaechea SOLAC (1930) **(B)** and Barrenechea, Olañeta and Juaristi B.O.J.S.A. (1939) **(C)**.

is crossed by a green axis for pedestrians and bicycles that connects all the current arrangement, turning Matsaria Street into a route that articulates the free spaces and puts into operation both sides of the railway barrier. The scar in the urban fabric represented by the Euskotren railway track is sewn with an elevated green square that, through its extensions, guarantees urban accessibility and establishes a corridor that reconnects Matsaria with the immediate urban context. The public transport node that Eibar's main station represents becomes a new connection point favored by the mix of uses and the reactivation of the surroundings.

The transformation of the obsolete fabric of Matsaria is consolidated into an eco-cluster with the capacity to produce in a sustainable manner, promote urban agriculture, have social self-sufficiency and establish a local consumption network. It proposes a neighborhood based on a continuous life cycle that responds to the production cycle itself. By enhancing the value of the adjoining hillsides, locating areas for cultivation and urban agriculture, local raw materials can be obtained by taking advantage of the area's reforestation.

In the different industrial buildings to be intervened, all the processes necessary to manufacture raw materials are carried out. On the first and ground a series of cooking workshops open to the neighbourhood, as well as others for the production of jams, compotes, preserves and aromatic herbs, through learning and training processes. The production cycle also has its space for consumption, sale and sustainable and local distribution of products in the buildings themselves, taking advantage of the new greened public spaces in the neighborhood. Consumption points are located both for raw materials and for the different by-products obtained in the workshops.

In addition, a local economy network is fostered with different stores where the inhabitants of the neighborhood can purchase products, which also incorporate collection points for containers to give them a new life. Understanding that everything is born and emerges on the hillside and in the fields to end up there again, all organic waste is processed to obtain compost that closes the life cycle of the neighborhood. The benefits of the green economy proposed in Matsaria have already been demonstrated in cities such as Milan. Beyond the immediate economic gains and job creation, urban manufacturing generates value for the biodiversity within the urban ecosystem. This is key to enhancing the city's competitive edge, attracting high-quality talent, contributing to placemaking, and advancing Environment-Society-Governance (Rappaport and di Torino, 2022, p. 211).

Beyond the strictly productive cycle, the buildings also have areas for work spaces that can be used by residents or by the various members of neighborhood associations. In addition to the leisure alternative, there is also the opportunity for training and learning different trades, as a key tool in resolving the integration, social cohesion and sense of belonging of the new community. The new productive eco-cluster seeks to promote an intergenerational meeting point between the neighbors of the neighborhood, the neighborhood associations and the users of the new residential units.

The strategies for the transformation of the industrial buildings to be intervened are based on the premise of not losing the industrial character and the productive fabric, proposing a hybridization of programs that will lead Matsaria to a self-sufficient mixed neighborhood, based on strategies of ecological resilience and sustainable production. Nina Rappaport, in the publication *Hybrid factory, hybrid city* writes that as the workforce grows, the hybridity of programs naturally evolves alongside this expansion. Currently, while horizontal growth has been traditionally preferred due to its cost-effectiveness, flexibility, and ease of movement for people, goods, and products, it is increasingly being challenged by strategies aimed at densifying urban areas, which now prioritize vertical growth (Rappaport and di Torino, 2022, p. 118).

Mixed uses are generated from the bottom up, with the first floor housing public facilities and neighborhood amenities, the second floor and roof dedicated to production and manufacturing, and the upper floors reserved for residential uses (Figure 9).

The ownership of the residential units will ensure that three of the lots remain publicly owned, combining sales, rentals and public housing. At least two of the lots will be reserved for housing cooperatives, promoting cohousing and community living models as a guarantee of fostering intergenerational attraction to the neighborhood. The rest will be market-rate housing, with the first floors dedicated to public facilities and commercial spaces.

The mix of uses proposed in the existing industrial buildings has been developed in one of the industrial structures that exemplifies the particular case of Matsaria. This is the building located at Matsaria Street 1, which has been used as an armory and later as a printing factory since its construction in 1961. It presents an architectural typology of a multi-story workshop or factory, with a structure of reinforced concrete pillars and beams, and a ground floor plus four additional stories. The trapezoidal shape of the floor plan, adapted to the geometry of the plot, is optimized by placing the service core and vertical circulation at one end and leaving the rest open and unobstructed.

The building also has the distinct characteristic of having direct contact with the railway trench on its southern elevation, which has led to the appearance of a connection via a pedestrian walkway to the center of Eibar. Once the railway tracks have been crossed over the bridge, the route continues via stairs that compensate or the elevation difference with Estaziño Street next to the San Agustín Parish Church. On the facade facing the pedestrian bridge and where the staircase stands the volume rises higher and extends beyond the general roof plane of the structure, designed to accommodate a sheet of water.

Its conversion involves repurposing the ground floor as a cultural facility for the neighborhood, the roof and second floor for the production and processing of aromatic herbs, and the second, third and fourth floors for residential uses (Figure 10). The three residential floors are not separate from the rest of the building but are integrated into the overall spatial and functional design.

The roof of the building has sufficient surface area to accommodate greenhouses, enhacing new plant life in Matsaria while incorporating technologies that ensure high levels of energy and environmental efficiency, such as those enunciated in *Factories of Resilience.* The goal requires an understanding of the strategies that guarantee the proper environmental performance of buildings with such characteristics. Therefore, it is essential to incorporate the concept of "ecological intelligence" into architecture, alongside a thorough examination of the specific features of productive spaces, to identify their potential in serving the communities that created them (Sánchez-Montañés and Castilla, 2020, p.3).

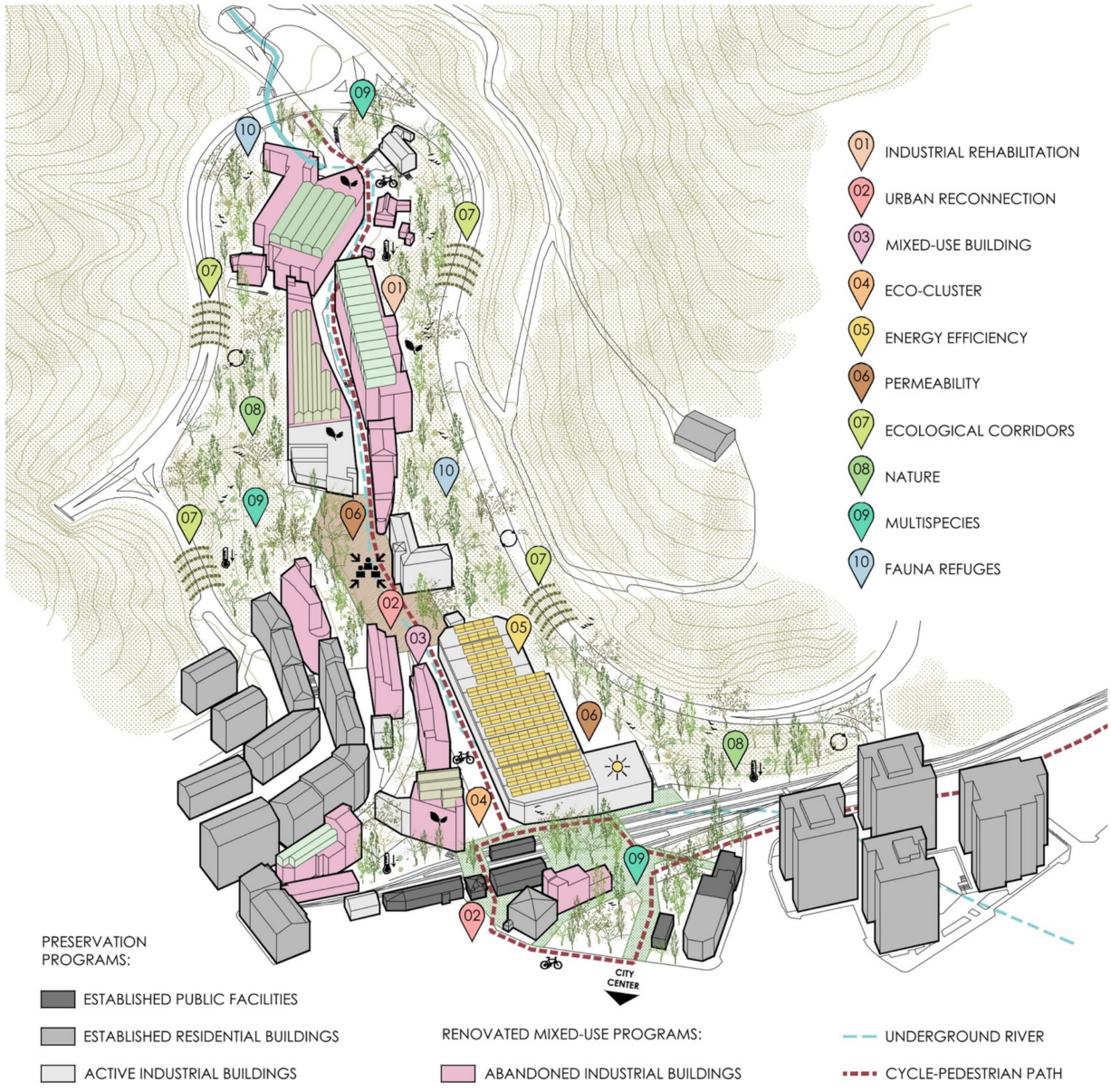

FIGURE 8
General arrangement of the new eco-neighborhood of Matsaria with the implementation of the 10 strategies.

Locally sourced plant species, which the building itself is capable of processing, are selected. There are also drying areas for the subsequent manufacture and packaging of the aromatic plants, and the semicircular or gabled geometries of the greenhouses favor the water collection system. Rainwater collected in cisterns is used for irrigation and distributed to other supply points within the building and, along with the system of photovoltaic panels also located on the roof, can generate domestic hot water for both production and residential uses below.

In the residential units, cross ventilation and natural lighting are prioritized through pass-through layouts, integrating galleries or exterior balconies as annexed or recessed elements within the original industrial volumes. Some galleries are designated for private use, associated with bedrooms and bathrooms, where spaces for drying clothes are incorporated. Others serve a public function, fostering interaction among residents and connecting with circulation cores and communal spaces designed to promote social engagement and coexistence.

3.2.3 More-than-human revolution: a new urban ecology

The transformation of the industrial fabric of the Matsaria neighborhood presents an opportunity for nature and the built environment to merge, fostering new hybridizations that go beyond the previously mentioned uses and promote interspecies coexistence. The objective is to decentralize the focus of design, which until now has been centered on the human being—or even on the automobile—and to begin reconfiguring the city from a post-human perspective. This approach proposes decentring the human being in planning and design to allow for alternative modes of existence, where public space becomes a stage for natural processes

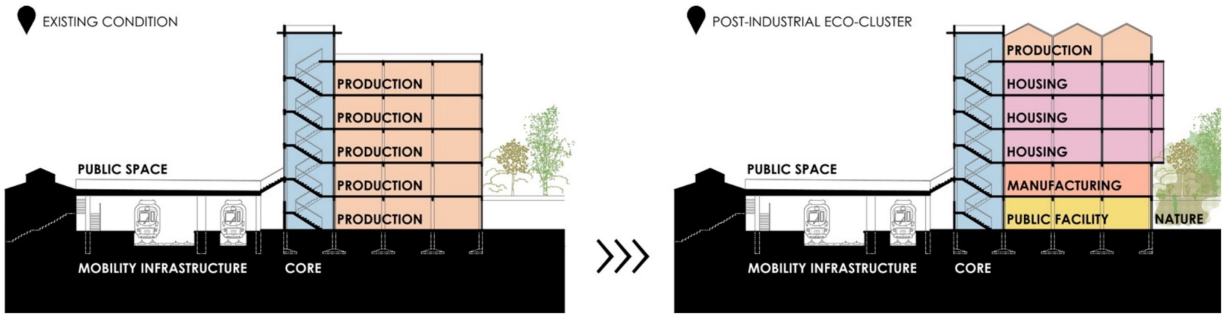

FIGURE 9
Change of use from productive buildings (existing condition) to hybridization and plant mixticity (post-industrial eco-cluster).

that were previously restricted due to the dominance of extractivist industrial activities. The industrial character of Matsaria generates a great contrast with the empowerment of new ecologies, but in this type of context its impact is more necessary than ever, unfolding other ways to think and understand ecology, starting from decentring the human of the ecological thinking. In addition, industrial parks cover large areas, so intervening in them implies larger scale interventions capable of generating structural changes. In this case, the location of the neighborhood undergoing transformation is favorable thanks to its proximity to other green areas, strengthening the integration and ecological continuity of the environment. New uses should not harm the living world, but should promote coexistence between artificial and natural forces (Poirier and Vignal, 2023, p. 163).

The intervention aims to contribute to mitigating the impacts of climate change, integrating sustainable and adaptive solutions into the environment, to promote ecological resilience. To achieve this, the project begins by transforming the artificial character of the main axis that articulates the district, to replacing the pavements with permeable surfaces, and introducing vegetation, which helps with the management of rainwater by mimicking hydrological processes, through *Water Sensitive Urban Design* (WSUD) practices. Soil and water are interconnected, without water the soil is lifeless, since it is the main element for three essential functions: infiltration and filtration, storage and return to plants (Agence Nicolas Michelin et Associés, 2023, p. 98).

The street section restricts the use of vehicles to make room for other activities, create new meeting places and implement non-artificial surfaces that enhace the interaction between fauna and flora. Most importantly, it increases vegetation, as they form the basis of the food chain and generate the oxygen we breathe, so it is essential to "make our cities greener, more permeable and as diffuse as possible" (Mancuso, 2024, p. 105).

In this way, the main street has permeable surfaces that allow for the rapid filtration of rainwater for subsequent storage in the gravel channel below (Figure 11). The water is then directed to surfaces designed to purify it locally, so that it can be used to irrigate the district's own cultivated areas. This filter park, which also becomes a refuge and corridor for multiple species, is located in the center of the district and functions as a plant purifier through the planting of emergent wastewater purification species.

These types of surfaces that feed the main axis, also serve as food production spaces, helping to mitigate the urban heat island effect, reducing CO2 emissions and also provide locally produced food for the population, as well as for insects and birds that have adapted to urban life. We are used to city flowerbeds being ornamental and composed of flowers that embellish the streets, but accepting the new ecologies in urban centers means understanding these green areas as an opportunity for the production of edible plant species, which strengthen the stimulation of more-than-human community, introducing new ways of understanding the post-natural landscape, where the green fabric goes beyond the limits of what is traditionally idealized. The Postnaturalism breaks with the human-idealized concept of nature, giving rise to a nature that is no longer related to beauty and seeks to deploy new ecologies. On top of that, urban farming enhances a lifestyle that regenerates people, regions, cities and the environment (Kondo and Tokyo Urban Farming, 2023, p. 6).

De-artificialization means allocating space to all these previously mentioned practices, which have been pushed aside by other types of human interests, but which, nevertheless, today need to be implemented in the built environment to adapt to the climate crisis we are facing and contributing to, and thus be able to "continue with the problem generating rare kinships due to the fact that we need each other in unexpected collaborations and combinations" (Haraway, 2019, p. 17).

Therefore, it is crucial to de-artificialize by leaving unplanned areas of free growth, so that any living thing that feels comfortable in the ecosystem can take root.

All these actions generate green islands where synanthropic fauna and flora—species that have adapted to the environmental conditions of the anthropized urban environment—are able to find refuge, and exemplify a multi-species architecture that transcends the exclusively human. Several species have become regular inhabitants of urban centers, such as the sparrow or the crow, and some species could even become extinct if cities were to disappear (Picard, 2022, p. 26). The aggressive expansion of agriculture and the use of pesticides in the fields have caused many animals to find food in the cities, where they do not feel the threat of predators, which is why the city has become synonymous with biodiversity. The fauna that lives in the city survives thanks to our activity, and in an urban environment we should be happy to cohabit with any species, since the arrival of new species that help build an urban ecosystem is positive (Picard, 2022, p. 19). Thus, it is paramount to generate green corridors that provide refuge and nesting areas of different scales for synanthropic species to establish and thrive. These ecological

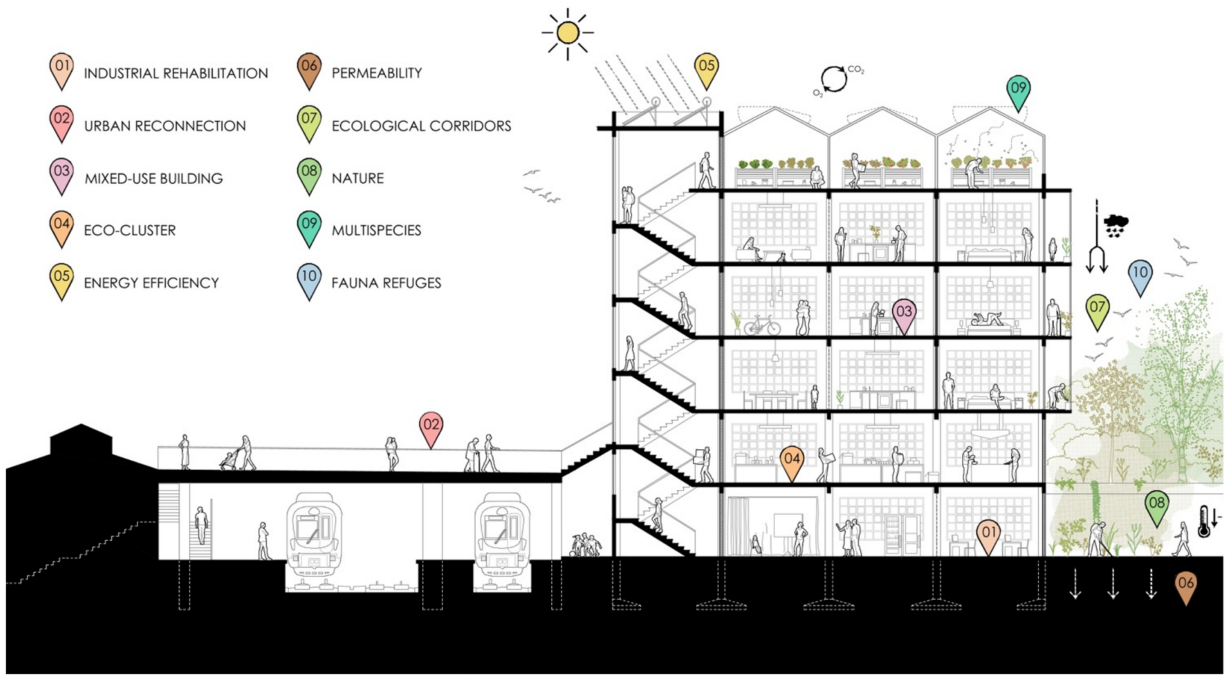

FIGURE 10
Section of the new hybrid building of Matsaria, in which all the strategies included in the research decalogue are implemented.

connectors extend throughout public space and the built environment through green walls, vegetated facades, green roofs, and urban gardens (Vollaard et al., 2017, p. 47), promoting multi-species coexistence. Such surfaces also help mitigate the urban heat island effect, further demonstrating that thinking the city from a more-than-human vision favors everyone.

However, to make this inclusivity integral, the project contemplates the creation of shelters for urban fauna in the built environment by incorporating niches, perforations, and textured surfaces. The existing architectures are adapted to accommodate other types of neighbors, without distorting their original industrial character, and the public space diversifies its urban furnishings to include insect hotels and bird nests. Diversity is paramount, due to the mutual relationships between species and between species and their environment; no species can survive on its own (Vollaard et al., 2017, p. 36).

Through this project, Matsaria becomes a space of great contrasts rich in diversity, where multi-species coexistence is promoted and certain ideals established until now—such as that of nature—are challenged, proposing a more balanced relationship with the environment (Figure 12).

4 Discussion

After the application of the defined strategies, a portrait of a new urban theory is obtained in the post-industrial area of Matsaria in Eibar. The degraded and deteriorated fabric becomes a sustainable hybrid infrastructure based on post-natural ecological design, which does not depend on external resources or landscapes for any form of life. Transforming the specialized organs of the city to create spaces in which to co-evolve is the challenge faced, through the design of revitalized industrial centers capable of welcoming a new nature that implies going beyond the aesthetic with the purpose of fostering new interspecies relationships. A strong cultural barrier related to the conception of the city as a separate from the surrounding nature must be overcome (Mancuso, 2024, p. 106).

The results of the research lead us to reflect on the application of a network of industrial eco-clusters that could be expanded throughout the disused industrial fabric, a constant in the European urban fabric, leaving the door open to analyze in the future their interconnections, synergies and relationships on a territorial scale. Starting the path towards the city without organs even allows us to consider the possibility of transferring these solutions studied to other types of non-industrial fabrics that are also endangered due to their specialization. It could be said that the purpose is based on designing inclusive, sustainable, metabolic and livable cities through the proximity of services, hybridization of uses, inclusion of nature, zero carbon footprint, and above all, designing with circular thinking (Loorbach et al., 2024, p. 13). The new urban balance provides space for more plant and animal species to cohabit, making it a more attractive living environment for both the new nature and people.

The concept of the post-organic city plays a crucial role in this transformation. Moving beyond rigid and specialized structures embodies a continuous, adaptive urban evolution that merges the artificial with the natural, fostering environments that are no longer dependent on predefined urban hierarchies. For this transition, cities should take inspiration from nature itself, particularly from trees, which lack specialized organs and instead distribute vital functions throughout their entire structure. However, urban environments have been shaped by specialization, with industrial areas acting as rigid and inflexible organs that struggle to adapt

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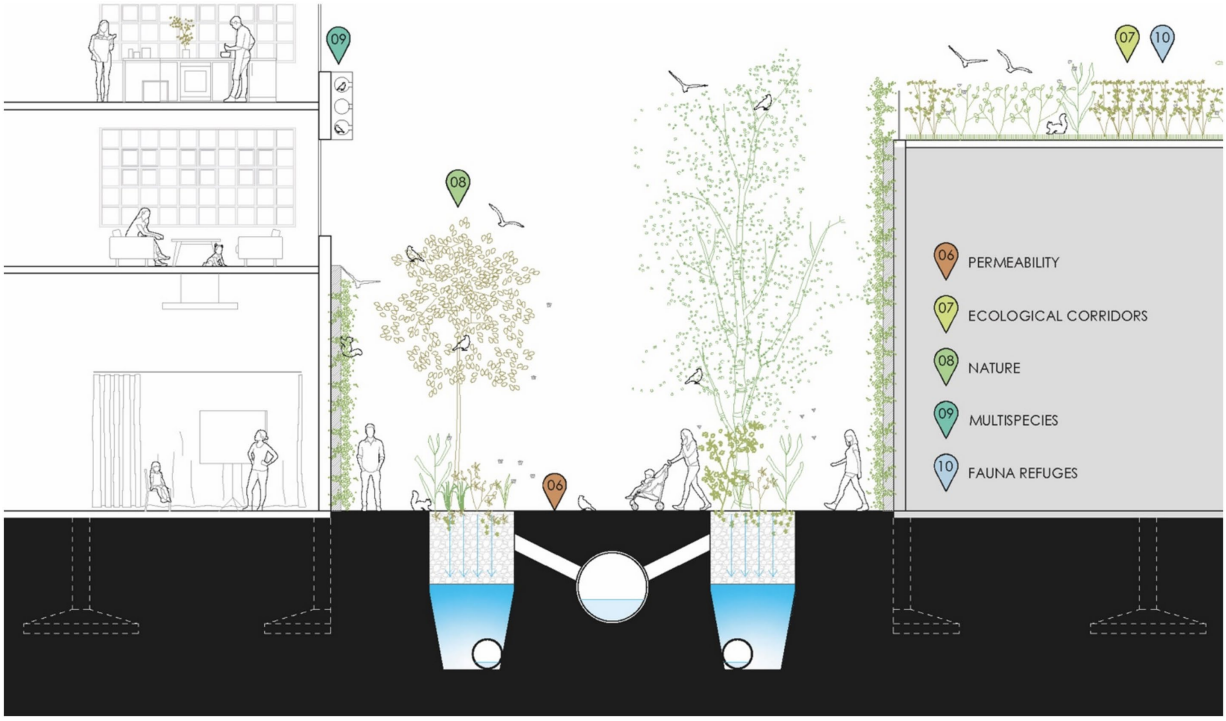

FIGURE 11
Section of the new main axis of the Matsaria neighborhood where the more-than-human design predominates.

FIGURE 12
Collages of new imaginaries showing interspecies coexistence in the new Matsaria neighborhood.

once their primary function becomes obsolete. The lack of versatility in such models hinders regeneration and contributes to urban decay. By adopting plant-like principles, cities should embrace functional diversity within the same spaces rather than concentrating specific uses in separate zones. The integration of residential, commercial, and industrial functions fosters resilience, creating urban ecosystems that are both sustainable and adaptable.

The evolution of cities from mechanized structures to organic, interconnected environments challenges the legacy of modern urban planning, deeply rooted in industrial efficiency and segregation of uses. Instead, this study proposes a paradigm shift where cities function as complex, metabolic systems, akin to natural ecosystems, capable of regenerating and adapting over time. The rigidity of the modern city, shaped by principles of industrial rationalization and functional zoning, led to urban environments that struggle to evolve alongside contemporary challenges. By reinterpreting abandoned industrial sites as catalysts for ecological and social integration, the research underlines the importance of rethinking urban spaces as dynamic entities that foster resilience, diversity, and sustainability. The findings encourage further exploration of how this regenerative approach can be scaled to different urban contexts, reinforcing the idea that the future of cities lies in their capacity to continuously transform and integrate multiple forms of life within their structure.

5 Conclusion

This study formulates and implements a new non-specialized urban theory in the disused industrial areas of Matsaria in Eibar, located in the Basque Country, Northern Spain, for its revitalization. The aim is to strengthen the urban ecosystem and implement a multi-species justice perspective in an environment previously characterized by its anthropocentric and extractivist activity. The research employs an inductive methodology based on the analysis of several case studies to identify strategies applicable in degraded industrial areas, integrating urban ecology and circular economy principles to foster sustainable regeneration models.

However, the study presents certain limitations. The number of existing case studies is relatively small, and many of them remain unimplemented, existing only as research projects or competition proposals yet to be executed in real urban contexts. Additionally, post-industrial regeneration processes require time to assess their effectiveness, meaning that the success or failure of these interventions can only be properly evaluated after years of development. A long-term perspective is necessary to fully understand the impact of these strategies.

Future research could expand in multiple directions. A deeper exploration of selected cases through direct contact with architectural firms, interviews, and systematic data collection could provide more precise and quantifiable insights. A structured review framework with standardized data sheets would enable a more comprehensive and comparative analysis, allowing for a broader set of replicable strategies. Additionally, expanding the number of analyzed cases and conducting more in-depth searches could encompass a wider range of territories, enhancing the adaptability and flexibility of the proposed urban solutions to diverse future contexts beyond Matsaria.

Moreover, the research can branch out and be practically tested in multiple urban contexts. By applying the strategies extracted from existing case studies to new urban spaces identified as post-industrial opportunity areas, it will be possible to assess and validate their effectiveness in real-world scenarios. The true impact of these strategies can only be fully understood through implementation and continuous evaluation in different urban fabrics.

This study should not be seen as a closed conclusion, but rather as an open-ended investigation. Engaging with public administrations interested in these concepts, testing strategies in different cities, and further refining the methodologies will ensure that this research remains dynamic and continues to evolve in response to future urban challenges.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

IG: Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. NA: Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. FG: Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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References

AAVV (2024). *No hacer, rehacer, deshacer para construir ciudad*. Madrid: n'UNDO.

Agence Nicolas Michelin et Associés (Ed.) (2023). *Terre, terrain, territoire: discussion autour des sols*. Paris: ANMA Architectes urbanistes.

Alonso, G. (2024). *La condición postnatural: glosario de ecologías para otros mundos*. Madrid: Cthulhu Books.

Balcells, E., and Grzesikowska, H. (2014). *The new urban Fabrik: Torrent Estadella Eco-Industrial Park*. Barcelona: EDUARD BALCELLS Architecture+Urbanism+ Landscape.

Banham, R. (1960). *Theory and Design in the First Machine Age*. New York, NY: Praeger.

Castro, A. (2023). *Futuros multiespecie: prácticas vinculantes para un planeta en emergencia*. Lugo: Bartlebooth.

Haraway, D. J. (2019). *Seguir con el problema*. Consonni, Bilbao: Generar parentesco en el Chthuluceno.

Holl, S. (1988). Within the City: phenomena of relations. *Des. Q.*:1. doi: 10.2307/4091209

Kondo, H., and Tokyo Urban Farming (2023). *Urban farming life*. Tokyo: Two Virgins.

Loorbach, D., Patteeuw, V., Szacka, L.-C., and Veenstra, P. (2024). *It's about time: the architecture of climate change*. Presented at the international architecture biennale Rotterdam. Rotterdam: nai010 Publishers.

Mancuso, S. (2024). *Fitópolis: la ciudad viva*. Barcelona: Galaxia Gutenberg.

Mozas, J. (2009). Usos mezclados. Híbridos horizontales: Un recorrido histórico. a+t HYBRIDS II, 160.

Mumford, E. P. (2000). *The CIAM discourse on urbanism, 1928–1960, 1*. Cambridge, MA: MIT Press.

Muratovski, G. (2016). *Research for designers: A guide to methods and practice*. Washington, DC: Sage.

Picard, P. G. (2022). Editorial. BAc Boletín Académico. *Rev. Invest. Arquitectura Contemporánea* 12:7. doi: 10.17979/bac.2022.12.0.9461

Picon, A. (2024). *Natures urbaines: une histoire technique et sociale, 1600–2030*. Paris: Éditions du Pavillon de l'Arsenal.

Poirier, F., and Vignal, B. (2023). *Terres fertiles*. Paris: Backland éditions.

Rappaport, N. (2015). *Vertical urban factory*. New York: Actar Publishers.

Rappaport, N. (2016). Preserving the modernist vertical urban factory. *Cuad. notas.*:153. doi: 10.20868/cn.2016.3487

Rappaport, N., and di Torino, P. (2022). *Hybrid factory, hybrid city*. New York, NY: Actar D Inc.

Rifkin, J. (2011). *The third industrial revolution: How lateral power is transforming energy, the economy, and the world*. New York, NY: Palgrave Macmillan.

Sánchez-Montañés, B., and Castilla, M. V. (2020). Fábricas de resiliencia: una oportunidad para el patrimonio industrial: el caso de La Trinidad. *Arch. City Environ.* 15:9192. doi: 10.5821/ace.15.43.9192

Vollaard, P., Vink, J., and Zwarte, N.de, (2017). *Stadsnatuur maken: making urban nature*. Rotterdam: nai010 Publishers.