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Vertical Ecosystems in Cooperative Housing. A Sectional Approach: The Paradigmatic Case of La Borda in Barcelona (Spain)

Globally, contemporary architecture is exploring new ways to integrate nature into the built environment, promoting both sustainability and social cohesion. One emerging trend in this field is the development of "vertical ecosystems," where buildings and urban spaces are designed to harmoniously connect. This approach seeks not only to reduce the environmental impact of construction but also to enhance the quality of life for residents by creating environments that foster social interaction and a closer connection with nature.
In cities worldwide, projects are being implemented that redesign urban spaces by incorporating vertical ecosystems that thrive. This article analyses how these projects, led by housing cooperatives, represent advancements in engineering and architectural design, offering innovative solutions to the challenges of climate change and urbanisation.

In this context, Barcelona stands out as a leader in implementing vertical ecosystems through its housing cooperatives. The city has pioneered housing models that not only integrate environmental sustainability but also promote social cohesion and community self-management. The emblematic case of La Borda illustrates how these principles are materialised in projects that combine the use of sustainable materials, participatory design, and the creation of intermediate spaces that facilitate community life.

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Keywords:
Cooperative housing, urban ecosystems, sustainability, sectional drawing.

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INTRODUCTION

In the pursuit of sustainable urban solutions, the design of housing cooperatives has developed into the creation of genuine vertical urban ecosystems. This article examines how the thoughtful design of sections within these cooperatives influences not only the visual aesthetics of the buildings but also significantly enhances the quality of life for residents and the surrounding urban environment.
According to Grijalba's perspective, the meaning of a drawing extends beyond the lines themselves to encompass the intention behind the design. Therefore, the crafting of sections in this type of architecture aims to reflect the level of ambition in achieving sustainability (Grijalba, 2004). As Moneo has argued, sustainable architecture emerges from balancing architectural traditions with the design process, informed by hands-on experience with the built environment (Moneo, 2004). Essentially, an architect must account for both the sectional design and construction experience to realise architecture that is sustainable and of high quality.
This integration of nature within urban architecture is manifest in the design of green spaces, which foster a synergy between urban living and ecological resilience, empowering residents to actively participate in the creation and management of these spaces. Additionally, it highlights the importance of spatial configurations and the distribution of communal areas, such as interior courtyards and vertical gardens, which provide spaces for leisure while fostering social interaction and a sense of community among residents. These elements encourage a slower, more communal lifestyle. The key challenge lies in drastically reducing the environmental impact without compromising the quality of life or spatial quality. This is achieved through the effective management of shared community living, ensuring sustainability and collective well-being.
Ultimately, such an approach fosters a model of eco-sustainable coexistence, where social participation and balance are achieved through mutual support among community members (Lorente et al., 2023). Thus, analysing cooperative housing projects through their section drawings establishes a clear link between three core elements: the immediate environment, the relationship between neighbours, and the life within the building. The fusion of architecture and sustainability generates vibrant urban ecosystems, offering environmentally conscious homes and cohesive communities.

Methodology and research aim

This article is part of a broader investigation into intermediary spaces in contemporary collective housing. It specifically addresses the intermediary space within a type of collective housing, such as cooperatives, while also examining its interaction with the surrounding environment in which they are situated. In these cases, the intermediary becomes the vertical core of the building, primarily formed by the constructed voids of courtyards and galleries, expanding across floors like tree branches and flooding the structure with small communal interludes. The primary objective is to analyse how these collective spaces act as bridges to their immediate surroundings. This can be understood in both physical and material terms, as well as how these interactions shape the configuration and thought processes within these ecosystems (Fig. 1).
In this context, intermediary spaces become a link between the exterior and the interior, the public and the private, the natural and the constructed (Fig. 2). This analysis helps clarify the relationship between space and the individual, translating into an improved quality of life within these communities. These diaphragms serve as meeting spaces, fostering interaction between residents and the urban environment, strengthening community resilience by providing shared areas that encourage a sense of belonging and coexistence. Thus, these so-called vertical ecosystems become critical nodes that enable a more sustainable integration of urban life and nature.

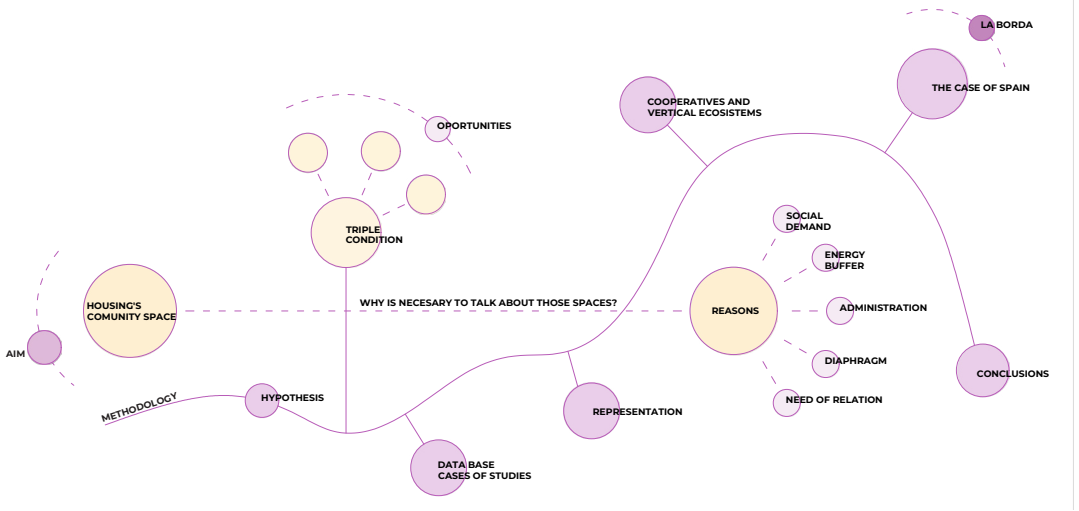

Fig. 1 - Study and work methodology.

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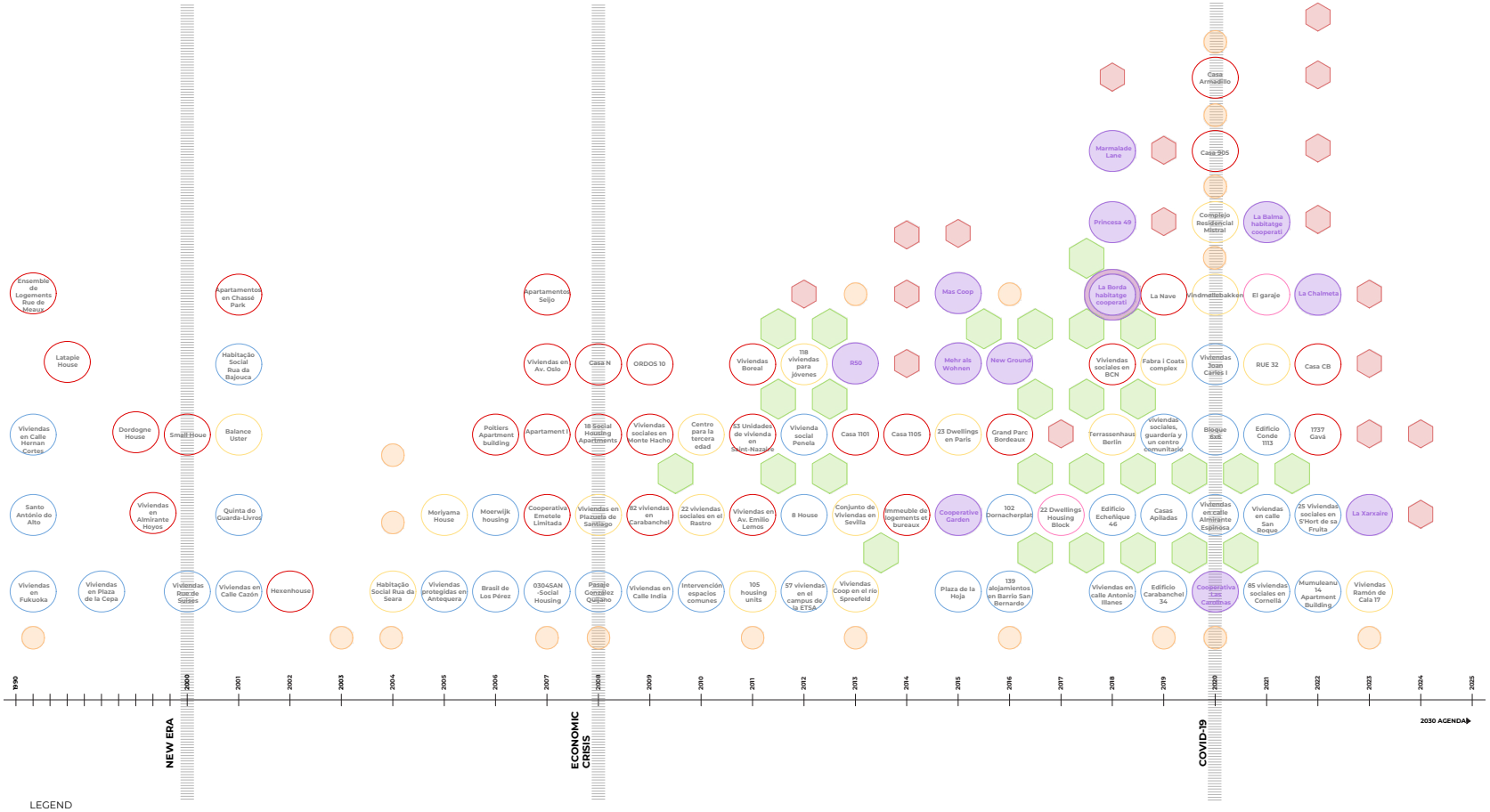

Fig. 2 - Genealogy: database of identified cases, bibliography, and timeline.

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THEORICAL BASIS

In the urban and architectural fabric, intermediary spaces play a pivotal role as inflection points within the city, located between the private and the public, the interior and the exterior. Existing literature has repeatedly emphasised that these spaces act as catalysts for change, connecting to their immediate surroundings and generating new possibilities for interaction and social cohesion. At this point, architectural design assumes prominence, transforming simple functional transitions into sensory and emotional experiences for individuals. As boundaries or thresholds, intermediary spaces create environments that invite reflection and foster a connection with both the space and the wider community. For this reason, the design and scale of such spaces are crucial to their effectiveness

We inhabit a world undergoing rapid and unpredictable changes. The need to transform and adapt to the present, coupled with the uncertainty of where we are headed, makes the concept of living increasingly flexible and fluid, impacting the very construct of the home. The way in which the solid matter of the home disintegrates is part of "a process of dissolution of the idea of home, at least of what is firm and compact [...] focusing on body-spaces that shift and slide without cohesion" (De la Iglesia, 1998, p. 71). This process creates an intermediary space that serves as a flexible area for all the rooms in the house, as well as a bridge between the street and the home, connecting both worlds. This interlude becomes a container of functions with no fixed order or character, continuously adapting to the changing needs of its inhabitants. As seen in the configuration of the Moriyama House, the home itself, as a composition of various spaces, unfolds into these distinct parts, enabling multiple ways of living to emerge (Fig. 3).

In this reconciliation between humans and space, sensations arise that can only be perceived by the individual as part of a unified whole. This relationship generates atmospheres where the individual and the collective interact intimately. These sensations are carefully elicited through elements such as light, textures, or even colour (Fig. 4). In his work Atmospheres, Peter Zumthor explores how all layers of architecture engage in a dynamic interplay between the material and the personal. "There is something very special in architecture that fascinates me [...] Suddenly, we find ourselves with an inside and an outside.
That means thresholds, transitions" (Zumthor, 2006, p. 9). It is precisely in these liminal spaces where "a play occurs... between the individual and the public," allowing architecture to function both as a refuge and as a site of encounter.

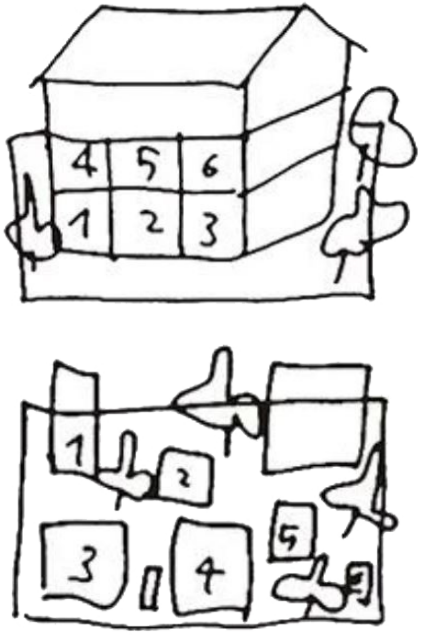

Fig. 3 - Moriyama House Diagram, Sanaa, 2002. Source: Sanaa, 2002.

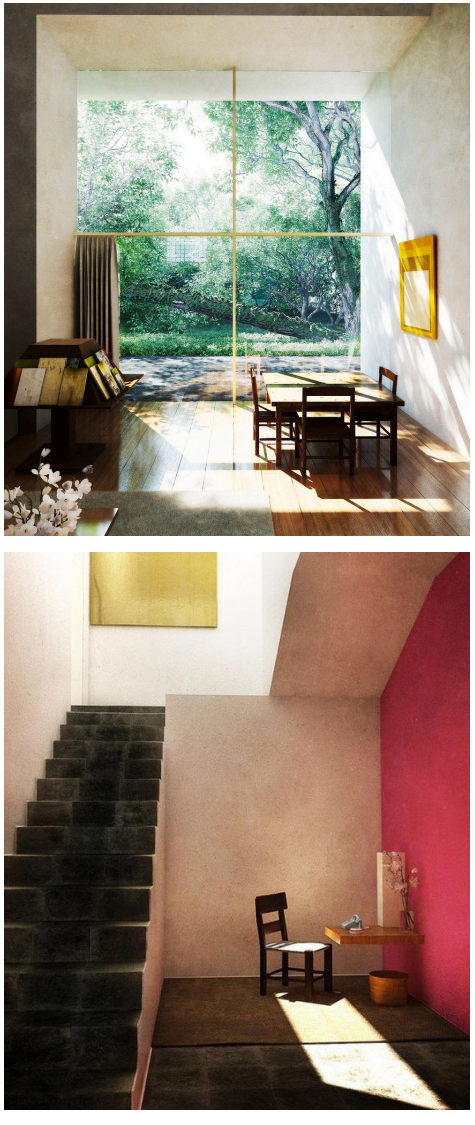

Fig. 4 - Luis Barragán Studio House, 1948. Source: Courtesy of Casa Luis Barragán

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Vertical Ecosystems

The term "ecosystem" is traditionally associated with biology, where it describes the complex interactions between flora, fauna, and their physical environment. However, this concept has been adapted to other fields, including architecture. In this context, the term is used to describe the dynamic interplay between all the elements that shape a built environment (Fig. 5). More broadly, an ecosystem comprises not only natural components but also the human, social, and cultural elements that interact within a given space.
When discussing vertical ecosystems, we refer to environments where the relationship between built structures and the natural world is vertically integrated into urban frameworks. This approach extends beyond the mere addition of green elements to buildings; it examines how spaces interact with inhabitants, how resources are managed, and how social interactions are fostered within these environments. As Kellert, Heerwagen, and Mador observe, "biophilic design is an innovative approach that seeks to reconnect humans with nature through the integration of natural elements into the built environment, fostering a greater sense of well-being and environmental responsibility" (Kellert et al., 2008, p. 3).
Vertical ecosystems create what is known as an ecotone—a term from ecology that refers to a transitional zone between two distinct ecosystems. In architectural terms, an ecotone can be defined as the intermediary space between the dwelling and the street, the interior and exterior, or between the built environment and the natural surroundings. This ecotone acts as a transitional zone where various activities converge and coexist. Newton notes that "incorporating biodiversity into urban design is not just about aesthetics; it's about creating sustainable environments that support life on multiple levels, from the microscale of soil organisms to the macroscale of urban fauna" (Newton, 2007, p. 112). Therefore, the architectural ecotone is much more than a mere passageway—it is an active space where meaningful interactions occur. These intermediary spaces, which can be formed by balconies, terraces, gardens, or social gathering areas, are designed to foster interaction between residents and their environment. The objective is to blur the boundary between interior and exterior, promoting a seamless continuity between the dwelling and the urban landscape.

Fig. 5 - Greenhouses as appropriation and generation of urban ecosystems in housing. Mulhouse, Lacaton & Vassal, 2001-2005. Source: Lacaton & Vassal, 2005.

Sustainability: Beyond Measurement and Concept

These spaces reflect an evolution in how sustainability is integrated into collective housing. As previously discussed, these complex systems aim to balance environmental, social, cultural, and economic needs. To fully grasp their impact and effectiveness, it is crucial to consider multiple critical factors that extend beyond the simple addition of green elements and influence both the functional organization of spaces and the construction and composition of the buildings themselves.
In this context, Adabre and Chan highlight the importance of identifying Critical Success Factors (CSFs) in the creation of sustainable and affordable housing. Among the most significant factors are energy efficiency, the use of sustainable materials, and affordability (Adabre & Chan, 2019). Similarly, the book Sustainable Architecture: Between Measurement and Meaning underscores that sustainability in architecture should transcend mere metrics of environmental impact. The authors note that "what we focus on, in particular, is how this behaviour leads to the production of buildings, and we do not consider a broader context, whether spatial, temporal, social, cultural, or otherwise. Building sustainably requires equal attention to the environmental, social, cultural, and economic impacts of a strategy" (Cucuzzella & Goubran, 2022, p. 3). Consequently, the assertion made by Carmela Cucuzzella in this same work is particularly insightful: "Sustainable architecture, as perceived, is vital when it aims to distinguish itself from other architectures that are not or do not appear to be sustainable. The visible ecological features included in a building are semantically significant. They provide meaning and purpose" (Cucuzzella, 2022, p. 38).
This consideration goes beyond mere numerical measures. In collective housing, sustainability fosters social cohesion, reflects local cultures, and contributes to the community's economic development. When all these aspects are integrated within a single framework, intermediary spaces in these complex systems can become essential components in strengthening communities.
Tosics further reinforces the idea that sustainability is a multifaceted concept that must integrate economic, social, and environmental dimensions (Tosics, 2004). Applying this perspective to vertical ecosystems implies that these projects must meet several objectives: being economically viable, socially inclusive, and environmentally responsible. Moreover, Jose M Blas, with his focus on biophilia, highlights the importance of incorporating natural elements into urban environments. Vertical ecosystems strive to naturalise cities by creating spaces that not only improve air quality and reduce temperatures but also offer areas for recreation. This integration is essential in transforming buildings into living ecosystems that benefit both the environment and the people inhabiting them.

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Cooperatives Around the World

Globally, housing cooperatives have re-emerged as a vital model to address contemporary challenges, offering innovative solutions that merge social inclusion, environmental sustainability, and urban regeneration. This cooperative approach, which intertwines self-management with sustainable practices, has empowered various communities to effectively confront issues related to affordable housing and inclusive urban development.

The development and evolution of cooperatives in Europe have been instrumental in tackling modern challenges, with a particular focus on social inclusion and sustainability (Czischke, Carriou, & Lang, 2020). This shift towards collaboration and self-management reflects a significant transformation in how urban communities seek to fulfil their housing needs, providing a theoretical framework to comprehend the development of cooperatives across cities globally. Initiatives such as Marmalade Lane in London, Cooperative Garden in Tokyo, New Ground Cohousing in London, Mas Coop in Beaumont-sur-Lèze, and Las Carolinas in Madrid emphasise urban regeneration and the softening of the urban landscape (Fig. 6). These initiatives demonstrate that cooperative housing has become a key agent in urban transformation (European Commission, 2020). This impact is evident in numerous European cities, where collective housing models have played a crucial role in enhancing the quality of life and revitalising neighbourhoods.

Among the many examples illustrating how housing cooperatives act as agents of change, cities like Vienna and Berlin stand out. These cities have witnessed the significant contribution of cooperatives to sustainable urban regeneration, fostering stronger communities. Such international experiences underscore the adaptability of cooperatives to diverse cultural and urban contexts, offering replicable models across various parts of the world (Murtagh & Boland, 2020). An emerging network of cooperative housing organisations across Europe demonstrate how it prioritises the

Fig. 6 - Relation of photographs of housing cooperatives worldwide. Source: All photos are from the official website of each case, except for the Chalmetan photos, which were taken during fieldwork.

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relationship with the surrounding environment and the reconnection with nature within urban constraints. Moreover, housing cooperatives act as intermediaries between residents and urban housing policies, a role that is crucial as it allows residents to participate in decision-making, strengthening social capital and fostering community integration (Blanco & León, 2013).
Thus, an analysis of resident participation in shared landscapes within cooperatives reveals how these spaces foster greater interaction between residents and facilitate better integration with the natural environment. The opportunity for neighbours to not only share physical spaces but also actively participate in the creation and maintenance of these environments strengthens both community identity and social sustainability. This approach focuses on creating spaces that hold meaning for residents, contributing to the development of a strong community. Participatory design is fundamental to the success of housing cooperatives in various urban contexts around the world (Grounded Patterns, 2024).

The Section as a Narrative Tool

The creation of vertical sections, designed as points of connection between the home and its surroundings, is driven by environmental, social, economic, and cultural factors. Socially, these spaces encourage interaction and cohesion among residents, fostering stronger, more connected communities. Economically, energy efficiency and the use of sustainable materials reduce operational costs, making these homes more affordable in the long term.
Culturally, adapting to local contexts and creating meaningful spaces reflects and respects local traditions while promoting architectural innovations that enhance residents' quality of life. Together, these factors work in synergy to transform buildings into genuine ecotones, balancing sustainability, functionality, and social cohesion.
In this regard, the representation of all these outlined factors must be captured in the drawing and communication of the project. The sectional drawing, along with its various compositional representations, becomes an essential tool for understanding and analysing architecture. In the context of this article, the section clearly reveals how the relationship between elements—ventilation, sunlight, structure, among others—is organised into a perfect tandem, providing a clear reading of vertical ecosystems.
The sectional drawing, alongside representations that evoke its essence—through collages (Fig. 7)—enhances the project's visual and communicative dimensions. It can be possible thans too the way that the section "reveals simultaneously its interior and exterior profiles [...], providing a vie of the object that is not usually seen" (Lewis et al., 2016, p. 6). These tools contribute narrative depth, clarifying the design's intent and offering a more integrated understanding of its architectural and social objectives (Fig.8).
Beyond their technical utility, sectional drawings possess a profound narrative power. They communicate the intent and vision behind architectural decisions, illustrating not only spatial configurations but also the interconnected layers of ecological, cultural, and social considerations. By doing so, they bridge the gap between conceptual ideas and their practical, real-world implications.
In this way, sectional drawings stand out as essential tools for both analysis and storytelling in architecture. Their ability to visualise and synthesise complex relationships elevates them beyond technical documentation, making them central to understanding and advancing the discourse on vertical ecosystems.

Fig. 7 - Collage of the final sectional state of the transformation project of 530 dwellings in Bordeaux by Lacaton and Vassal: Source Lacaton and Vassal, 2017.

Fig. 8 - Competition section by Lacol for Coop de Falç habitatge cooperatiu amb La Dinamo Fundació. A healthy implementation that can be narrated through the drawing. Source: Lacol, 2017.

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THE CASE OF SPAIN: BARCELONA AS A CATALYST FOR CHANGE

In recent years, Barcelona has emerged as a driving force in promoting new housing models and urban interventions that aim to reconnect architecture with nature and strengthen social bonds. The city has launched a series of initiatives that go beyond conventional vertical gardens, embracing broader concepts of vertical ecosystems that holistically integrate people, construction processes, and sustainability. In this context, housing cooperatives have taken on a prominent role, where community cohesion and the relationship with the surrounding environment become tangible. These cooperatives foster a more collaborative and sustainable way of living, contributing to the transformation of urban spaces into more habitable and accessible environments. They cultivate a new awareness of our relationship and interrelationship with nature, encouraging a more collective mindset (Lacol & La Ciutat Invisible, 2020). In many ways, the cooperative model seeks a return to the early stages of human history, where communal life and connection with collective processes, such as gardening, were fundamental.

In the case of Barcelona, the idea of community and connection is not entirely new. Before the Cerdá Plan, the relationship between the city and the surrounding villages was very close. However, it was this urban plan that redefined the city with the creation of the new district of l'Eixample, aiming to create a more equitable city by eliminating disparities between neighbourhoods. Despite its intentions, the plan had negative repercussions on the quality of life, as it prioritised a rational and functionalist urban design at the expense of the integral relationship between the inhabitants and their environment. Over the past decade, local policies have supported the development of spaces that restore green areas and social interaction zones to the city. This is where the vertical ecosystems, as previously described, fit into Barcelona's dense urban fabric, where small plots serve as injections of regeneration and change. In this regard, cooperatives in Barcelona have managed to position the city as a national leader in the construction of socially and environmentally sustainable residential buildings (Fig. 9). This creates a new map of small ecosystems distributed throughout the city, weaving a network of green spaces linked to housing, acting as "lungs" that enhance the quality of life and serve as drivers of change.

To address the shortcomings of this historically rooted urban planning, the intentionality with which cooperative projects are designed extends from the horizontal plane of the street to the vertical plane of the building's core. In other words, it is a consensual stratification between the building and its surroundings.

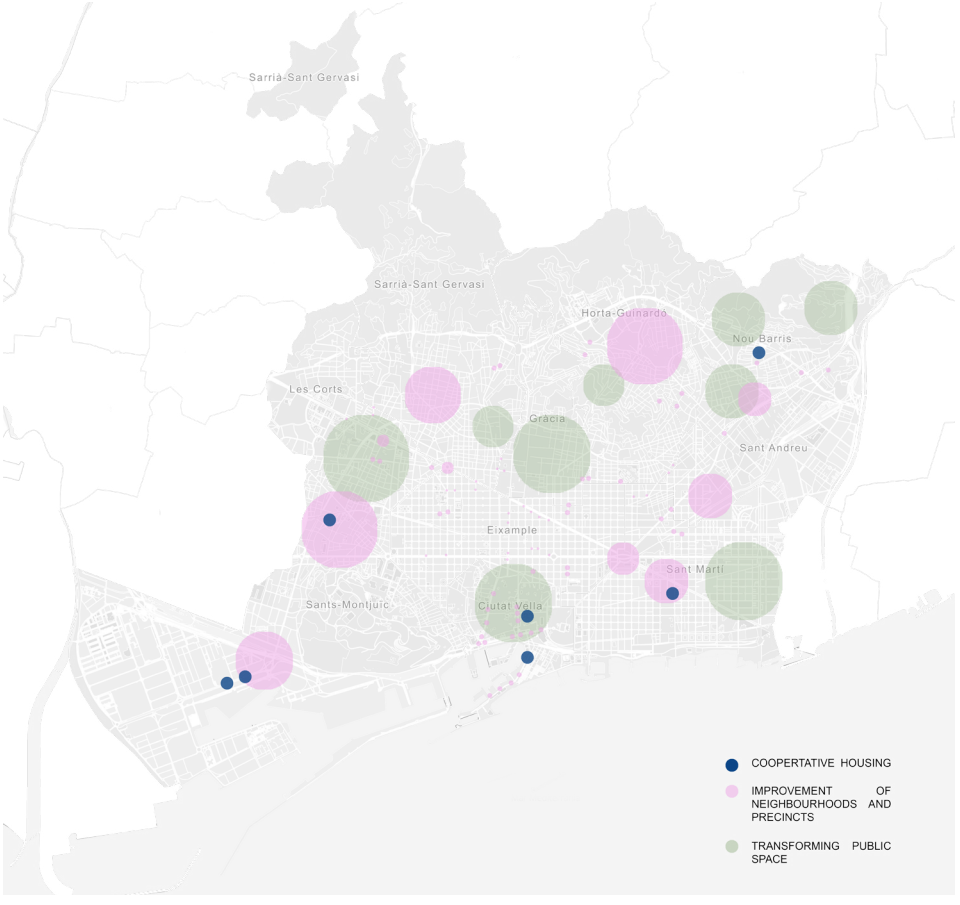

Fig. 9 - Mapping of housing cooperatives in the city of Barcelona.t

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CASE STUDY: LA BORDA. BEYOND COOPERATIVE HOUSING

There are undoubtedly various cooperatives that allow for the drawing of a sustainable section, where the built environment interacts with its surrounding context. In Barcelona, the La Borda Cooperative project plays a leading role, emerging as a paradigm of this approach. This year, it was awarded the European Housing Award in the category of new construction. Located in the Sants neighbourhood, La Borda exemplifies the creation of an integrated social ecosystem, built upon a long-standing tradition of cooperatives of all types (Fig. 10). It is important to note that these cooperatives share a common human foundation, with members working together to address social and economic concerns (La Borda, 2016).

La Borda is part of a broader initiative known as Can Batlló. As described on their words, Can Batlló is an "old industrial complex from the late 19th century that, in 1976, was designated by the Metropolitan General Plan as an area for public facilities, social housing, and green spaces" (Can Batlló, 2016). Can Batlló is becoming a reference point for the creation of new models of production and consumption, as well as for promoting culture and the arts. The La Borda project is just one of many initiatives revitalising this former industrial complex. In line with the project's broader programme, it ensures that the established goals of its construction are met.

La Borda is more than just a housing project; it is a lifestyle model that promotes self-management, sustainability, and solidarity. Residents actively participate in decision-making and the management of shared spaces. There are three key guiding principles of the project (Lacol, 2016): redefining the concept of collective housing, environmental sustainability and equality, and user participation. All of these are under the slogan "housing to build community." With these factors in mind, La Borda has emerged as a prime example of urban architecture and planning, aligning with the definition of vertical ecosystems we have constructed. It exemplifies the sustainable sections in terms of the construction of the built environment, its relationship with the surroundings, and social cohesion.

Fig. 10 - Interpretation Collage: The Regeneration of Can Batlló.

The Construction of the Structure

The main objective of the project has been to build a structure that minimises its environmental impact, both during the construction phase and throughout its lifecycle, achieving optimal comfort in the homes with minimal energy consumption. The strategy adopted focuses on reducing the initial demand on all environmental factors of the building, particularly by prioritising energy efficiency through passive strategies to maximise the use of existing resources (Figure 11).

Through a design rooted in bioconstruction and the use of sustainable materials, La Borda establishes a symbiotic relationship with its surroundings, acting as a microcosm where architecture, nature, and people coexist harmoniously. This approach is clearly reflected in the wooden structure, starting from the first floor, which functions as a natural regulator of the internal climate, reducing energy dependency and promoting a more environmentally conscious way of living. The integration of renewable energy sources is another key element of the project. On the rooftop, solar panels generate clean energy, and an urban garden, where plants and vegetables are cultivated in raised beds, is integrated into the design. This combination of renewable energy and urban agriculture strengthens La Borda's commitment to sustainability, transforming the building into a model of efficiency and environmental stewardship.

Finally, the building incorporates an advanced temperature monitoring system, which allows its large shell to open or close according to the seasons, functioning like a greenhouse. The translucent materials covering the building are reminiscent of agricultural greenhouses, as they optimise the management of light and heat, adjusting to the climatic needs of summer and winter.

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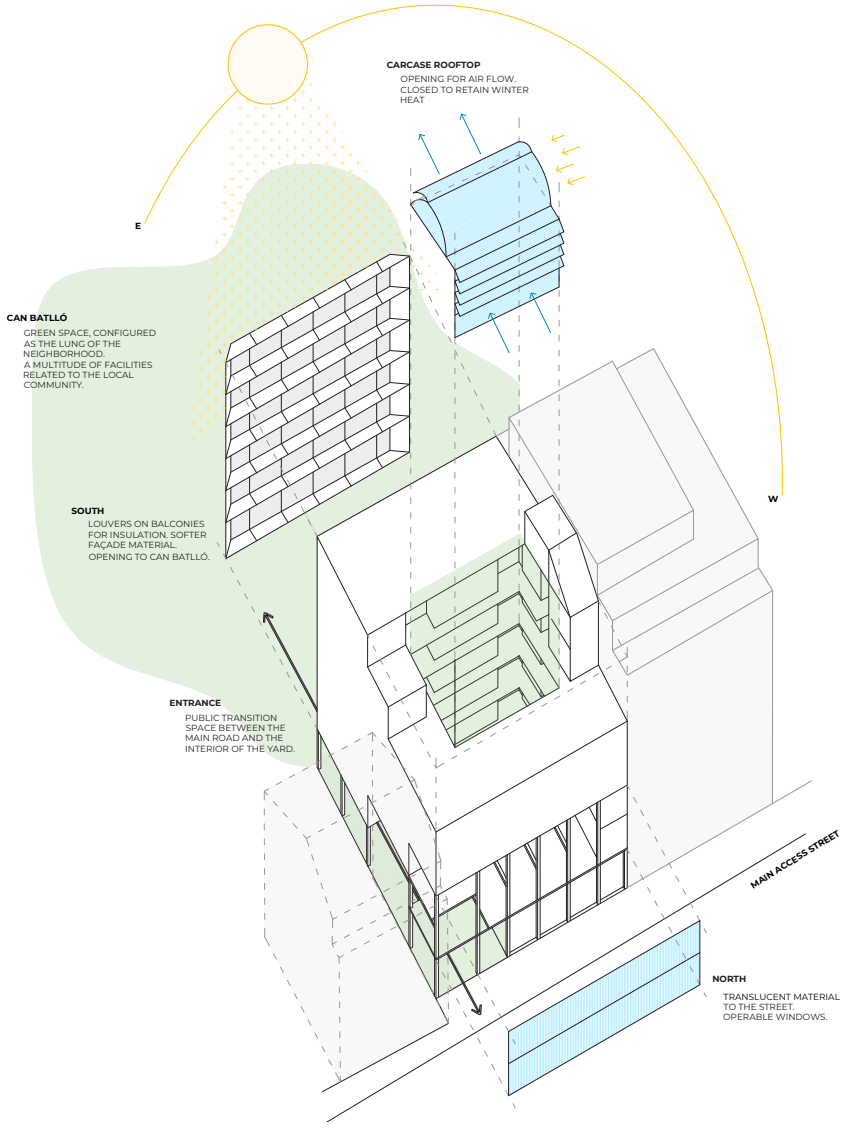

Fig. 11 - La Borda ecosystem functionality.

Relationship between the Components

The design of La Borda includes 28 housing units of various sizes, along with a series of communal spaces that extend the living experience from private areas to public ones, aiming to foster community and neighbourly life (Lacol, 2016). Among these communal spaces are a kitchen-dining room, laundry room, multipurpose room, guest space, health and care area, plant storage, as well as exterior and intermediary spaces such as the patio and terraces. All these spaces are organised around a central patio, a large interaction space that evokes the "corrales," a type of housing common in central and southern Spain.

To this end, the image represents a cross-section of the building, configured through a composition of overlapping photographs. Each photograph illustrates different moments and aspects of the building's internal functioning, including circulation flows, communal spaces, and access areas. This approach allows for a visualisation of how the building's dynamics interconnect from the exterior to its core, highlighting the relationship between the entrances and the common areas. The collage not only presents the physical design but also conveys its vitality and the everyday use of its spaces (Fig.12).

Moreover, La Borda reclaims the idea of community in its broadest sense, where social dynamics and their relationship with the urban environment come back to the forefront in a society that is increasingly independent. La Borda represents a "consensual stratification" between the building and its surroundings, connecting the horizontal plane—the street and communal spaces—with the vertical plane, comprising private spaces and social hubs (Figure 13). This interaction between the physical and social aspects transforms the cooperative into a catalyst for community cohesion, bringing residents together in a shared project. Like the small green ecosystems spread across the city, La Borda acts as a "lung" that revitalises both the urban space and the quality of life of its inhabitants.

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The interior courtyard becomes a key intermediary space, an antechamber to the homes that serves as a transition between what could be considered exterior and interior. This space opens out to the street in various ways, serving as a meeting point and a filter between the urban environment and private space. In this way, the courtyard becomes a dynamic space that facilitates connection and interaction, reinforcing the open and communal character of the cooperative.

Fig. 12. The construction of an unusual section of La Borda based on photographs taken during the fieldwork visit. Reconstruction on a horizontal collage: artefact and life, a cross section between the street and the yard. Source: From left to right: 1st, 4th, and last image by Lacol, 2018. Remaining images are original.

Fig. 13 - Sustainable Sections in Cooperative Housing: The Paradigmatic Case of La Borda. Transition and in-between space.

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Social Cohesion

The proactive attitude of the residents is one of the main drivers for self-promotion and the subsequent management of the project once it is in use. This participatory approach becomes the most distinctive and defining characteristic of the initiative. The ability to address the residents' needs internally, responding to specific situations, is key. La Borda consists of more than fifty people of different ages, all of whom are connected to the Can Batlló space. The shared goal is to harmonize the need for dignified, socially inclusive, affordable, and environmentally sustainable housing. This, in turn, aims to foster new forms of cohabitation and build community through neighbourly interaction (Fig. 14).
Within the framework of local policies that strive to reintroduce green areas and spaces for social interaction in Barcelona, La Borda stands out for its capacity to promote the reconfiguration of the surrounding urban fabric. Its project connects with the broader Can Batlló environment, a space revitalized by community action. In this way, the project not only becomes a reference for sustainable housing but also contributes to the transformation of its neighbourhood, promoting a model of urbanism that prioritises community life, accessibility, and connection with nature.

Fig. 14- Living La Borda, the collage that you can heard.

CONCLUSIONS

Housing cooperatives that incorporate vertical ecosystems represent an innovative response to contemporary urbanisation challenges. By combining environmental efficiency with a strong community focus, they create spaces that facilitate social interaction and strengthen the sense of belonging among their inhabitants. In a context where sustainability and social cohesion are increasingly valued, these initiatives emerge as models that go beyond conventional solutions, proposing an urban lifestyle that integrates nature into everyday life and can be replicated in other cities worldwide. As we have seen and analysed, the La Borda Cooperative serves as a tangible example of how architecture can transcend the mere construction of habitable spaces, becoming a true vertical ecosystem that integrates people, nature, and urbanism into a cohesive and sustainable whole, aligned with the principles of a new urbanism that seeks to humanise the city and reconnect its inhabitants with their environment.
In this way, the vertical ecosystems implemented in housing cooperatives, such as in the case of Barcelona, effectively demonstrate that a balance between environmental sustainability and social cohesion is achievable. At the same time, they are solidified as global references. This approach, aligned with current trends in sustainable architecture and urbanism, proves that it is possible to create resilient and just urban communities in harmony with their natural surroundings. Thus, it reaffirms the idea that architecture plays a central role in transforming urban environments into more inclusive and sustainable models, paving a clear path for future interventions in cities around the world.

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