The background is a solid teal color. Overlaid on this are several thin white circles of varying sizes that overlap each other, creating a complex, abstract pattern. The text is white and positioned within the central area of these circles.

**Innovation
and Resilience**

**Through
Bio-artifacts
and
Circular Design**

edited by

Raffaella Fagnoni
Jörg Schröder
Annapaola Vacanti



Innovation and Resilience Through Bio-artifacts and Circular Design

Research exchange and doctoral training by CTRL+JUNK LAB at Università IUAV di Venezia and the Territorial Design group at Leibniz University Hannover

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To Manuel Gausa Navarro
*with the gratitude of those
who will continue to advance
architecture and design
with open minds.*

This book grows out of a series of research experiences we had the privilege of sharing with Manuel, colleague, mentor, and friend.

In those moments, we came to know and appreciate his extraordinary humanity, his intellectual vitality, and his rare ability to combine rigour with curiosity, openness with depth, turning every encounter into a meaningful exchange, and every project into a truly collective learning experience.

His generous and forward-looking vision fostered encounters across disciplines, cultures, and perspectives, leaving a lasting impression on all those who had the good fortune to work with him, the mark of a research practice that was alive, humane, and shared, always accompanied by his distinctive joyfulness and convivial spirit.

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Introduction

Raffaella Fagnoni, Jörg Schröder

In the effort for a transition of our ways to live and habitats to sustainability and resilience, environmental and technological approaches are in the foreground of debates and actions in society and politics. With this book, we aim to advocate for creative and cultural approaches to urban transformation and working with nature, two of the core themes when it comes to realise transition for everyday life. We believe that creativity and culture, in this perspective, can also contribute to enhance innovation – for a green economy, competitiveness, but also social innovation in communities and networks, oriented to advance resilience as forward-looking empowerment and necessary capacity. Thus, we claim that complex urban – and territorial – as well as natural dynamics can be understood and re-directed in the sense of a ‘Laboratory of Survival’ driven by research as well as emerging practices in society and economy.

Bio-artifacts and Circular Design are brought forward as two major research fields in this context, explored and set in dialogue in a series of research efforts at Università Iuav di Venezia, by the Interactive Design group, and at Leibniz University Hannover LUH, by the Territorial Design group.

This interdisciplinary cooperation has been initiated with the international conference ‘Laboratory for Survival’ organised by the two groups in June 2023 at Iuav Venice and developed with a joint international research workshop and doctoral colloquium in November 2023 at LUH Hannover. The exchange between the researchers from both part-

ners has been the basis for joint research projects of groups of doctoral candidates, their publications in this book have been validated through an independent peer review process. In the first part of the book, essays from researchers from luav and LUH present recent research in the fields of bio-artifacts and circular design (Schröder et al. 2023). In the second part, the research projects of joint groups of doctoral candidates are presented. The highly productive tension and interaction in this joint research and publication, between urban-territorial and design oriented approaches, is set on a stage of circular thinking and circular economy, in order to ‘territorialise resilience’ (Schröder, 2021).

This research and book has been inspired by and contributes to the work of the EU-project Circular Design Innovation Alliance (CiD). It supports to fill the gap in skills and knowledge about circularity and circular economy in the sectors of architecture, urban design, product/service design. CiD is offering a radically new model on how to link design to circularity and urban transformation, inspired by the paradigm to regenerate environments and living spaces - and not only to recycle materials and use renewable materials. This principle can influence also the uptake and upscaling of design innovation – in a broad sense, across different scales and fields – to transform towards a Circular Economy, since “design is at the core” (Ellen MacArthur Foundation, 2017) to reconfigure all sorts of processes in the material expression of human life.

The essay ‘Laboratory of Survival’ by Davide Crippa, Raffaella Fagnoni, Annapaola Vacanti (Università luav di Venezia) brings a novel perspective for the topic of waste, fundamental in the move towards a circular economy. In a design approach, a new and holistic integration between products, services, territory, culture, and traditions is articulated. The concept of ‘Hyperlocal Design’ is presented as expression of a paradigm shift towards more localised and human-centred models to build economies, fostering community participation and civic responsibility (Fagnoni et al. 2024). The following three essays position circularity concepts for urban transformation, transferring ideas from a focus on materials to a focus on space. The essay ‘Lagoon. Thinking Venice archipelagically’ by Alissa Diesch (LUH) offers a cultural perspective on the islands of the Lagoon of Venice, inspired by Edouard Glissant, a Caribbean poet and philosopher. By highlighting hybridisation of cultures and ecosystems, a new understanding for regenerative approaches in the context of circularity is promoted. The essay ‘Venice. A Vision for Sustainable and Circular Transformation’ by Federica Scaffidi (LUH) discusses regeneration in the context of circularity with a focus on the re-use of urban space and stresses the role of foundations and associations play as hybrid actors, connecting institutions, citizens, and grassroots practices. The essay ‘Venice as stage and medium for ideas of circularity’ by Riccarda Cappeller (LUH) is exploring filmmaking as tool and platform for urban knowledge creation in a range from use in



Fig_01
Photo from the "Laboratory for Survival" seminar held at the luav University of Venice

education, for research, and for awareness and discussion in society. Its focus is on a reframing of contemporary spatial agency, to understand and work with existing urban space, its trajectories and potential of transformation and circular dynamics involved. The research articles by the interdisciplinary and international groups of doctoral candidates start with 'Collective eco-innovation. Designers and citizen communities promoting ecological change through informal practices by André Araújo Almeida (LUH/Mackenzie Presbyterian University Sao Paulo UPM/UNIFOR), Carmelo Leonardi (luav), Maria Manfroni (luav), and C. Mattia Priola (luav). The article focuses on informal methods and open design approaches which can foster small but impactful change realised by community-driven initiatives. Cooperative design practices in promoting sustainable development are examined with a selection of case studies in four categories: bio-communities, low-impact communities, social communities, and self-planning communities. The article 'Circular Tools and Processes in Architecture and Design: A Shared Framework' by Massimiliano Cason Villa (luav), Christian Corral (LUH/UPM), Michele De Chirico (luav), and Carmen Digiorgio Giannitto (luav) analyses the impact of sustainability assessment tools in the fields of architecture, specifically adaptive reuse and sustainable construction, and product design, with a focus on eco-design for exhibitions and circular prototyping. It asks about the role of these instruments in the formulation of design strategies for the development of a multidisciplinary

disciplinary framework for close-loop projects and research. The article ‘Bridging Circular Design and Territorial Planning through rice waste enhancement: the Ricehouse case’ by Francesca Ambrogio (Iuav), Fernanda Paz Gómez (LUH), Andresa Lêdo Marques (LUH/UPM), Eugenia Morpurgo (Iuav), and Luciana Varanda (LUH/UPM) presents a novel perspective on the actual sustainability of circular processes for biomaterials. Based on a case study of a startup currently producing biomaterials from industrial rice waste that fosters synergies among diverse stakeholders within a circular approach in the Piedmont region of Italy, the article identifies key overlaps, gaps, and opportunities that arise from the integration of bioproducts design, territorial planning, and circularity.

The multidisciplinary approaches and results achieved in these joint research and publication clearly highlight interdependencies in promoting sustainability in a trans-scalar perspective from products and services to territories, combining different fields of knowledge and innovation to bring together design of bio-artifacts and circular transformation. Ultimately, a key outcome of this international collaboration, and of the book itself, was the process through which it unfolded: initiated through mutual study visits and workshops between Hannover and Venice, and developed through over a year of regular long-distance meetings, it led to shared research contributions and the definition of a common methodological framework.

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Fig_02 Remote group photo of the project team



Fig_03
Photo from the workshop held at Leibniz University Hannover, where the Phd students involved in the project presented their



Fig_04_05
Photo from the "Laboratory for Survival" seminar held at the Iuav University of Venice

Laboratory for Survival

Waste studies,
hyperlocal, social,
and circular design

Raffaella Fagnoni, Davide Crippa, Annapaola Vacanti

1. The acceleration of change. Living with extreme situations

The speed and acceleration of change represent a central and distinctive feature of our era, not merely one factor among many, nor a secondary element in the landscape of forces shaping contemporaneity. This condition gives rise to a new normal, marked by a continuous and dynamic adaptation process. We navigate within an adaptive evolution, which Edgar Morin describes as an era of poly-crisis and turbulent advancement. To endure within such complexity, it is essential, as Morin reminds us 'never give in to the delusion of the collective responsibility of a people or an ethnicity. [...] with the effort to understand the complexity of the problems without ever giving in to a partial or one-sided vision. It requires research, verification of information and acceptance of uncertainties' (Morin, 2016).

The past serves as an essential source of learning. The recent pandemic has shown us how the acceleration of change is one of the primary consequences of large-scale critical events. The acceleration of development has impacted every field since the 1950s, contributing to the disruption of the ecological balance previously maintained. Although trade and the movement of goods between different areas of the planet have existed for millennia, it is the acceleration in resource consumption, combined with overproduction and energy dispersion, that has brought us to a critical threshold of sustainability.

Today we must learn to live with extreme situations and recognise them as an integral part of our adaptive condition. This contribution proposes considerations and possible strategies to adapt our skills to this new reality.

The sustainability discourse, the practices and policies adopted, as well as the numerous publications on sustainable development in recent years have not yielded the expected results. Even the measures and projects implemented at the central, European and national level, along with the efforts of research groups, have not had significantly impactful effects. In particular, they have failed to prevent the increasingly disruptive effects of climate change.

Two predominant responses have emerged: one rooted in denial of the problem, and another in resignation—the belief that it is already too late for effective intervention. Both stem from a shared premise: a steadfast commitment to the idea of progress, within which sustainability has represented merely another iteration (Blühdorn, 2016). While one may still argue in favour of a transformed or revitalised version of sustainability, the failure of the current paradigm cannot be ignored (Foster, 2018), especially considering that 2030 is only six years away, the year by which the Sustainable Development Goals (SDGs) were supposed to be fully implemented with tangible results. Blühdorn (2016) analyses the reasons why the sustainability paradigm is perceived as failing yet continues to maintain a hegemonic position. Furthermore, he highlights

how the transformation of the sustainability agenda into an unsustainability policy effectively addresses the specific needs of liberal consumerist societies.

There is now a broad consensus that this approach is unable to generate the structural change necessary to prevent severe social conflict and ecological collapse. It could thus be argued that we are living in a post-sustainable era. The critical challenge lies in identifying which political and design strategies remain viable in the face of increasingly irreversible environmental degradation.

As early as 1973, E.F. Schumacher, in his famous essay *Small is Beautiful*, opposed the model based on infinite growth and centralisation with an alternative focused on the small scale, centred on human beings and the environment rather than exclusively on profit. The aim was to promote human welfare and social justice. This text served as a key reference for the environmental movement, asserting that reducing economic scale does not necessitate abandoning progress but rather reimagining it through a more sustainable framework.

Schumacher foresaw many of the challenges that society faces today. He proposed the need to shorten distances, bringing the economy closer to human needs and reducing the gap between production and consumption. This would avoid the growth model based on the uncontrolled expansion of companies and markets, responsible for increasing inequalities and environmental degradation. He also advocates for decen-

The two predominant responses to this situation – one characterized by denial of the problem and the other by the belief that it is already too late for intervention – originate from a common underlying premise: a steadfast commitment to the concept of ‘progress’, within which sustainability has merely represented another iteration.

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tralisation through the adoption of locally suited technologies - less invasive for the environment compared to large centralised infrastructures - promoting more sustainable production tailored to territorial characteristics. 'Man is small, therefore small is beautiful. Moving towards gigantism means moving towards self-destruction' (Schumacher, 1973, p. 129).

Nevertheless, our society has based its apparent development on large concentrations of forms and substances, following a trend opposite to this natural pattern, with all the consequences that have ensued. Reversing this development model is not easy.

2. Hyperlocal design

Territorial approach

Although the sustainability paradigm has long been central to academic and policy debates, it has failed to bring about the structural transformations necessary to address the contemporary ecological crisis (Blühdorn, 2016). On the contrary, it has often served to perpetuate a status quo oriented toward the exploitation of natural resources and ecosystem degradation. The mechanisms of capitalism, grounded in relentless production and consumption, reflect the cyclical crises described by Marx (Clarke, 1990), in which productive forces ultimately self-destruct due to their internal

contradictions. This dynamic is particularly evident in the current ecological crisis: unlimited economic expansion has led to the depletion of natural resources and environmental degradation on an unprecedented scale. Faced with scenarios of irreversible loss, it becomes essential to go beyond the idea of design as the restoration of a past balance, adopting instead a vision of constant evolution and transformation contextualised in a given territory.

Awareness of the depletion of material resources, the decline of ideals, and the fragmentation of communities (Wizinsky, 2021) have nonetheless fueled research trajectories and design experiments that diverge from the logic and rhythms imposed by capitalism, aiming to establish alternative balances with the planet.

One such approach is the concept of Hyperlocal, supported by the thesis that it offers an experimental means of addressing the consequences of the ecological crisis and the social upheavals we are currently experiencing (Fagnoni, 2022).

The Hyperlocal concept is closely linked to the notion of bioregion (from the Greek bios, meaning 'life', and the Latin regio, meaning 'territory'), which emerged from 19th-century ecological thought. This includes studies on human impact on ecosystems, such as George Perkins Marsh's *Man and Nature* (1864), as well as investigations into the relationships between humans, place, and labour, pioneered by Patrick Geddes, a forerunner of urban ecology (*Cities in Evolution*, 1915). Geddes' idea

of civics encompasses geography, history, and society (place, work, folks), framing it as science-oriented toward citizens and their active responsibility as a prerequisite for transforming places. Adopting an active and conscious attitude in the evolution of the heritage each generation leaves to the next requires specific training: an understanding of history, the ability to engage in collaborative action, a willingness to cooperate, and a sense of responsibility for individual actions.

The tools and approaches of design are applied to intervene in specific situations and devise actions that transform an existing situation into a preferred one, as H. Simon (1969) suggests. The concept of ‘designing for’ something has gained particular significance as Design has expanded from designing physical products to developing services, experiences, processes, and imaginaries. Product-service systems are developed and focused on the service interface, understood as the sphere, the situation, and the experience in which interactions between service providers and users take place, related to a site-specific context in which these actions unfold.

Each site-specific context, environment, or setting, has a multilayered structure, encompassing:

- geographical framework, similar to the bioregion concept as defined by Tackara: ‘(it) embodies the interconnection of our minds and nature’s at a molecular, atomic, and hormonal level. A bioregion, in this sense, repairs the unity of mind and world that

has been fractured by modernity. A bioregion is literally and etymologically a life-place (in Robert Thayer’s words, 2003) that is definable by natural rather than political or economic boundaries. Its geographic, climatic, hydrological, and ecological qualities –its metabolism—can be the basis for meaning and identity because they are unique’.

- cultural framework, the rituals and traditions witnessed by traces (Fagnoni, 2018).
- procedural-methodological framework, the scope of sustainability linked to the circular dimension.
- time-related framework, connecting the past, present, and near future.

The concept of Hyperlocal Design extends beyond the mere geographical, social, and economic dimensions of the local. The combination of the prefix hyper- with the term local expresses a continuous evolution in the relationship with proximity, adopting a dual perspective: on one hand, the connection to tradition, territory, traces, and histories; on the other, the transformative potential that this condition of proximity can offer, fostering collective imagination and future aspirations. The adjective local is often misunderstood as a constraint, implying small-scale events or limited contexts, thereby overlooking broader frameworks and more complex structures. In this context, however, the term is understood in a broader sense, where the local is seen as the outcome of multiple, layered elements. The integration of a holistic approach — one

that considers the interconnections between the natural and human-made landscape, acknowledges environmental limits and constraints, encourages community participation, and promotes active citizen responsibility in territorial development and production processes — falls within what can be defined as the bioregional territorial design, from which the concept of Hyperlocal emerges. In our interpretation, the Hyperlocal concept relates to the notion of Hyperspace, which, in mathematical terms, extends beyond the three physical dimensions of space to include a fourth dimension linked to the relationship with time. The temporal dimension is thus integrated with the spatial one in Hyperlocal Design (Fagnoni et al., 2024): design actions and circular relationships are embedded in fragments, remnants, and traces that constitute both individual and collective history, reconnecting these layers with the rituals and traditions that give meaning to existence. Design engages with the past, using it as a resource for innovation and renewal in projects that emerge from a well-defined context, exploring its history. These traces, in turn, become opportunities for innovation, fostering a cyclical relationship between the past and the future. The hyperlocal project embraces the place in which it operates, linking past and present — what can be created from the remnants of what once was, bridging an immutable past with a probable future. Through this approach, it generates a cyclical and spiral dynamic, where actions

and situations are continuously reshaped by time and human agency. Research on Hyperlocal Design is being developed through teaching and experimental activities within various courses at Università Iuav di Venezia, such as the 2023-24 Product, Service, and Interaction Design Laboratory, titled Sitopía. Design for Hyperlocal Food Ecologies. This research explores hyperlocal food systems within the Venetian context, focusing on the valorization of experimental practices and hyper-contextual design approaches that foster new forms of interaction between people and places. Building on Carolyn Steel's perspective (2020), this project aims to enhance the territory through the food system and the relationships it fosters: from production to distribution (cultivation – production – sale); from distribution to consumption (preparation – cooking – eating); and from consumption to waste management (waste – transformation – reuse). A key focus of the investigation is the identification of local stakeholders belonging to the cultural and historical dimensions of the territory. This approach enables the research to respond to local needs while addressing relevant contemporary issues and anticipating future scenarios for the Venetian lagoon. By doing so, it fosters meaningful connections between the territory and its traditions, promoting a holistic concept of well-being that integrates culture, services, and experiences. The actors involved in this investigation,

while operating across different fields, share the common goal of preserving territorial identity, supporting the local economy, and promoting community-driven and ecological initiatives. Their commitment is reflected in the reclamation of abandoned spaces, the safeguarding of local resources, the dissemination of knowledge, and the creation of short supply chains and solidarity-based networks across various sectors. Collectively, these efforts generate a narrative and set of testimonies that describe places, operational conditions, and challenges specific to the Venetian context. In response, design concepts and future development proposals have been formulated, envisioning potential scenarios for 2050. Some research activities undertaken provide alternatives to conventional design education and testify how Hyperlocal Design can integrate human-object-place interactions, material flows, traditions, and social practices. This underscores the value of a design attitude that, rejecting conventional disciplinary boundaries, embraces a radical and experimental practice—not as a stylistic choice, but as a means of survival in an era of profound environmental and social transformation.

3. Waste studies

CTRL+J(UNK) LAB

Studies on waste are an emerging field that examines waste in a broad sense, moving

beyond conventional perceptions of trash and refuse. The Italian term *scarto* (waste), derived from the verb *scartare* (to discard), inherently implies an act of selection. This selection process is a fundamental component of waste generation, as discarding entails determining what has value and what does not. However, this process is not limited to materiality; it also involves systems of relationships, activities, and dynamics that produce and reproduce social and environmental inequalities, affecting people, objects, and places. Waste is often defined as a depleted material with no residual value, resulting from an act of production or consumption, but it can also refer to anything that has been used (Lynch & Southworth, 1991/1994, p. 202). In Italian, *scarto* also denotes *scartato* (discarded), thus conveying the idea of a residual element. However, this term does not fully capture the process through which an entity—whether an object or a person—consumes itself and transforms, losing something in the process, conveying a sense of dissipation (Lynch & Southworth, 1991/1994).

Waste is commonly understood as something devoid of value or purpose for human use. It signifies reduction without productive outcome—entailing loss, abandonment, decline, separation, and even death. Addressing the issue of waste, therefore, extends beyond material studies; it also encompasses social systems, exposing the power structures and policies that discard people, places, situations, and objects.

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Armiero (2021) conceptualizes these dynamics as Wasting Relationships, referring to global-scale processes that create wasted places and wasted people. Waste, understood as a relational process of exclusion, does not merely select a targeted community but actively produces it, identifying it as a sacrifice zone—a place designated to host what no one else wants.

The growing economic and social stratification has deepened pre-existing inequalities (Gutiérrez & Jurow, 2016), leading to what has been metaphorically described as “wasted lives” (Bauman, 2004/2007).

Designing for sustainability requires system-wide changes, encompassing legislation, new business models, and shifts in consumer behaviour (Meadows, 2008; Ryan, 2014; Conway et al., 2018), as well as the promotion of new circular models for design, production, and use.

As defined by the Ellen MacArthur Foundation (2015), the circular economy provides a systemic solutions framework that addresses global challenges such as climate change, biodiversity loss, waste, and pollution. It is based on three design-driven principles: eliminating waste and pollution, circulating products and materials, and regenerating nature. The implementation of these strategies is central to policy frameworks and initiatives promoted at international and national levels (UN Resolution, 2015; EC, 2015; EC, 2019; EC, 2020; MISE, 2021; MITE, 2022).

A typical approach to waste is to minimize it, reducing consumption, ensuring the per-

manence of objects, and maintaining them with care. However, waste can never be eliminated, as it remains inherently chaotic, even though we seek order, stability, and boundaries within it (Lynch & Southworth, 1991/1994).

The CTRL+J(UNK) LAB research centre at Università luav di Venezia was established to address the issue of waste by exploring materials—natural, biological, or artificial—and examining the impact of digital ecosystems from an interdisciplinary perspective. Understanding recycling as the activation of a new cycle, the centre’s research approach counters the role that design often plays in greenwashing, where communication strategies and superficial design solutions emphasize sustainability while concealing inappropriate content behind aesthetic choices. Instead, the core prerogative of CTRL+J(UNK) is to go beyond the notion of waste as an impure material, uncovering its latent potential. Waste can represent a highly concentrated deposit of valuable elements (Lynch & Southworth, 1991/1994). A shift in perspective is proposed, conceptualizing matter as something in continuous transformation—and in this process of change, it does not necessarily become waste. In this sense, abundance itself can have a positive impact, becoming a heritage, knowledge, or resource to be preserved rather than discarded.

Material is the primary object of investigation—not merely as an outcome of research aimed at enhancing technical and functional performance, but as a medium for inven-

tion, a site of conscious design (Manzini, 1986). Rethinking the reality we want and need to carry out implies that every raw material, every pre-existing resource, can be transformed, acquiring new meaning, new form, and new function (Ferrara, 2004, p. 11). This outlines a design scenario in which the untapped potential of materials is revealed, enabling productive, economic, ecological, and cultural transformation in the use of material resources. Such an approach is not only necessary but also strategic, turning resource limitations into a design opportunity to counteract the looming waste apocalypse (Armiero, 2021). Furthermore, waste as a concept emerges as a catalyst for collective commoning practices, generating both shared goods and communities (De Angelis, 2017; Bollier & Helfrich, 2012). These anti-waste strategies are among the most fertile, as common relationships foster well-being through care and inclusion, rather than exploitation and destruction (Armiero, 2021, pp. 95-96). By seeking to reproduce both resources and communities, commoning practices actively dismantle processes of exclusion and othering.

4. Research fields

Among the design principles for sustainability, techniques for separating and disassembling material components are regarded as essential for effective recycling and

resource recovery. However, while these techniques are well-established, they do not represent the most effective anti-waste strategies and, on their own, cannot achieve a zero-waste society.

The accumulation and circulation processes occurring in marine environments lead to the formation of plastiglomerates. Sedimentary granules and organic debris – such as wood fragments or seashells – are cemented together by melted plastic through wave movement and environmental heating processes. These material aggregates, resembling rocks but composed of fused plastic waste, mixed with sediments, volcanic lava fragments, and organic debris, exemplify the transformation of nature itself in the Anthropocene era.

In recent years, these formations have inspired various experimental projects by artists and designers, exploring techniques that respond to the incorporative nature of these neo-materials, understood here as hybrid aggregations. Taking inspiration from nature's integrative and absorptive processes in forming plastiglomerates, alternative methods can be proposed to complement separation and disassembly practices. These approaches contribute to the formation of new materials that embody a recognizable waste aesthetic.

Research on waste and discard studies is structured into the following categories:

4.1 – Material waste: raw materials, by-products, semi-finished goods, etc.

4.2 – Spatial waste: temporary installations,

spatial setups.

4.3 – Digital waste: waste and environmental impacts generated by digital systems.

4.4 – Social and civic approaches: waste management about community and public engagement.

4.1 Material waste, raw materials, by-products, neomaterials, biomaterials

With a projected global population exceeding 9 billion by 2050 and the rapid economic growth of developing countries, the demand for natural resources and materials is expected to rise exponentially in the coming decades. This trend will also lead to increased environmental impacts unless policies and measures are adopted to ensure a more efficient use of resources. In anticipation of this scenario, the widespread adoption of a circular model of production and consumption has been identified as a strategically significant approach (Ellen MacArthur Foundation, 2015).

In recent years, the European Commission has taken action by proposing and implementing a series of strategies and policies aimed at facilitating the green transition. These include the Waste Framework Directive 2008/98/EC, which introduced the concept of ‘End of Waste’; the European Green Deal, which outlines various commitments to waste reduction; the Circular Economy Action Plan; the European Strategy for Plastics; and the Single-Use Plastics

Directive. However, ‘being circular’ does not merely involve the technical reintegration of waste into production cycles – it also requires a semantic recalibration of the concept of waste itself, recognizing that everything holds value (Lacy, Rutqvist, Lamonica, 2016). A substantial body of contemporary research focuses on the development of innovative materials through various material-based design approaches. Among the outputs of these approaches are emerging and experimental supply chains for neo-materials, particularly those derived from second-generation materials that are not integrated into conventional recycling streams (Pellizzari, Genovesi, 2021). As the final stage in the linear system of design, production, distribution, and consumption, ‘waste consists of materials stripped of the right to exist and of a recognized identity’ (Rau, Oberhuber, 2019, p. 114), ultimately resulting in the loss of the raw materials from which they are composed. Waste is something we ignore; by definition, it is something we discard from our lives and our consciousness – something that is (and remains) outside through a process of removal and exclusion (Lynch, Southworth, 1991/1994).

Michael Thompson’s Rubbish Theory (1979) explores how objects can shift in value over time, transitioning between the states of transient, rubbish, and durable. Transient objects are those considered to have temporary value, destined for deterioration or destruction. Durable objects, on the other hand, are those of high value, meant

to be preserved over time. Rubbish refers to objects deemed valueless, discarded, or considered useless. The central idea of Rubbish Theory is that value is not fixed but is shaped by evolving social and cultural perceptions.

Matter inherently contains the potential for multiple future materializations, existing as something continuously transformable, capable of evolving into a resource, heritage, or form of knowledge, something that persists rather than being discarded. Reconsidering the identity of waste reveals the urgency of a paradigm shift: waste, as a tangible capsule of material resources, must be reinterpreted as both an opportunity and an untapped reservoir of value. Design, as a discipline capable of fostering tools for change, can address the fundamental challenge of sustainability, namely, the necessity of always approaching it in relative rather than absolute terms (Wilkes, 2015).

Established material recovery techniques are predominantly based on separation and disassembly; however, these are not necessarily the most effective anti-waste strategies. A wide range of sorting and separation technologies exists for the pre-treatment of waste. Some rely on the direct selection of physical material properties, such as screening, froth flotation, air separation, cyclonic separation, electrostatic separation, and magnetic separation. Others integrate sensor-based technologies for indirect sorting (e.g., optical or spectral sorting), while some employ chemical addi-

tives and heat-based processes. In certain cases, as with composite materials, separation procedures can have significant energy and economic implications compared to the use of mixed materials processed through pre-treatment fragmentation. When combined with eco-friendly binding agents that preserve their environmental quality, this approach remains a viable alternative for generating novel materials (De Giorgi, Lerma, Dal Palù, 2020; Brunner, 2021).

The challenge of mitigating a looming waste apocalypse (De Chirico, Crippa, Fagnoni, 2023) remains unresolved as long as the reintegration of waste into productive cycles is not prioritized. Pathways that extend beyond conventional separation and disassembly techniques represent a possible direction, bringing with them a redefined aesthetic perception of waste (Morozzi, 1998, pp. 20-21).

Bio-based materials, on the other hand, warrant a dedicated discussion, as they constitute a key area in the ecological transition. Experimental approaches using algae, fungi, bacteria, and various types of agricultural or food industry waste enable the development of materials with highly diverse properties and applications. While the scalability of production processes is crucial – ensuring a rapid response to market demands with cost-effective and low-impact solutions – these developments cannot be considered independently of their environmental and agricultural consequences. Their large-scale implementation may have repercussions on biodiversity and

landscapes, raising concerns about their broader ecological impact.

Numerous platforms are emerging that facilitate the matching of supply and demand for waste and materials, reframing waste as a resource, an abundance, and a raw material. Among the most notable examples are enabling platforms such as the Dutch Harvest Map (iharvestmap.org), which support resource exchange. Other platforms, such as Sfridoo (sfridoo.com), facilitate material transactions, while Circularity (circularity.com) provides consultancy services for circular economy solutions.

Some platforms focus on specific material categories, such as TerraCycle (terracycle.com), which specializes in packaging and recycling, or Recovo (recovo.co/it), which repurposes unsold garments and surplus textiles. Others serve as European marketplaces for industrial waste and by-products, such as Cyrkl – Waste2Resource Marketplace (buycircular.it).

Certain platforms are promoted by industry associations to facilitate the transition toward more sustainable and circular business models. For example, Albo Circular (albocircular.it) is backed by Confindustria Emilia Area Centro to enhance waste exchange. In the construction sector, Ecomateria (ecomateria.it) supports material and equipment exchange, while Re-sign (re-sign.it) enables the trade and sale of goods, semi-finished products, and waste materials. Additionally, Borsino Rifiuti (borsinorifiuti.com) operates as an industrial platform specializing in waste management

services for both individuals and businesses.

4.2 Waste from temporary events and exhibits

Exhibition design represents a field in which the dynamics of material input and output are becoming increasingly significant, as installations typically have a short life cycle and, in most cases, are discarded after their first use. While environmental considerations were not historically a priority for designers or curators, sustainability has now become an essential and central concern in contemporary discourse within this sector. Through the adoption of innovative solutions, the strategic use of technology, and the practical application of material studies and life cycle analysis, it is now possible to envision new design scenarios. These include the use of secondary raw materials and by-products, alongside recovery and reuse strategies, thereby creating conditions to minimize the environmental impact of events and implement ethically responsible solutions. The analysis of the necessary 'ecological transition' that the exhibition system must undertake in the short term, in order to adapt to a constantly evolving global context increasingly oriented towards sustainability, represents a topic of pressing relevance. The extremely short life cycle of exhibition setups negatively impacts the overall sustainability of the exhibition process, both due to the high

costs of production and disposal and the lack of effective planning for the end-of-life phase. This design deficiency often results in exhibition structures being relocated to costly storage spaces or, more frequently, being disposed of, generating a significant environmental impact. In certain urban contexts characterized by intense exhibition activity, such as Milan and Venice in Italy or Paris and London internationally, this phenomenon has reached the scale of true 'exhibition pollution'.

To counter this trend, the first initiatives and research efforts aimed at identifying more sustainable practices emerged as early as 2021. Among these, the study conducted by ICOM Italy, which mapped recycling strategies for museum exhibitions through a survey addressed to Lombard museums (ICOM, 2021), and the introduction of CAM Eventi, the Minimum Environmental Criteria that provide guidelines for organizing events on a national scale, are particularly noteworthy. These instruments constitute the first concrete step towards an ecological transition within the exhibition sector. Within this framework, the establishment of the national cluster NSBVN – Sustainable Exhibit in Venice represents a key initiative aimed at identifying sustainable solutions in a sector that has traditionally been less inclined to embrace such practices. The Cluster has initiated a broad reflection process, engaging key national stakeholders and research centers to integrate circular economy principles into museum, trade fair, and exhibition systems. As part

of its activities, it organized a two-day event (June 17–18, 2024, Palazzo Cà Tron, Venice), managing six thematic working groups focusing on the following areas: The economic system of exhibitions: market snapshots; Climate change and monitoring of exhibition pollution; Digital fabrication for eco-design; Regulations and minimum environmental criteria; Circular economy in exhibitions: from sharing to recycling; Experimental practices: case studies and practical applications. One of these working groups has since evolved into a permanent observatory, currently engaged in revising the CAM Eventi and proposing the establishment of CAM Allestimenti, to address knowledge gaps in the sector and support operators in transitioning toward more sustainable practices.

In parallel, the Cluster has developed a digital platform in collaboration with the start-up NonSiButtaViaNiente S.B.A.R.L., to promote a sharing service for the reuse of exhibition materials, initially targeting museums. This initiative has led to the launch of the first pilot project focused on the reuse and recycling of exhibition materials. Additionally, the platform includes a training service designed to assist stakeholders in identifying sustainable solutions applicable to future exhibition projects. Thanks to these features, the platform serves as a reference point for industry associations and as a concrete operational tool to facilitate the sector's ecological transition. Unlike initiatives based solely on guidelines, this platform provides practical tools to translate directives into

effective actions, in line with the CAM Eventi introduced in 2021.

Over the next two years, NSBVN – Sustainable Exhibit will experiment with a series of activities and initiatives in collaboration with the Ministry of Culture, aiming to promote the “ecological transition” outlined in the TOCC – Capacity Building research framework, supported by the Italian government.

4.3 Digital energy, energy communities, digital consumption, e-waste

This line of research focuses on the energy impact and pollution generated by contemporary technological infrastructure, with a doctoral thesis analyzing the role of design in shaping future energy scenarios, and the project Sustainable Scenarios for Digital Ecosystems which specifically explores the hidden physicality and the underestimated impacts of digital activities. The per capita energy consumption of the more technologically advanced societies reveals a dependence on energy-intensive technologies, to the extent that the average consumption of a North American is more than double that of a European (with Italy’s average being approximately 30% lower) and twenty times greater than that of an African (Vacanti, Leonardi, 2024). The breadth of this gap underscores the urgency and complexity of balancing energy consumption; it is evident that it is not feasible to aspire to spread the Western lifestyle to other societies due to

the limited resources available (De Decker, 2017; Rau and Oberhuber, 2023).

As the discipline tasked with bridging the gap between artefacts and users, integrating technology into everyday environments, Design plays a crucial role in achieving the energy transition, focusing on the system and prioritizing experience in both its tangible and intangible dimensions. The paradox of efficiency where technological improvements lead to an increase in energy consumption rather than a reduction, highlights the need for a design approach that supports and develops interventions to reshape the complex interaction between socio-ecological and socio-technical systems (Ceschin and Gaziulusoy, 2019). Utilizing the transformative power of design in broader and more systemic contexts (Barbero and Ferrulli, 2023) represents a significant opportunity to imagine more desirable scenarios, from both a social and technical perspective (Di Dio et al., 2022). This thus involves “appropriate technologies” (Schumacher, 1973), emphasizing the importance of developing techniques suited to the resources and needs of each local context, which are also efficient, replicable, and respectful of diverse cultures and environments. These premises have led to the development of various visions, integrating their activities with sustainable approaches to energy consumption. Some experiments propose alternative practices, while others are the result of movements and bottom-up communities, such as Solar Punk, Low Tech, and Permaculture,

which act as catalysts for the transition to a lifestyle with a lower ecological footprint, while also promoting individual and collective autonomy and resilience (Vacanti, Leonardi, 2024). The relevance of Design in this process is fundamental: designers have the task of making alternatives to technophilic and energy-intensive lifestyles more attractive and desirable, deeply transforming the way we interact with technology. Design does not merely solve technical problems; it can serve as a mediator between the human being and their environment. The intermittency of renewable energies and the need to effectively integrate alternative systems for energy production and storage require a radical rethinking of the parameters of technological design, considering the key element of the temporal variability of energy supply. The energy transition requires changes at multiple levels and systemic innovation, which entail a design transformation and a pathway toward energy management that is not only technically efficient but also culturally meaningful, rejecting technophilia (Pone, 2022), understood as uncritical enthusiasm for technological solutions, which risks leading to technocratic lifestyles that further compromise the positioning of humanity within the biosphere (Vacanti, Leonardi, 2024).

4.3 Social and civic design

In the social sciences, civic sense refers to individuals' identities, their roles as citizens, and the corresponding public institutions that foster such behaviours and provide a space for these actions (Evers, 2009). Civic Design focuses on the design of services, spaces, and interactions that contribute to improving community life while promoting engagement and civic responsibility. It is an interdisciplinary field that bridges multiple disciplines, including design, urban planning, and the social sciences.

Its origins can be traced back to the urban planning and social design movements of the 20th century, which addressed issues such as accessibility, social justice, and sustainability. Civic Design practices are oriented toward collective well-being, fostering participatory processes and sustainable solutions for managing urban spaces and resources. Within this framework, the management of waste, understood both as material waste and as marginalized elements in decision-making processes, plays a central role in redefining urban development strategies. Through practices of social inclusion and the valorization of individuals traditionally excluded from urban transformation processes, Civic Design engages with waste. Experiences of upcycling and participatory design demonstrate how material reuse and co-creation with local communities can generate value, reduce environmental impact, and enhance territorial resilience. In our era,

notable by environmental crises and social inequalities, Civic Design emerges as a strategic approach to transforming waste, both physical and social, into valuable resources.

5. Conclusions

The world we live in is undergoing transitions driven by climate change and the impact that human activity has imposed on the planet. This deals with artificial intelligence and the excessive energy consumption that the system must grapple with. It is immersed in a transformation of production systems, labour, cycles, and, more broadly, everyday life. In the face of inevitable changes that sustainable development has failed to reverse, what remains is a time of urgency, a state of constant exception. We witness the contingency of an immediate and unforeseen, yet anticipated, crisis, unfolding within a temporal dimension that rejects duration and the linear organization of intervals, instead privileging the present moment. More than thirty years after the Rio de Janeiro Summit, our vast world stands at a crossroads (Franz, 2022, p. 232): we can choose to embrace individual and collective behaviours grounded in consumption moderation, or we can persist in dissipation and growth. If an alternative path is conceivable, the solution is not individual but collective; it begins with the acceptance of precariousness as an ontological condition of existence, linked to our

capacity for adaptation and for navigating change.

Through the exploration of research's trajectories focused on waste – whether in project materials, exhibition design, social practices, or territorial strategies – this text proposes a perspective that reconsiders hyperlocal and circular dimensions as viable alternatives for a possible future, a kind of survival laboratory.

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Lagoon

thinking Venice archipelagically

Alissa Diesch

1. The Venice Lagoon

“The entire world is becoming an archipelago” (Glissant 1997)

Venice and its lagoon represent in a condensed form many contemporary global challenges regarding climate change and societal shifts. The interface of different spaces on several scales has engendered a rich heritage and dynamics of exchange and trade: the Lagoon of Venice is the site where culture and products of the inland and the Alps meet the sea which has enabled relations to Byzantine/Istanbul and the region of the eastern Mediterranean. Today it is a global city where people from all over the world meet and relate to (Scheppe 2009). The territory of the lagoon itself represents transitional situations: It is not the open Adriatic Sea; salt water and tides are discernible in parts, while others are dominated by fresh water. Waterways for shipping, shallows, swamps and *barene* (Salt Marsh) structure and differentiate the water space as it changes over time (Fig_01, Fig_02).

Archipelagos of clustered islands, transformed, connected and augmented by architecture and infrastructure over a long time have created systems of water and land, shifting in uses, density and relation (Fig_03). Temporal dynamics like regular tides, flows of people, goods, ideas and cultures arriving from water and land have made the lagoon a vivid and inspiring envi-

ronment and shaped places like ports, markets and cultural venues. The interrelated and rich economic range comprises locally specific activities developed over a long period of time in farming, fishing and crafts as well as in services related to tourism and culture and the continuity of trade and transport, mainly represented in the port of Marghera.

The diverse natural niches of the entire lagoon have been adapted to specialised places, creating a dense natural and cultural ecosystem. Hydrogeological risks and corresponding responses to pollution, *acqua alta* and rising sea level reveal the fragility and at the same time highlight the intrinsic resilience of the territory. Solutions

to challenges related to climate change have been found by adapting existing structures, however, more transformations on all levels will be needed to tackle concepts of adaptation and the strengthened mitigation by decarbonisation.

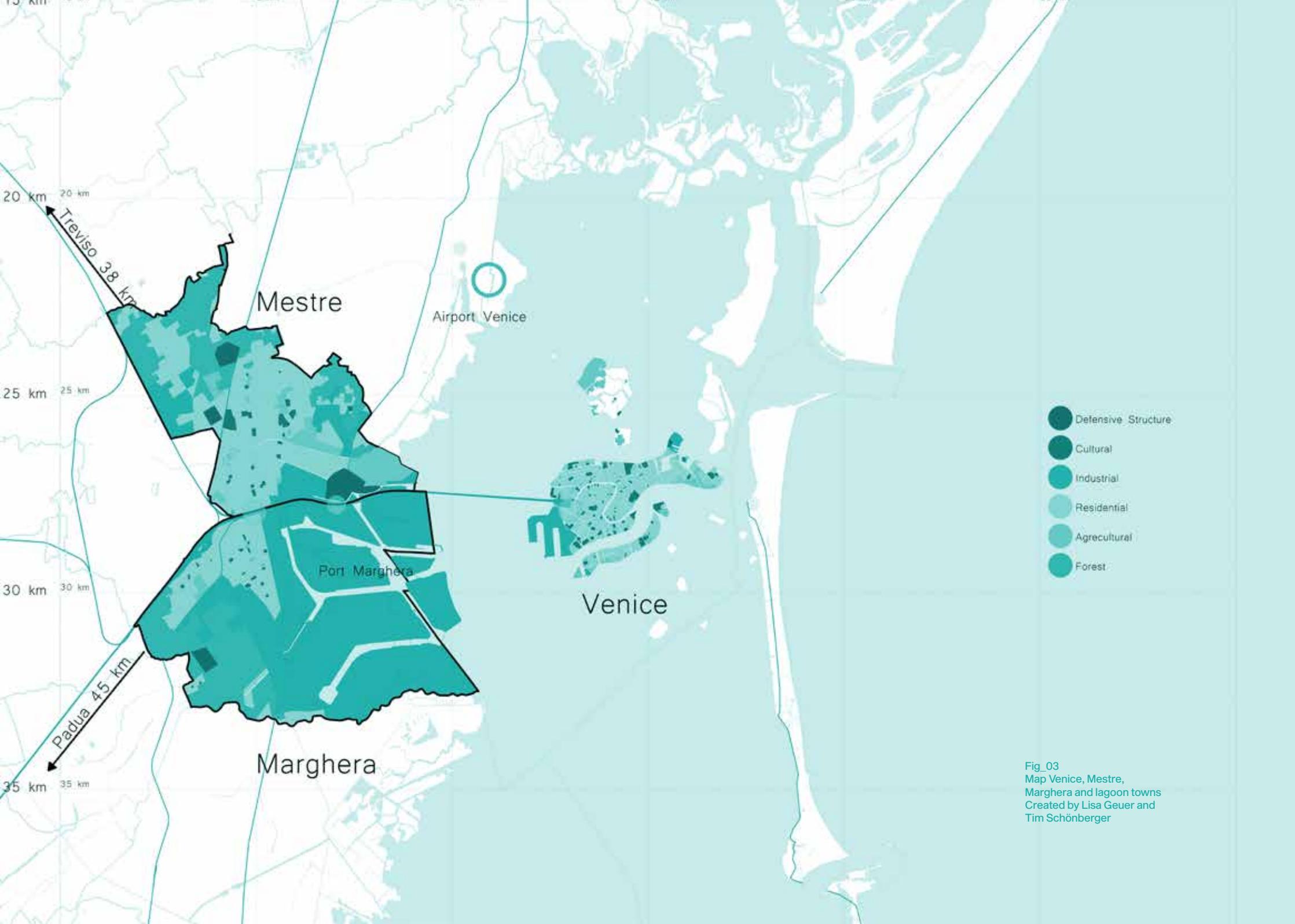
Flows and exchange with nearby regions and on a global scale have enriched the lagoon in many senses but are clearly showing its limitations, too. Overexploitation of natural systems, human individuals and different social groups must be questioned and renegotiated to achieve a just and cosmopolitan social structure through decolonisation and to maintain Venice and the lagoon as an inspiring and attractive territory.



Fig_01
Venice granularity.
Created by Celine Flüg and
Tim Mödeker.



Fig_02
Venice acqua alta.
Created by Celine Flüg and
Tim Mödeker.



Fig_03
Map Venice, Mestre,
Marghera and lagoon towns
Created by Lisa Geuer and
Tim Schönberger

2. Archipelagic thinking

The observation of the entire world mirrored in an interrelated, hybrid territory of mainland and islands related by hybrid dynamics echoes Glissant's statement, cited in the opening quotation. Edouard Glissant, a Caribbean poet and philosopher born in 1928 on the island of Martinique, proposed an "archipelagic thinking" to approach the world as a network of interconnected yet distinct, entities, resembling an archipelago. He describes this thinking as non-systemic, but inductive, fragile, exploring the unpredictability of the world (Glissant [1996] 2005) and contrasts it with "continental thinking" which he refers to systematic and precise – modernist and technocratic – approaches. In his writings, Glissant takes the reader on poetic journeys, performing his proposed way of observing and thinking, circling his main concepts while shifting perspectives and relating them to multiple scales and contexts, avoiding hasty conclusions. Glissant, who died in 2011, is often considered a precursor to current decolonial debates (Wiedorn 2021, Maesschalck 2023). He conceives the world through relational thinking, embracing unpredictability as well as ambiguity, and privileging interconnected multiplicities over unicity. Glissant in his writings describes the steadily tightening interconnected world as becoming more and more "archipelagic". This can be understood as both a critique of

unchecked globalisation and the Western "polycrisis," – comprising climate change, democratic backsliding, an increasing number of armed conflicts and socio-economic transitions due to new technologies – and simultaneously a possible way out: a proposal for new perspectives and linkages, overcoming obsolete hierarchies and structures, and a rediscovery of rhizomatic relations that had fallen into oblivion: a renovated attention to networks, dynamics and actors that have not been represented at the forefront of decision making, that have rather subtly shaped realities from the background. On one side of the coin lies the widely discussed objective fragmentation and detachment of global causal networks and trading chains. On the other side are the less visible subjective, often ephemeral relations to places, people, and cultures, globally scattered and connected communities produced by diverse forms of migration, kept alive through modern communication and mobility. Glissant describes his vision of archipelagic linkages as a sense of belonging to particular places while sensing relations to the world – through personal connections and cultural entrenchments. Complex – Glissant, drawing on his Caribbean background, calls them "creolising" – cultures can be found in the Caribbean but, according to Glissant, increasingly also in other places that due to a globalising world are based on global-personal relations and trans-cultural encounters that evolve beyond multinational business connections. Following archipelagic thinking in these scenarios

The urban-lagoon territory of Venice is a “Laboratory of the Future”: a system that is endangered by climate change due to rising sea levels, water scarcity and diminishing biodiversity affecting all levels of living and at the same time a global example of cultural integration and inventiveness in constant adaptation and transformation.

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means listening to others to amplify one's own spiritual dimensions (Glissant [1996] 2005) and embracing ambiguity and transitions as potentials. Glissant's advocacy for increasing archipelagic thinking stands in radical contrast to what he consequently describes as "continental" thinking, where formal contracts and networks dominate, and where precise categories and definitive conclusions are required.

3. Venice as a Laboratory of the Future

Venice Architecture Biennale 2023 was titled a "Laboratory of the Future" (Venice Biennale 2023), proposing visions tackling two global challenges simultaneously: decarbonization and decolonisation. Following the philosophy of Glissant, archipelagic thinking might offer the exploration of undervalued accesses to the field, empowering global creolisation to uncover networks and agencies that lie in rhizomatic communities and rooted cultural knowledges. Sticking to the concept of shifting, trans-scalar perspectives on global-local challenges, the urban-lagoon territory of Venice is such a "Laboratory of the Future": a system that is endangered by climate change due to rising sea levels, water scarcity and diminishing biodiversity affecting all levels of living and at the same time a global example of cultural integration and inventiveness in constant adaptation and transformation. Venice and the lagoon

are built for a large part on this resilience, that has been developed on many islands and their respective relations.

4. Hybrid Dynamics, Hybrid Territories

These hybrid dynamics in the territorial design master studio "Lagoon" were taken as a resource to create a vision of habitat innovation, based on green economy, a strong sense of community and culture. On a material level, the city and its territory are a culturally built and lived statement. They are a unique and exemplary manifestation of how urban systems benefit from and actively form cultural expression and synergies between their liquid and solid structures. Together with the students of the studio we explored existing and proposed new interpretations and scenarios for the complex and multilayered spaces, extending between the *terraferma* (solid land) and the Lido strip towards the Adriatic Sea. These hybrid territories of land and sea, of nature and culture have been an attractive scenario for shifting activities, constantly transforming and adapting the lagoon, the coastlines and rural-urban constellations. Following this, the students worked on individual projects in specific places, representing the diversity of spatialities and realities of the territory: small islands in the lagoon such as La Certosa, Le Vignole and Torcello, Arsenale and Tronchetto as unique areas of the city and on the main-

land in Marghera.

On the one hand, the complex history—rich in its manifold cultural expressions and famous for renowned masterpieces—is understood as an active asset that has shaped the spatially diverse context of the present lagoon. On the other hand, circularity and circular dynamics—understood in a material as well as an immaterial sense—have been at the core of efforts to invent readings and design pathways for regeneration (Schröder, Cappeller, Diesch, Scaffidi 2023).



Fig_04
Torcello
Photo by Alissa Diesch

5. Transformative Heritage, Archipelagic Futures

Cultural heritage understood as “discursive practice” as claimed by Stuart Hall (1999), a Jamaican-born cultural theorist, focuses on the individual and common relations to specific places, the meanings and interpretations they have – a concept that resonates with Glissant’s archipelagic thinking. These considerations assume that cultural significances are not stable, the revalidation of the discursive meaning is a reciprocal relation between people and places, reflecting and inducing cultural, social and societal change. In this perspective, archipelagic thinking not only becomes a pow-



Fig_05
Torcello
Photo by Alissa Diesch

erful tool to describe spatial and cultural multiplicities—it also activates a proposing and visioning agency that can be framed as “transformative heritage” (Diesch 2024). This concept unleashes opportunities to envision and design new urban and territorial transformations by activating culturally and spatially rooted structures and dynamics. As the relations and meanings of spatial-territorial configurations of multiple scales for the communities that inhabit or relate to them, is part of the heritage itself, the understanding of these interrelations is a precondition to propose further transformation. The agency of these relations, then, can become a powerful lever for introducing new urban or territorial visions: heritage turns into a transformative trigger



Fig_06
Torcello
Photo by Alissa Diesch

for new urban and territorial projects. By linking the discursive understanding of heritage (Hall, 1999) with relational-spatial – archipelagic – logics (Glissant [1996] 2005) urban designers can reimagine the lagoon not as a fixed, protected, historical artefact, but as a living, shifting territory of opportunities, interrelated by multiple spatialities but also temporalities and cultural narratives. This approach enables new perspectives of design for resilience through openness and unpredictability. To understand the city’s and lagoon’s heritage as an active asset, the urban interplay of architectural spaces working as catalysts (Rossi [1966] 2002) with manifold transversal relations and flows becomes an important potential for resilient futures. The places comprehend and represent temporal transversality as polyvalent and shifting, past and present spaces which highlight their promise to be meaningful places in the future city, too - based on their architectural capacity (Wolfrum, Janson 2015). Being part of trans-scalar connections in networks of different scales, their existing horizontal relations (Viganò 2019) hold the potential to maintain these linkages as well as, furthermore, create meaningful relationships for new agendas. Opening up to archipelagic thinking, then, means exploring dynamics and relations that emerge through deeper, careful observation; it calls for unlearning hierarchies and fixed doctrines, and fostering resilience rooted in the fertile ambiguities of land and water, past and future, and the multiplicity

of cultural rhizomes.

Transferring the concept of creolisation to the Venice Lagoon means focusing on the relations between the existing places, communities and significances; revisiting, recognizing and empowering them while at the same time generating openness to new actors and relations, amplifying and strengthening these potentials. This will not follow a precise cause and effect relation, enhancing creolisation calls for trusting the agency of uncertainty and the new spaces of opportunities that emerge from this openness. It is here that urban design becomes archipelagic: by amplifying existing linkages and trusting in emergent ones, we can cultivate futures grounded in relational, creolising dynamics rather than imposed

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Venice

A Vision for Sustainable and Circular Transformation

Federica Scaffidi

1. Introduction: Circularity as a Regenerative Force

The Venice Lagoon is a space of constant negotiation between water and built structures, shaped by centuries of adaptation and transformation. It is a network of urban cores, industrial zones, transit hubs, and scattered settlements, all linked by a fragile equilibrium that is now under strain. Climate change, unsustainable tourism, industrial decline, and rising sea levels threaten the stability of this space, calling for new strategies that embrace regeneration rather than depletion.

A circular approach to transformation offers a way forward, shifting away from extractive models towards a system where waste is minimized, resources are revalued, and interventions restore rather than consume. In the Venice Lagoon, this means rethinking the flows of materials, reimagining abandoned spaces, and developing new forms of coexistence between the built and the aquatic. This is not simply a matter of technical solutions but a fundamental reorganization of how spaces are used, valued, and connected.

The Venice Lagoon represents a unique and dynamic interplay between urban structures, water ecosystems, and cultural heritage. However, it faces growing environmental and socio-economic challenges, including rising sea levels, biodiversity loss, and tourism-driven pressures. The concept

The Venice Lagoon, defined by its territorial complexity and delicate balance, reveals three key spatial categories driving circular transformation: spaces of intellectual exchange, collective and touristic gathering points, and environments shaped by natural forces and resilience strategies —making it a model in the discourse on sustainable and innovative territorial development.

of circular regeneration offers a pathway toward revitalising the lagoon by embracing sustainability, resource efficiency, and innovative urban design (Murray et Al., 2017; Scaffidi, 2022; 2024; Schröder et Al. 2023). Circular regeneration in the Venice Lagoon is not merely about material recycling but also includes cultural, social, and economic revitalisation. This approach involves the creative regeneration of spaces, innovative governance models, and strategies to enhance climate resilience while promoting a green economy (Ratti, R., 1989; Moulaert et Al., 2005). By integrating historical knowledge with contemporary sustainability principles, the lagoon can transform into a laboratory for regenerative urbanism.

2. Understanding the Lagoon's Complex Territorial System and its Embedded Circular Potential

Venice and its lagoon form an intricate territorial system that extends beyond the historic city to include Mestre, Marghera, Chioggia, the Lido, and other islands. This hybrid territory comprises various landscapes, from urbanised centres to protected natural areas. The lagoon's ecological and spatial diversity presents both opportunities and challenges for circular regeneration (Scaffidi, 2022; 2023).

In this broader context, it is essential to acknowledge the city's ongoing cultural and intellectual vitality, which reinforces

its capacity to lead such transformations. To this day, Venice remains a vital center of cultural production, design experimentation, and conceptual innovation. It continues to be a place of transformation, of idea generation, of Intelligens—natural, artificial, and collective—as highlighted by the 19th International Architecture Exhibition of Venice, titled “Intelligens. Natural. Artificial. Collective” (Venice Biennale, 2025). This recognition underlines Venice's capacity to host and generate plural forms of intelligence that operate in synergy to address contemporary challenges through regenerative processes.

Building on this cultural richness, the spatial and ecological complexity of the lagoon further enhances its potential as a site for experimentation in sustainable urbanism (Böhme, 2005; Jullien, 2016; Barata et Al., 2017). The Venice Lagoon, with its territorial complexity and fragile balance between natural and human-made elements, presents itself as an open-air laboratory for sustainable transformation. It is an urban-environmental ecosystem that demands a circular and regenerative approach to confront today's threats—climate change, erosion, depopulation, and tourist pressure—and to envision a resilient and equitable future.

This positions Venice not only as a heritage city (Fig. 01) but also as an urban prototype for testing new forms of circular and inclusive development. Venice can therefore be interpreted as a laboratory city for eco-

logical transition, where the interweaving of cultural heritage, environmental challenges, and human capital creates an ideal space for experimenting with models of sustainable and circular development. This model goes beyond waste management or material recycling, requiring a systemic rethinking of how spaces are used, how material and knowledge flow, and how social and economic relations are structured (Schröder et Al. 2023). In this context, three categories of spaces emerge that currently function as active nodes of circular transformation. These nodes can be grouped into three interconnected categories, each

contributing in specific ways to the larger vision of regenerative urbanism. In Venice, sustainable regeneration manifests in multiple forms, beginning with spaces of intellectual exchange, which represent the cognitive core of this transformative process. In these places, knowledge is produced, new languages are tested, interdisciplinary networks are woven, and innovation is nurtured. Exhibitions and Fuori Biennale events, for example, blend art, architecture, technology, and sustainability, generating alternative narratives about the city's future. University buildings act as active hubs of research and educa-



Fig_01
Venice Urban Heritage.
Photo credit: Helen Schrettenbrunner; Nel Alexander Dau.



Fig_02
Venice. Spaces of collectivity.
Photo credit: Helen Schrettenbrunner; Nel Alexander Dau.

forms of craftsmanship (Fig. 03) and graffiti scattered among Venice's buildings speak of collective identity and support local economies within a framework of proximity and cultural regeneration (Jullien, 2016). To regenerate these spaces means to activate tangible forms of participation and collective care—capable of connecting residents and visitors, memory and future, aesthetics and function. Beyond the cultural and social layers, the ecological forces shaping the lagoon demand equal attention in any circular transformation strategy.

Finally, spaces that embody natural forces and resilience strategies reveal the ecological soul of the Venice Lagoon, making it a paradigmatic case in the discourse on sustainable development. Here, regeneration necessarily involves the recognition and valorisation of environmental elements that shape urban life on a daily basis. Tides and floods—known as *Acqua Alta*—are not merely critical events, but vital cycles that call for adaptive strategies rather than emergency responses. Phenomena such as salinity, erosion, and the traditional construction on piles speak of a historical intelligence capable of coexisting with instability (Fig. 04). Elevated walkways and flood barriers, such as the MOSE project, are infrastructures of protection that should be seen not merely as passive defences, but as integrated, resilient components within a dynamic urban ecosystem. These spaces and devices thus become true bridges between past and future, between

Venice



shops are also a big problem for us venetians. Unfortunately they close down; shops go out of business one by one and they convert into souvenirs shops for tourists. And our lives become harder and harder.

It's been there three times now, and would happily go back. It's exclusive, crowded, and more than a bit of a tourist trap, but if you're looking for a little urban-ghost town as a souvenir, but there's nowhere quite like Venice for a number of reasons.

If you've already been, maybe not go again. If you've not been, it is legitimately beautiful. If you have to see it, try to give it so much you want to return, research how to do sustainable tourism there. Avoid Venice during peak season. And whatever you do, don't take a cruise ship in or out of the city as they are doing the greatest damage at the moment.

engineering technologies and ecological approaches, and must be interpreted within a systemic vision of resilience that unites landscape with infrastructure, and technical solutions with innovative governance (Scaffidi, 2022). It is precisely this intersection of natural, cultural, and infrastructural dimensions that creates fertile ground for circular strategies to emerge and take root. This complexity provides a fertile ground for the implementation of circular strategies. The historical adaptability of the lagoon's spaces—whether through fluctuating uses, shifting economic activities, or evolving governance structures—demonstrates that resilience is embedded in its DNA. Recognising these underlying patterns, the transition to a regenerative future must align with this intrinsic adaptability, leveraging existing spatial dynamics and knowledge systems.

Therefore, the transformation of the Venice Lagoon cannot rely on isolated projects but must emerge from a systemic rethinking of how spaces interact, how materials circulate, and how activities evolve over time. Circular regeneration does not impose a single fixed solution but establishes a framework in which adaptive, self-sustaining cycles replace extractive and linear models (Scaffidi, 2023). For example, Marghera, the industrial port of Venice, once symbolised modern progress but now stands as a space of transition. The decline of heavy industry has left behind vast structures, infrastructures, and contaminated zones that demand new roles in a

shifting economy. Rather than viewing this space as obsolete, circular transformation seeks to integrate it into a system where production, research, and sustainable industries replace outdated models. Rather than resisting change, the Venice Lagoon can become a space where transformation is embraced as an ongoing process, one that values continuity as much as innovation. By embedding circular principles into the way spaces are used, adapted, and connected, the lagoon can offer a model not just for its own survival but for the future of water-based urbanism worldwide. Ultimately, the convergence of these forces—intellectual, social, and ecological—allows Venice to position itself as a living model of circular urban transformation.

In this interweaving of knowledge, practices, and territories, Venice positions itself as a tangible model of circular transformation, where every place can contribute to the construction of a sustainable future.

3. Conclusion: Towards a Regenerative Future

The Venice Lagoon stands as both a warning and a promise. Its layered spatialities, rich cultural heritage, and ecological complexity present an urgent call for action, but also a fertile ground for pioneering transformative approaches. Through circular regeneration, the lagoon can transcend

reactive measures and become a proactive model of sustainable urbanism—one that is rooted in local specificity yet globally relevant.

The projects and visions developed within this research and design framework demonstrate how heritage, ecology, and innovation can intersect to build adaptive, inclusive, and resilient futures. By embracing hybridity, temporality, and material-cultural synergies, the Venice Lagoon emerges not only as a fragile environment in need of protection, but as an active laboratory for regenerative design.

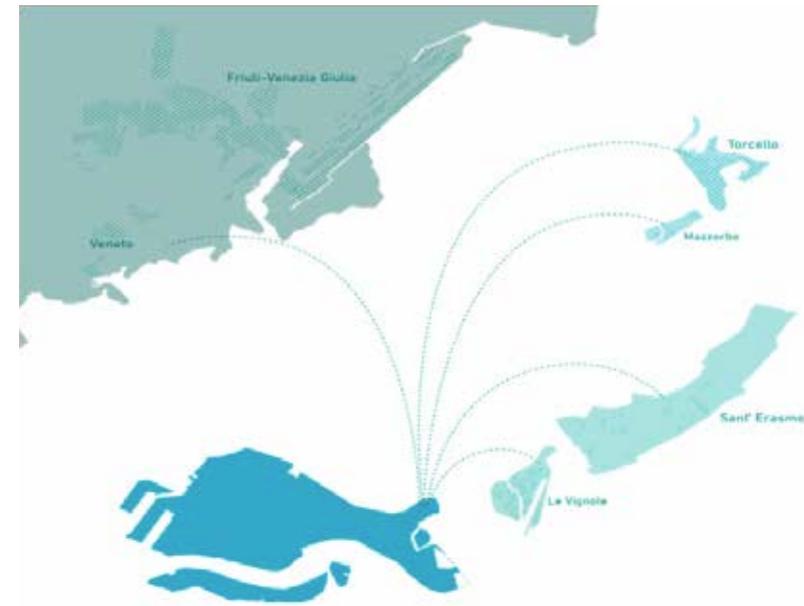
As the waters rise and landscapes shift, it is this spirit of transformation—grounded in circularity and guided by collective agency—that will determine whether the lagoon remains a symbol of resilience and renewal for generations to come.

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Fig_05
Venice. Spaces of collectivity.
Credits: Zuzanna Cattau, Ala
Hallasy and Jing Kong .

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Venice as stage and medium for ideas of circularity

Exploring filmmaking as form of urban knowledge creation

Riccarda Cappeller

Venice - city on the water,
trading city, tourist city,
sinking city,
restored, reused, rewritten,
rebuilt, renovated,
reimagined, revived.
A city scenery, an archipelago,
a miraculous illusion
sometimes...a dream?

Looking at Venice as an architect, still allows to see infinite possibilities of imagination.

This is not only about the main characters of the city – the generous palazzi, the labyrinth of bridges and canals, the secret gardens or unexpectedly appearing ‘Campi’ within the built fabric. It is to a large extent about the lagoon city itself, the realized impossibility to build and live on water, and the people adapting their Everyday life to the tides and changing conditions of the environment, people’s migration dynamics and ways of living. Furthermore, it is about the confrontation and surreal coexistence of historic ideals and today’s technological progress, thinking of images where two-story, red brick-build houses meet a swimming skyscraper in form of a cruise ship, or recalling ‘M.O.S.E’, the storm surge barrier that reminds of the biblical figure. The walls of the cities tell stories of an ongoing reuse and reactivation of old buildings and materials; thinking of the poetic details of dealing with water in ‘Fondazione Querini Stampalia’, where Carlo Scarpa transformed an old palazzo into a public library. Or, as other examples, the ‘Scuola grande di San Mar-

entrance to a hospital and the 'Arsenale', an old shipyard that today functions as huge exhibition hall and public platform inviting artists, architects and visitors from all over the world to bi-annual discourses and deepened debates.

Where, if not in Venice do past, present and future come together in many ways. And where, if not here can aspiring architects and urban designers best experiment, grasping the existing surrounding, reflect upon it and open up new perspectives. Perspectives that look at the existing and develop new ideas out of it, while connecting to the urban context as a real-life situation. Perspectives, that initiate a thinking process and aim to contribute to our understanding of the discipline and to our positioning as architects and urban designers within. Perspectives that enter an invisible dimension, a feeling for space, highlighting experiences, urban capacities, aesthetic collections, fictional worlds and 'what if-imaginaries' that lay within the floating walls and living spaces of Venice. And overall, perspectives that connect to grasping ideas of circularity that can lie in as many aspects as the field of architectural and urban design

Perspectives to understand the architectural and urban design practice as process

and the knowledge creation within reaches. Gaining these perspectives connects to understanding the architectural and urban design practice as process, which according to Rendell 'doesn't occur only through the design of buildings but also

through the activity of using, occupying and experiencing and through the mode of writing and imagining used to describe, analyze and interrogate them' (Rendell 2011).

Learning Architecture and understanding the complexity of the urban context thus is much more than making maps, models and drawings. It is about observing, questioning, abstracting, setting into relation, discussing, finding languages, thinking of alternatives and conceptualizing – following various modes of production and perception in an open process. It is about grasping and communicating complexities and circular relations, following not only product chains but particularly looking at cycles of activation, lifespans of our material resources and the dynamics of social life that change the built environment again and again. Furthermore, the design practice itself is circular – translating thoughts, observations and ideas into material and immaterial, visual outputs. Training becoming architects and urban designers in these aspects, I am convinced, lives of the exchange with other disciplines, the dealing with different approaches that manage to open up the common and already at early stages profoundly incorporated design processes. As Deamer states, 'Architectural efficacy depends on specific knowledge found outside of architecture' (2023, p. 61). She argues that 'non-studio material must infiltrate the studio and live up to the responsibility that [a] rehearsal of real-world

to expand the boundaries of the discipline and reach out to different ways of thinking and making. Filmmaking and the capacity of deeply analyzing urban space through the moving image thus is one possibility to do so. The material gathered while exploring and documenting spatial situations, engaging with them in a practical way, invites for reflection and to be experimented with in multiple ways, each time allowing to change the message or experience that can be gained.

When approaching Venice, pre-selected spatial situations and narratives would foster ideas of circularity. Some of the initial questions posed in the preparation of the course, were the following:

How can the capacities of spatial situations be grasped and communicated in more open ways? What kind of approaches can support to take a step away from the traditional architectural toolset and allow people to engage with or experience spatial situations differently? How can these approaches and the formats developed from it better initiate discussions, look at, think about and discuss urban space, its design and transformation? And in which way do they contribute to a new understanding of the architectural and urban design discipline?

To set initial points for exploring possible answers, two seminars and international exchange formats, conducted at the chair for territorial design at Leibniz Universität Hannover, used Venice as a stage and medium and approached the city through filmmaking. In both, selected urban spaces and spatial situations became settings of experimentation and media to reflect upon ideas of circularity and convey them to others. Tackling 'ideas of circularity' a theoretical foundation for the filmmaking experiments was the conceptual vision of Circular Design by Schröder (2023, p. 26). Thus, some of the topics addressed were 1. layers of different uses in public space, stressing the liveability and accessibility, 2. the recycling of existing buildings or neglected spaces as resetting them into sustainable cycles, 3. the cultural capacity and atmosphere as a value to maintain or the reimagination and adaption of the urban structure for future uses as a reaction to climate change. These aspects and further topics were grasped through the moving image to reflected upon the practice of designing in Architecture and Urban Design from a broader perspective. In the course 'Scenes' the Campi (Venetian piazza) were explored as urban islands within the built fabric. Here a focus lied upon the existing as important resource and connection points for Circular Design. And, on its value and the necessity to be maintained, but also transformed, in order to react to current challenges and be prepared for a possible future.

In the course 'Circular Design' architectural reference projects from various centuries were the points of call to tackle the topics conversion, social housing, infrastructure and public space. Here the focus in the following, both courses and their different approaches will be shortly introduced to then discuss in which way the working with the moving image in architecture can bring in new perspectives and is able to enrich an urban knowledge creation.

1. Scenes of Italo Calvino's Invisible Cities

With this format, selected Campi in Venice were set as stages, foregrounding spatial situations that represent the idea of public space as open and dynamic endower where people's actions are manifested and confronted with the belief of others. Historically the Campi were not only used by people to come together, but they were centers for trading and exchange of all sorts. Connecting to the Biennale Topic 2021 'How will we live together' introduced by Hashim Sarkis, the idea for the first step of the seminar was to create short films and imagine scenes of Everyday life for the Campi.

As a base for this, the stories 'Invisible Cities' by Italo Calvino (1972) were used in order to work with existing fictions to create narratives of the spaces and reflect on their characteristics and qualitative values. The Campi thus were interpreted as important

places of community in which (new) dynamics were set into practice. In a second step the short films were reworked and developed further, creating visual essays that would integrate the initial departure points, the spaces and Calvino stories, but at the same time reflect on urban space and its capacities through the moving image. The circular dimension here was addressed implicitly, through the reflection on the selected spatial situations and their cha-



Fig_01
Screenshots Student's filmic views 'Finding Valdrada'

With 'Finding Valdrada' Marie Schwarz and Lennart van Hofe used Calvino's mirrored city Valdrada in 'Cities and Eyes 1' (Calvino 1972) to compare scenes from Hannover and Venice in the past and present. They put together architectural impressions from the cities located at the waterfront and in continuous construction and change, vivid moments from people's lives as visitors or local inhabitants circulating through the city and exceptional archive material that introduced unusual happenings and historic events while following Calvino's words. An emphasis here was placed on the process of experiencing space and its atmosphere from a people-cen-



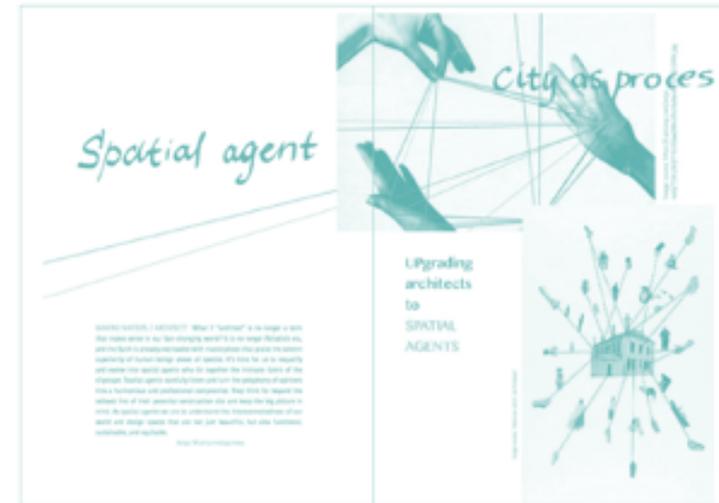
Fig_02
Screenshots Student's filmic
views 'Campo Rialto'

In 'Campo Rialto' Rebekka Wandt and Sophie Kalwa used the Calvino's city Procopia in 'Continuous Cities 3' (Calvino 1972) to explore density as an important urban quality and the dynamics of use throughout a day at Campo Rialto, the central market square in Venice. Working with overlays of sound and image, the by tourists and traders crowded campo was also shown from its other side – as exceptional architectural scenery in the quiet, even a bit mysterious dawn. The exploration was introduced by short reflections and map that schematically showed the density – as more or less crowded spatial situations. An emphasis here was placed on the changing dynamics and the capacity of Campo Rialto reacting to them, while at the same time questioning the today's city's use and the changing city-scape – being overrun by tourists.

2. Circular Design and the Venetians of the future

With this format, the aim was to explore spatial agency linked to circular approaches, fa-

cing global challenges such as climate change, rising sea levels, drying out, migration, tourism, segregation. In order to do this, first an understanding of a contemporary spatial agency needed to be framed, together with a collection of topics related to Circular Design. The review of the current practice of Architecture and Urban Design was realized through short visual and written reflections by the participants, who brought together a range of topics relevant within the today's practice. Together these brief reflections created a visual collection of thoughts related to the topics of the Architecture Biennale 2023, 'Agents of change' and 'The laboratory of the future', introduced by the



Fig_03
One example from the Visual
Collection on Spatial Agency

In a following step, Venice was set as stage to develop ideas how a possible future living in the city could look like. For the short films that would display 'Venetians of the future' a central question was how the creative potential of tensions between material space, social space, perception, movement and action would become visible? As examples, two of the short films created are briefly described.



Fig_04
Screenshots Student's filmic views 'Back to the past'

In 'Back to the past' by Nel Dau and Felix Müller, the tension between a slower pace of a former life in Venice and today's rising sea levels, the frequency of using the water infrastructure and the damage it causes for the city of Venice, is contrasted to rediscovering the qualities of former Venetian ways of use and stress a change of action that re-evaluates the past and the traditional image of Venice to think about the present and how it could be changed in future. An emphasis is placed on the water as infrastructure and character of the city that at the same time is becoming a challenge that has an urge to be addressed.



Fig_05
Screenshots Student's filmic views 'Agents of change'

In 'Agents of change' Helen Schrettenbrunner, Tim Schönberger and Asiya Mukhamedzyanova worked on future scenarios for the Scuola Grande di San Marco, imagining future uses in case of water floods or dried out channels in Venice. Their design-based approach set out a very forward-looking perspective that believes in humans to be able to adapt to transformations and continue to change our living environments. This idea emerged from learning about the history of the place and its transformation throughout centuries. Originally built by a confraternity in 1206, the Scuola with its characteristic facade later burnt down, was redesigned and -built and later used as a military hospital that turned into a civil hospital which is still running today. An emphasis here is placed on the belief in design to be able to deal with the effects of climate change and invent new scenarios and possible spatial adaptations that lead to a different use of the changed urban context.

Currently, the focus of designing is on a re-discovery and reinvention of the existing. Its occupation is moving from the product – the building or space– to the processes, which foregrounds how aspects of urban life and imagination or social and spatial dynamics are interrelated and brought forth. A situated knowledge creation and deep understanding of the territories and spaces to be worked on thus is key for an experimentation with future uses, stressing ideas for circularity.

Having introduced selected aspects from the seminars' contents, now a more general reflection on the two seminars and the filmmaking approach as possible urban learning instrument will follow. Filmmaking opens up the common architectural approaches to spatial situations and fosters a different way of thinking and reading. It allows to intuitively follow a specific way of looking at the world and – in the viewing and editing process – continuously confronts us with the question what is there

When approaching a spatial situation through a camera, we observe differently.

to see and how to bring it to the front. When approaching a spatial situation through a camera, we observe differently. The camera becomes a 'Machine that can observe the performance of an everyday environment' (Penz 2017, p. 220-221). It frames our view as architects-filmmakers and makes us select parts of what we see. As De Jong, Knudsen and Rothwell argue that 'reality doesn't present itself in a suitable order or structure' (2014, p. 19). Instead, it is about collecting fragments and later search ways to put them together. We then 'create a narrative to analyse and represent realities' (Ibid.). This stresses the way in which we make sense of the recorded material. Filmmaking, equally as 'doing architecture', meaning the process of designing, has various stages of perception, reflexive thought and creation that bring attention to hidden aspects. They work with experiences and initiate dialectic thought processes trying out alternatives and systems of ordering over and over again.

Currently, the focus of designing is on a rediscovery and reinvention of the existing. Its occupation is moving from the product – the building or space – to the processes, which foregrounds how aspects of urban life and imagination or social and spatial dynamics are interrelated and brought forth. A situated knowledge creation and deep understanding of the territories and spaces to be worked on thus is key for an experimentation with future uses, stressing ideas for circularity. Regarding an urban knowledge creation in architecture and urban design, filmmaking is able to bring in a sort of experimentation. It helps to open up established rhythms of work, introduces approaches and tools to work with, changes perspectives becoming different observers and adds the dimension of time and movement more consciously to our thought. The creation of experiences in the moving image causes emotions and allows people to enter urban contexts, grasping an atmosphere, which – as I would argue – is a fundamentally important aspect for re-thinking, reimagining and developing ideas of living for architecture. Circular Design within such settings of experimentation is a fundamental principle that needs to be addressed and interpreted in order to come to a better understanding of the aspects contained and ways of dealing with them in a future-oriented way. One, that continues to see existing urban space and its possibilities of transformation as key to imagining how we will live together and work with the city as a laboratory kind of setting.

The creation of experiences in the moving image causes emotions

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Collective eco-innovation

Designers and citizen communities promoting ecological change through informal practices

André Araújo Almeida, Carmelo Leonardi, Maria Manfroni, C. Mattia Priola

1. Community centered approaches

Current social and environmental transformations have driven researchers and designers to face global challenges, interdisciplinary strategies, and collaborative practices. Such bottom-up or horizontal territorial experiences (Santos, 2005) bring collective meanings, favouring organic approach and integration of design to daily life and to the existing order in local territories (Almeida, Alvim, 2024). Adopting participatory methodologies, in which designers can collaborate with communities (Manzini, 2018) and activate collective experimentation practices, may involve updated knowledge and skills to generate new ways of acting (Meroni, Selloni, 2022). In this context, we face the development of new practices in which designers often adopt open approaches (Eco, 1997).

Cooperative actions promoted by different groups of people, citizens together with designers, can bring impactful changes through community-centred approaches, including activism, collective learning, shared design strategies, DIY self-production models, organic practices, and development of low environmental impact solutions, and even self-managed spatial planning. In recent years, a growing interest has emerged in the concept of 'social sustainability' and related aspects. Although a complex conceptual field, sustainable development is seen as socially imperative,

requiring informed, theoretically sound, and pragmatic solutions (Chick, 2012). Social innovations are seen as enhancing society's capacity to act (Murray, Caulier-Grice & Mulgan, 2010) by actively involving affected individuals and empowering them in decision-making. The process of social interactions between individuals, addressing certain social needs, involves several actors and stakeholders who have an interest in solving the problem and empowering the beneficiaries in developing new solutions. Place-connected communities (Manzini, Thorpe, 2018) are characterised by resilience and provide great potential for design and collaboration to benefit community development and attachment. In the field of design, we are moving towards designing for and with local communities, for territories and contexts in which we live and operate (Fagnoni, 2018; 2022), through a holistic, strategic, and systemic approach to address the complexity of contemporary problems.

In this perspective, the community-centred approach (Villari, 2021) refers to those initiatives in which designers involve communities, considered as main users and project actors, for the activation of knowledge, the use of local resources, and the creation of value for the community.

Such projects seem to adopt the 'collaborative commons' perspective prefigured already 10 years ago by Rifkin (2014), where shared resources are collectively managed for the common good. Experimental urban and energy models, interpreted as incu-

bators of innovation policies for transition, provide fertile ground for developing new sustainable policies and practices (Crippa et al., 2024).

2. Framing communities and collaborative design concepts and practices

The increasing dialogue between designers and citizens in recent years has facilitated the emergence of Creative Communities (Meroni, 2007) and citizen movements capable of implementing alternative sustainable solutions. These communities are described as groups that autonomously, and often informally, develop innovative strategies to enhance their daily lives, typically in response to unsatisfied social needs. They arise from bottom-up initiatives, characterised by the sharing of resources, knowledge, and local practices, thereby promoting social innovation through self-organisation and collaboration. In this context, design serves to support and facilitate these initiatives without necessarily leading them. Conversely, Changing Communities (Gonzaga et al., 2023) extend beyond creative self-organisation, emphasising active transformation through structured co-creation processes. In this framework, community members not only devise solutions to meet their needs but also engage actively in a broader, institutionalised design process that involves designers, stakeholders, and

researchers. These communities evolve through continuous interaction with design, interaction with design, not only supporting but also guiding social and cultural transformation in response to global challenges such as climate change.

Also the concept of Circular Communities (Leclercq, Smit, 2023) has recently emerged, highlighting collaboration among residents, businesses, and governmental agencies. These collaborative initiatives contribute to the creation of multiple values—economic, social, ecological, cultural, and aesthetic—and underscore the necessity for a systemic approach to resource management. The “Circular Value Flower” method is employed to assess various aspects of these circular initiatives and to guide the development of sustainable neighbourhoods (Leclercq, Smit, 2023).

Additionally, the concept of Eco-communities (Cattaneo, 2014) has been articulated as intentional communities designed to promote sustainable living and ecological principles. These communities seek to foster sustainable lifestyles through resource sharing, cooperative labor, and reduced consumption, with a focus on achieving well-being through ecological balance and community cooperation.

Framing communities within collaborative design proposals reveals a rich landscape of interaction and engagement. Traditional communities thrive by fostering local collaboration, building strong relationships through direct connections. Developing these approaches, we can cultivate resilient

and inclusive structures that address contemporary challenges and improve social cohesion.

3. Methodology

This study focuses on the opportunities offered by adopting a cooperative approach to design, exploring the role that designers and citizens can play in promoting this approach and developing new solutions. This paper discusses the current request for active citizenship in order to contribute to the development of eco-communities, capable of positively dealing with contemporary challenges. In this context, an important question arises: what innovative contribution may citizens bring from local knowledge to sustainable development? It is already known how local activism, usually strong in a DIY do-it-yourself community, can bring answers to complex problems with simple and low-cost solutions (Roversi, et. al., 2021). From these concerns, this paper aims to bring experiences of civic engagement that promote innovation from bottom-up creative experiments conducted by local citizens within informal practices of participatory design and community planning. It is expected to see how their territorial knowledge and local identity may empower circular communities through the activation of local dynamics that contribute to technological/sustainable cultural transition.

In order to achieve these objectives, a short case study method is adopted based on the analysis of experimental pathways initiated in the last decade.

Through a qualitative investigation and the analysis of significant cases, we aim to highlight the potential impacts that interdisciplinary collaboration between designers and citizens could have in the field of eco-innovation. Remote observation was applied to external projects, while direct observations were conducted in cases already included within the authors' research activities, enabling a deeper contextual understanding. There were also conducted semi-structured interviews with local citizens in the role of community leadership within the case of self-spatial planning. Worldwide significant projects led by local communities will be analysed in a collaborative environment formed by a network of supporters of local institutions, experts, designers and public agents, bringing a system of knowledge oriented towards the development of sustainability solutions. The criteria adopted for the selection of the case studies are: 1) semantic adherence, realities that carry out research activities and favour the dissemination of practices for the involvement of local communities; 2) time frame, realities operating between 2010 and 2025; 3) project approach, realities that adopt democratic design, production models and community planning, involving citizens and local realities through DIY practices; 4) field of application, cases which promote integration between diffe-

rent knowledge systems for the development of ecological solutions, related to four fields: social innovation, bio-design, low environmental impact and self-managed spatial planning.

In particular, community-centred cases and projects are examined (tab. 1).

bio-communities	low-impact communities	social communities	self-planning communities
<p>DIYbiosphere.org, online A global platform for DIY biology offering resources like tutorials, guides, forums, and tools to democratize science and biotechnology.</p> <p>Dutch DIY Bio Group, Amsterdam A community for biology and designers, providing workshops, materials, and a collaborative environment for biotechnological innovation.</p> <p>Openpace Biolab, New York A community lab offering STEAM education, cultural events, and support for researchers and entrepreneurs.</p>	<p>Schoonschip, Amsterdam A sustainable floating neighbourhood utilizing solar energy and efficient water management. Developed by citizens, it promotes energy self-sufficiency and ecological living.</p> <p>Mediamatic, Amsterdam A cultural center with an urban aquaponics project combining plant cultivation and fish farming. It fosters sustainability, recycling, and environmental education through DIY workshops.</p>	<p>Kiosk of Reciprocity A mobile platform promoting discussions about the solidarity economy and collaborative matters. It aims to connect citizens and experts, fostering dialogue to activate a proximity economy in Milan's socio-cultural spaces.</p> <p>Fabrique de Quartier A modular device that involves residents in their neighbourhood using visual tools to gather ideas. It creates a space for exchange and aims to engage the community in public space planning.</p>	<p>Popular Plan to Gato do Parto Neighbourhood An urban planning process conducted by residents in cooperation with local designers and planners, sponsored by the Brazilian Chamber of Architects in Fortaleza, Ceará, in a shared learning environment oriented to local sustainable development and political empowerment to deal with urban struggles and disputes over a maritime territory.</p>

Tab_01.
Different forms
of eco-communities

3.1 Bio-communities

To address the complex challenges of sustainability and the production of sustainable materials, designers investigate biological processes of nature, involving living organisms in the design process (Priola, 2024). Alternative practices, such as Biodesign (Myers, Antonelli, 2012), which combines design and biology (Oxman, 2016) and encourages the use of collaborative biotechnological processes (Priola, Manfroni, 2024) for the development of ecologically compatible products (Fagnoni, Manfroni, Priola, 2024), are rapidly spreading alternative practices. The result is a matured degree of collaborative practices that foster the dissemination and promotion of both individual and collective self-production models (Rognoli, 2015). In this sense, DIYbio communities, such as DIYbiosphere.org is a platform that promotes DIY biology and accessible scientific innovation through the sharing of biological resources and knowledge. It is a community composed of a global network of biology enthusiasts, scientists, designers, students, and citizens who work together to explore new frontiers in biotechnology. The platform offers tutorials, practical guides, discussion forums, and access to materials and tools necessary to start biological experiments in small independent laboratories. The main goal is to democratize access to science and biological technology, making it available and accessible. The Dutch DIY Bio Group in Amsterdam (fig. 1), It is a community of biology enthusiasts



Fig_01
Dutch DIY Bio Group
meetup.com/dutch-diy-bio/

and designers who come together to explore and innovate in the field of biotechnology through practical experiments and collaborative projects with the aim of democratizing access to scientific knowledge. The group organizes discussion workshops where members can learn from each other and work on projects that push the boundaries of DIY biology. They also offer access to a variety of materials and equipment, allowing members to conduct experiments and develop new biotechnological solutions in a supportive and collaborative environment. The Genspace Biolab in New York (fig. 2) is a community biology lab that provides hands-on STEAM education programs for youth and adults, cultural and public outreach events, and a membership program to support New York's community of creative researchers and entrepreneurs. These community realities offer spaces for

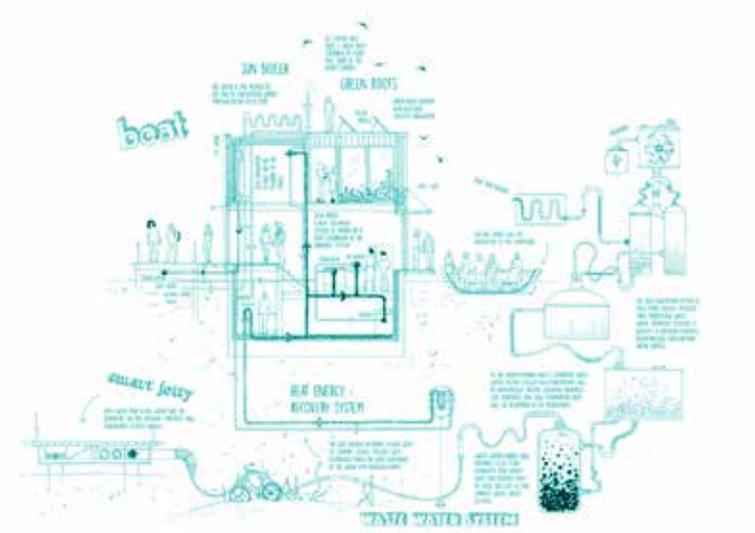
collaboration between experts, designers and citizens, supported by approaches that favour the development of projects and experiments through the use of biomaterials.



Fig_02
Genspace Biolab
genspace.org/

3.2 Low-impact communities

In the energy transition, low-impact communities have emerged, where collective well-being replaces individual interests. Schoonschip (fig. 3), a floating neighbourhood on Amsterdam's Johan van Hasselt canal, is a prime example. Developed between 2010 and 2021 by a citizens' association, it's recognized as Europe's most sustainable neighbourhood. Its eco-friendly homes use local energy, efficient water management, solar



Fig_03
Schoonschip
schoonschipamsterdam.org/

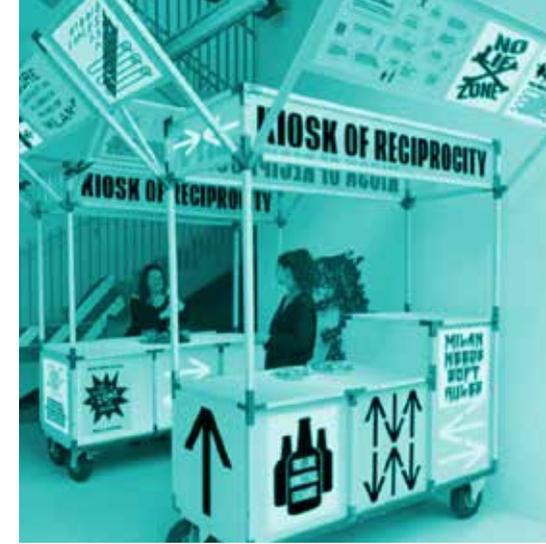
panels, and heat pumps, promoting energy self-sufficiency (Leonardi et al., 2023). Schoonschip emphasises collaboration and sustainable living integrated with nature. Urban communities also face food supply challenges. Mediamatic, a cultural centre in Amsterdam, explores urban cultivation through aquaponic systems, combining plant growing and fish farming. Its Miniponics project (fig. 4) introduces aquaponics in homes and schools, using recycled materials. Workshops teach participants about water conservation, waste reduction, and ecosystem care.



Fig_04
Miniponics
mediamatic.net/en/page/46742/miniponics

3.3 Social communities

The active involvement of citizens forms the core of The Kiosk of Reciprocity (fig. 5). Acting as a mobile platform between various socio-cultural hybrid spaces, it promotes exchange and dialogue on the solidarity economy and collaborative welfare. The goal is to encourage conversations between citizens and experts to activate a proximity economy in Milan's hybrid socio-cultural spaces and neighbourhoods. At the Salone del Mobile 2024, the kiosk was part of Stecca3's Crafting Dialogues, a programme featuring public discussions,



Fig_05
The Kiosk for Reciprocity
temporioso.org/

design exhibitions, and installations focused on the intersection of design, knowledge, and ecological transition. Similarly, the Fabrique de Quartier (fig. 6) is a participatory tool that invites neighbourhood inhabitants to rethink their daily lives through visual and graphic tools. This installation is an urban workbench that encourages DIY actions to address local challenges. It offers citizens a platform to share ideas that could form the basis for future projects, while actively transforming their everyday spaces.





Fig_06
Fabrique de Quartier
plateforme-socialdesign.net/

3.4 Self-planning communities

Social protagonism is a relevant topic also to spatial planning issues, bringing important findings to design innovation regarding technical method and limits, as well as the role of designers as community partners in a collective, complex and multidisciplinary context. Even though there are several and diverse cases of participatory spatial planning to be explored worldwide, significant experiences in Latin America reveal tendencies of active citizenship outperforming institutionalised participation processes. Social participation often results in invited action spaces, while self-managed processes have high potential to generate invented action spaces (Miraftab, 2016, p. 368). Parti-

cipatory processes are widespread marked by governmental limits and contradictions, while self-planning community processes, as other commoning practices, inspire new contributions to creatively change local governance through informal practices (Maricato, 2014; Boeri et al., 2020).

Public management oriented to a market-business format represents a disconnection from the core role of the state, as a mediator agent between different interests and guarantor of civil rights and sustainable development, especially to those communities that do not enjoy the city as an economic entity, but as a living environment. Tendencies of contemporary urban planning based on a market-oriented format are leading Latin American cities to a “predatory urbanism” (Maricato, 2014) that forces local territories into deepening socioeconomic inequalities and promoting unsustainable ways of living. This situation is forcing reactions from local groups towards self-competence improvements to promote community autonomy in self-managed spatial planning. One of the most recent cases in Brazil is happening in the Cais do Porto neighbourhood, in the Northeastern city of Fortaleza (Ceará State): a community resistance against constant state efforts to develop urban projects that promote forced removal of local residents. This case was chosen not to develop an exhaustive analysis, considering that there are many different conditions and other situations in the continent, but to show a representative example of local interaction between residents, academics, designers

and other stakeholders in a co-planning reactive experience. Titanzinho community is organised in local resident commissions and neighbourhood associations (fig. 7, fig. 8), supported by a network of local partners dealing with right to the city issues. They conducted a spatial planning process from 2021 to 2022 resulting, at the beginning of 2023, in the Plano Popular (Titan; Titanzinho, 2022) to Cais do Porto ZEIS, a Special Zoning for Social Interest, a regulatory legal instrument defined in the City Plan. A substantial part of this work was sponsored by Ceará State Chamber of Architects (CAU) with earmarked funds for technical assistance. The Plan includes six strategic axes hereinafter: 1) housing; 2) environment and infrastructure; 3) open spaces and public facilities; 4) socioeconomic conditions and eco-solidarity economy; 5) cultural development; and 6) community development. The methodology and the whole approach were developed in an integrated and propositional format, embracing territorial diagnosis, data analysis, and collective proposals for urban interventions and local services implementation, everything built in an inclusive and community-led planning process involving residents and partners. Regarding institutional planning processes, this self-planning format brings several advantages. Considering the previous discussion about “predatory urbanism” and the human dimension of sustainability, the main important gain is local empowerment; understood as the self-insertion of residents



Fig_07
Titanzinho Community landscape (July 2024)
André Araújo Almeida archives



Fig_08
Participants in local commissions and neighbourhood associations
Source: Titan, Titanzinho, 2022, p. 104 [free translation: “Titan (community) is not on sale”];

as leading actors, undertaking protagonism in the urban planning processes instead of the current consultancy role without deliberation powers. A popular plan is a positive tool due to its potential to reinforce and/or consolidate local instances. Such a plan becomes also a political instrument, able to face unsustainable urbanisation models and landscape erasure threats that may lead to community removal top-down decisions from public projects acting over this territory. The sustainable proposals presented in the Popular Plan refer to the human dimension of sustainable development, specially regarding the development of local people facing socio economic challenges such as inequalities and poverty, social inclusion and city and civic rights. It is also remarkable, due to the territorial connection of local residents, how they are able to promote ecological changes in their own cities through eco-innovation proposals in a Popular Plan. In the case of Titanzinho Popular Plan, it is also significant the presence of eco-innovative proposals, related to low-cost initiatives, low-tech and low-complexity design that may be developed by the own community with their own resources (or partner's), to face environmental threats of urban density and lack of urban infrastructure that are not target of public investment over the years. It happens in parallel to eco-solidarity economic proposals, where intelligent and responsible forms of using local resources promote socio-economic progress and overall well-being. We may affirm, from this case, that the local approach of a self-plan-

ning community allows it to overcome public-institutional plan constraints beyond the technical-political-economic triad, incorporating local conditioning, such as environmental, cultural, and social dimensions, pertinent issues to the sustainability of local territories.

4. Design focus, the value of relations

This section presents a comparative qualitative analysis of different mapped case studies, with the aim of highlighting the value of design and urban planning in addressing complex socio-environmental challenges. This approach explores specific parameters to analyse how collaborative design practices promote citizen interaction, awareness and participation in heterogeneous community contexts, offering a detailed view of the impact created by such projects (tab. 2, tab. 3, tab. 4, tab. 5).

Analysing the values generated by these initiatives means exploring not only tangible outcomes, such as developed products or services, but also the transformative effect that design and planning can have on the communities involved. In particular, social innovation projects stand out for their ability to generate profound impacts, improving collective well-being, promoting self-sufficiency and fostering cultural change; but it is often a challenge to try to measure this. The qualitative approach adopted in this analysis,

therefore, allows us to observe how design contributes to building social networks and stimulating participatory practices, both through access to scientific knowledge and support for participants' autonomy. The impact of these initiatives, often aimed at democratizing science, collaborative resource management and building ecological scenarios for the city, highlights the role of design and planning as an engine of innovation and social change. By studying the scale of interventions, stakeholder engagement and collaborative design practices, this analysis aims to understand how design and urban planning are able to produce not only concrete results but also indirect benefits for communities, supporting a transition towards more responsible and inclusive living models.

The qualitative analysis here applied is structured around five main parameters:

- Intervention Scale
Examining the local, regional, and international scopes of the initiatives;
- Stakeholders
Identifying the composition and collaboration of community members involved;
- Design Practices
Analysing the collaborative approaches and contributions of design;
- Output
Evaluating the developed projects and services;
- Impacts
Measuring the direct and indirect benefits of these initiatives.

The analysis results reveal a complex landscape, characterised by a multitude of initiatives that vary according to context. Biocommunities operate to promote interdisciplinary practices for sharing biological knowledge and democratizing access to biological sciences in independent laboratories and for the diffusion of do-it-yourself practices that support self-production. Social communities promote participatory visual and graphic tools to facilitate the sharing of ideas and urban transformation, DIY actions, dialogue, co-creation and encourage engagement in the proximity economy. Their actions strengthen communities, promote the adoption of green practices and stimulate active citizen participation in urban transformation.

The analysis of low-impact communities highlights the importance of participatory and collaborative design in promoting sustainability and social cohesion. Through the integration of ecological technologies, the utilization of local knowledge, and circular models, design supports resilient and self-sufficient communities capable of addressing global challenges. These projects serve as sustainable prototypes for future urbanization, inspiring environmentally and socially inclusive policies.

The main contributions of the studied self-planning community to this work are regarded the independent approach from institutional public instances, a key element that brought new possibilities to local awareness and residents' responses to urban challenges. It was seen emerging new capabilities

through self-governance and shared learning in local networks as well as impulses to creativity and innovation in planning proposals for urban interventions and services, as suggested by Krätke (2011). It may be underlined that local knowledge was put in action when this community was stressed by unsustainable and undemocratic urban project; leading residents to civic engagement in resistance social movements. The social empowerment feeling historically existing in this territory was potentialized by partnership between residents and academic and local non-profit organisations that catalysed community competences in urban planning conduction; an strategic issue to stimulate creativity and to bring innovative proposals to urban plans in vulnerable territories. Low-impact and bio-communities demonstrate that integrating ecological technologies and circular models can lead to self-sufficient systems that inspire environmentally responsible behavior. These models can serve as scalable prototypes for future urbanization, encouraging policies that support environmental stewardship and social inclusivity.

Bio-communities and related DIY initiatives highlight the importance of interdisciplinary practices that democratize access to science and technology. Sharing resources and fostering a collaborative atmosphere allows for grassroots innovation, supporting wider adoption of sustainable practices and empowering individuals to engage with complex problems. Self-planning communities show that in-

dependence from institutional bodies can foster creative and resilient responses to urban challenges. Through partnerships with academics and non-profits, these communities have strengthened their capacity for strategic urban planning, facilitating adaptive solutions tailored to local contexts. The integration of design in these communities helps build stronger social bonds by fostering collaboration and collective problem-solving. In social and low-impact communities, this leads to greater resilience and the development of a support system that can better navigate environmental and socio-economic challenges.

bio-communities	Intervention scale	Stakeholders	Design practices	Output	Impacts
DIYbiosphere.org online Dutch DIY Bio Group Amsterdam Genespace Babel New York	Local (research labs, independent labs, public and community spaces) International (online) networks and open-source platforms	Designers, biocientists, biologists, materials engineers, students, citizens	Promotion of collaborative practices and projects through the integration of design and biology Collaboration with scientists and citizens to develop biotechnological initiatives using an interdisciplinary approach Coordination of workshops to create practical guides and tools that facilitate information sharing	Collaborative biological projects focused on biomaterial experimentation Workshops and practical guides to share scientific and technical knowledge Publications documenting experiments and findings through articles, blogs, and forums	Promotion of interdisciplinary practices for sharing biological knowledge Democratization of access to biological science Provision of materials for experiments in independent labs Dissemination of DIY practices supporting self-production
Social communities	Intervention scale	Stakeholders	Design practices	Output	Impacts
The Kiosk of Reciprocity Fabrique de Quartier	Local (neighbourhoods, public and community spaces) Both projects operate at the local level, focusing on communities and socio-cultural hybrid spaces	Citizens, neighbourhood inhabitants, experts of socio-cultural hybrid spaces, local designers, civic organisations	Participatory visual and graphic tools to facilitate idea sharing and urban transformation, DIY actions, dialogue, co-creation and to encourage engagement in proximity economy	Projects generate public discussions, design exhibitions installations, urban workbench facilitating DIY initiatives for sharing ideas and addressing local challenges	Community empowerment, promote the adoption of ecological practices and stimulates the active participation of citizens in urban transformation

Tab_02; 03
 Bio-communities analysis;
 Social communities analysis

Low-impact communities	Intervention scale	Stakeholders	Design practices	Output	Impacts
Schools and Mediatec	Neighbourhood in urban space	Citizens, designers, local governments, environmental groups, civic organisations	Eco-friendly architectural design, renewable energy integration, sustainable water and waste management	Energy-efficient homes, urban agriculture DfF systems, self-sufficient energy infrastructure	Enhanced environmental sustainability, reduced carbon footprint, strengthened community collaboration

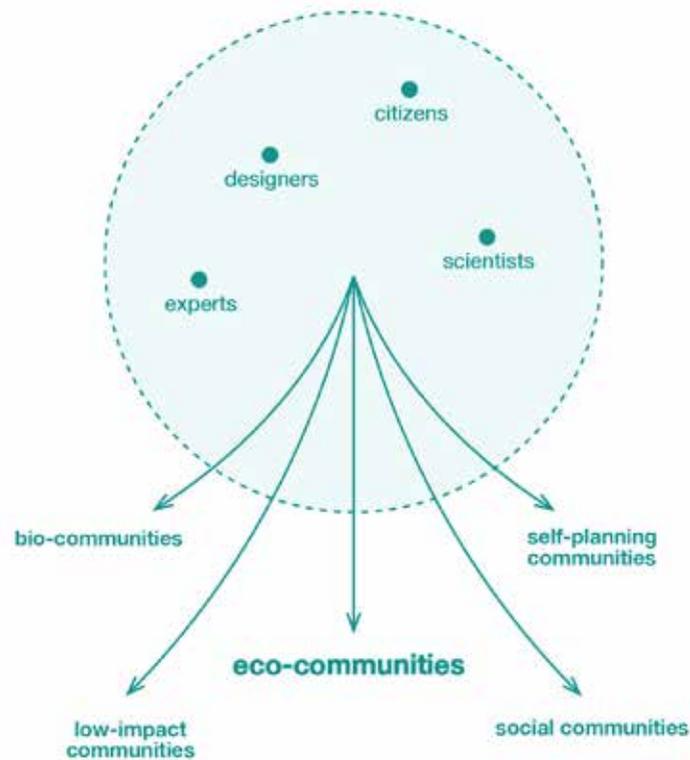
Self-planning communities	Intervention scale	Stakeholders	Design practices	Output	Impacts
Plano Popular de ZSE Cas do Porto	Local role of influence (community public spaces and its surrounding territories)	A Neighbourhood Committee, the association of residents supported by professional council and architects, urbanists, and other professionals and academics acting also in the Third Sector involved with urban issues.	Integrated and proactive approach, embracing territorial proportional diagnosis, data analysis, and collective / participatory design decisions for community urban interventions and local services improvement.	The popular plan itself is the main output of this self-made urban planning process as a technical and political instrument to demand the right for the city principles...	Shared learning between local partners in order to overcome institutional planning constraints beyond the technical / political / economic triad, incorporating local conditioning, such as environmental, cultural, and social dimensions, pertinent issues to the sustainability of local territories. Community empowerment through self-insertion of residents as leading urban actors, undertaking protagonism in local planning processes. Contribution to consolidation of community's territorial management instances.

Tab_04; 05
Low-impact communities analysis;
Self-planning communities analysis

5. Different forms of eco-communities

The observed cases and experimental paths have made it possible to identify the potential positive impacts that interdisciplinary collaboration between different levels of knowledge could generate in the field of design. These practices call for an in-depth reflection not only on the current state of development of current experiences, but also on the possible future results that could be generated by the interaction between designers and local communities. In this perspective, design can be seen as an agent of change (Amatullo, 2022) capable of developing, together with communities (fig. 9) alternative scenarios of more sustainable planning, design, production, and consumption.

The analysis of case studies across bio-communities, social communities, low-impact communities, and self-planning communities underscores the transformative role of design in fostering resilience, sustainability, and social empowerment. Design practices that involve community members directly encourage a sense of active participation. This approach enables communities to harness local knowledge and create tailored solutions to meet their unique needs. In self-planning and social communities, participatory tools stimulate creative thinking and enhance civic engagement, resulting in more democratic and inclusive urban development.



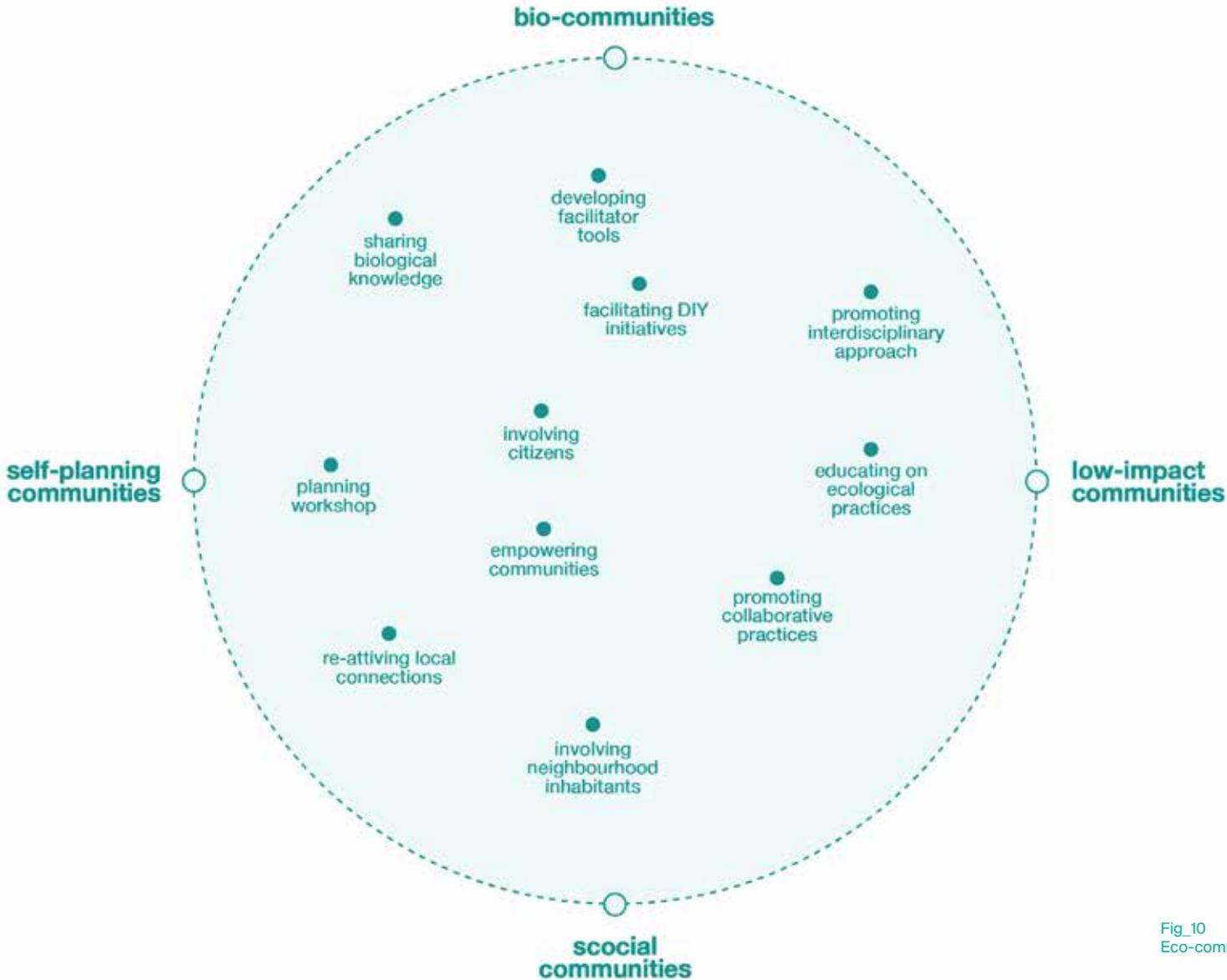
Fig_09
Different forms of
eco-communities

By encouraging collaboration, leveraging local knowledge, and incorporating sustainable practices, design not only responds to immediate community needs but also lays the foundation for long-term resilience and adaptability in the face of global challenges.

A critical issue that emerged during the collection of case studies was the lack of available information, which affected the completeness and depth of the analysis. To address this challenge, it may be necessary to explore additional data sources or implement more effective information-gathering strategies to ensure a more comprehensive and accurate framework.

Despite the realities found, there are still areas and aspects to be explored. The further development of this research hopes to investigate and evaluate how these projects and the action of eco-communities may be able to maintain their value over time (fig. 10). In addition to the lack of clear definitions or frameworks for each identified community type, another critical aspect is the ambiguity surrounding the participants involved. The fact that the individuals engaging in these activities may change over time can significantly impact the consistency and direction of the projects, adding a layer of complexity to their sustainability and effectiveness.

To maximise their impact, it is essential to implement transformational strategies that foster multi-level cooperation and address the challenges related to scalability and long-term sustainability. Future research



Fig_10
Eco-communities impacts

should focus on further exploring the role of design and designers in these processes, with particular attention to identifying and elaborating the disciplinary tools that can effectively support the development and sustainability of DIY community initiatives, thereby enhancing their scalability and durability over time.

Author contribution statement

The contribution is the result of a common reflection of the Authors, who defined the main concept for the research activity.

Moreover, the paragraphs “Community-centred approaches” and “Social communities” are to be attributed to Manfroni M., the paragraphs “Framing communities and collaborative design concepts and practices” and “Bio-communities” to Priola C. M., the paragraphs “Methodology” and “Self-planning communities” to Araújo Almeida A., “Low-impact communities” and “Different forms of eco-communities” to Leonardi C.

The paragraph “Design focus, the value of relations” is to be attributed to all authors.

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Circular Tools and Processes in Architecture and Design

A shared framework

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1. Introduction

1.1 Theoretical introduction

The unregulated exploitation of resources and human interventions have contributed to an anthropogenic climate effect. The IPCC (2014) presents a compelling argument that the rapid increase in global temperatures is a consequence of human activities with profound international implications. These include severe impacts on ecosystems, species, and human populations, along with heightened vulnerability to extreme weather events, floods, vector-borne diseases, and increased demographic displacement. In light of the pressing environmental challenges outlined by the IPCC (2014, 2021, 2022) and the United Nations (2016), as well as the increasing strain on ecosystems, it becomes evident that a shift away from the linear model is crucial for the development of sustainable models in human practices.

Concepts such as “circular economy” — which refers to regenerative systems aimed at minimising waste and making the most of resources — and “eco-design” — the integration of environmental considerations into product design — are key to this study (Geissdoerfer et al., 2017).

According to Scaffidi (2022), society is currently undergoing a transition from a linear economic model, characterised by production, consumption, and waste gene-

ration, to a circular model focused on the reuse of waste, particularly food waste and its byproducts. The transition to circular systems, particularly in the sector of design and architecture, represents a viable solution to the mitigation of human-induced climate impacts. The integration of circular strategies into design and production not only addresses environmental concerns but also promotes long-term socio-economic benefits. A study conducted across seven European countries revealed that transitioning to a circular economy could result in a reduction of greenhouse gas emissions by as much as 70% while simultaneously increasing the workforce by approximately 4% (Stahel, 2016). As such, integrating sustainability principles in design and architecture is essential for reducing environmental impact, as discussed in the document on sustainable design principles (Sustainable Product Design, 2024). Tools such as the Product Environmental Assessment Tool (EPEAT) and Total Carbon Analysis for Architects (Autodesk, 2024) play a crucial role in evaluating and optimising sustainability attributes in design decisions. The literature review emphasises the critical role of sustainability assessment tools in architectural and product design, showcasing how these tools contribute to enhancing environmental sustainability, optimising processes, and improving project coordination. By utilising advanced methodologies such as CAM (Environmental Minimum Criteria), LCA (Life Cycle Assessment), BIM (Building Infor-

mation Modelling), and EM (Environmental Management), designers and architects can effectively integrate sustainability principles into their work, leading to more sustainable and environmentally friendly outcomes.

However, the limitations of sustainability assessment tools with respect to their ability to suggest real design strategies are already highlighted by Vezzoli and Manzini (2008).

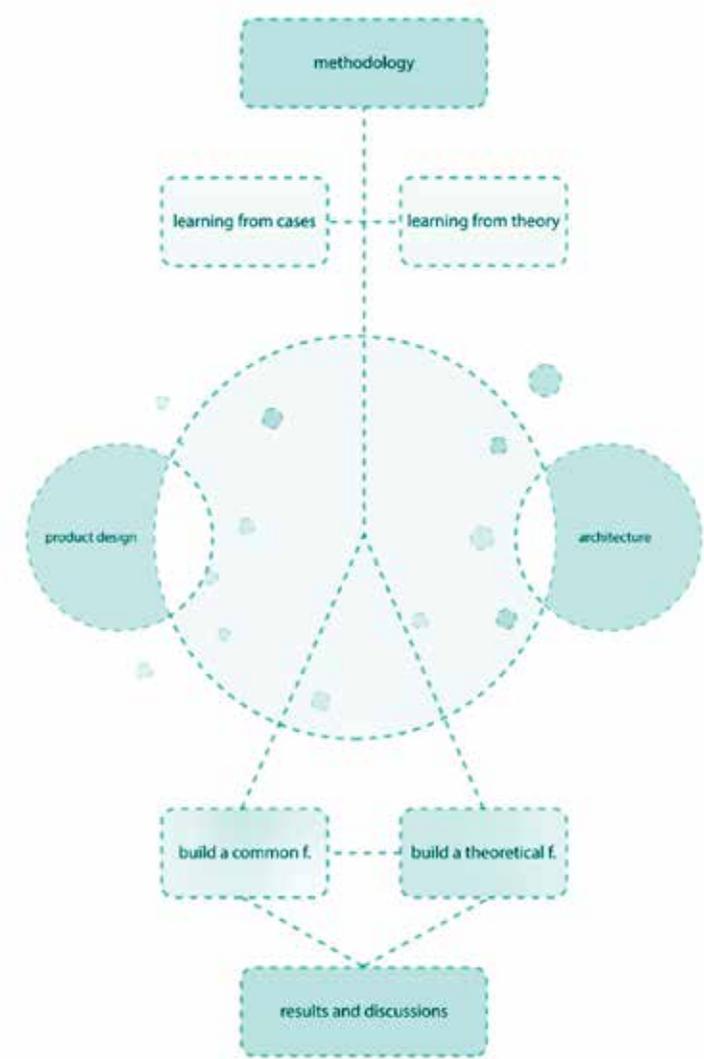
On the one hand, these limitations are linked to socio-economic and technical-regulatory reasons, such as the industry's inertia toward reorienting the production system and the constant evolution of disposal technologies and regulations in terms of product sustainability. In a design context, however, an inherent limitation of life cycle assessment tools is noted, which are effective in making choices between different products but do not represent actual design tools capable of suggesting

1.2 Objectives and Methodologies

This study focuses on specific sub-fields within architecture (adaptive reuse and sustainable construction) and product design (eco-design for exhibitions and circular prototyping), aiming to compare tools and strategies across these contexts. The work will adopt an interdisciplinary and hybrid methodology, analysing qualitative and quantitative tools from both the disciplines of architecture and design to under-

stand the complexity and dimensionality of eco-design strategies and their transferability to other fields (see Figure 01).

The research is structured into two sections: 1) A theoretical exploration and 2) A case study analysis. The initial section of the study examines the theories and concepts, with a particular emphasis on the current tools available for eco-design. In addition, it places significant emphasis on qualitative approaches for the assessment of sustainable strategies in the fields of architecture and design. While it considers quantitative tools such as LCA and BIM, these are primarily employed for contextual awareness and understanding rather than for in-depth quantitative analysis. The second section employs a case study methodology, following Groat's (2013) approach, to investigate patterns across selected cases in architecture and design. The objective of these case studies is to elucidate the similarities and differences in eco-design processes, thereby providing insight into how circular economy principles are applied in both fields. The objective of this paper is to develop a shared framework for evaluating, implementing, and monitoring eco-design strategies across architecture and product design as a starting framework for further research exploration. The focus remains on the articulation of qualitative and quantitative methods, ensuring a comprehensive approach to how these strategies can be applied to achieve sustainability across scales and disciplines.



Fig_01
Research's Methodology.
Created by the authors.

2 . State of the art, Quantitative assessment tools versus qualitative Design Tools

2.1 Regulatory framework

The development of a Circular approach to architectural and product design is closely related to regulatory proposals, which make the use of sustainability assessment tools and processes mandatory in project development.

Under this light, architecture represents a more developed discipline, with the introduction of the building information modelling (BIM) method as early as 2019, which is within the ISO 19650 regulation. BIM represents an approach to design and project management in architecture that integrates digital processes to improve efficiency and collaboration between the parties involved, and the regulation provides structured guidelines for information management within a BIM project, defining principles and requirements for organisation, collaboration and data exchange. In particular, ISO 19650 promotes an integrated view of information management throughout the entire life cycle of a building, from the conceptual phase to demolition, ensuring that data is accurate, accessible and up-to-date. This standard is crucial to ensure the quality and efficiency of projects, especially in a

context where sustainability and intelligent resource management are increasingly vital (Pan et al., 2024).

On the contrary, Design is still a somewhat vague field in terms of Sustainability regulation. ISO 14040 recognises LCA as a standard procedure for quantifying environmental impacts in Eco-design, allowing meaningful comparisons to be made between different products. Once such comparisons are available, design decisions can be directed towards managing, minimising, or eliminating negative impacts (Andersson et al., 1998; Bhandar et al., 2003; Millet et al., 2006).

Furthermore, in the last months of 2024, the Ecodesign for Sustainable Products Regulation (ESPR) was introduced. ESPR is a major EU initiative to improve the circularity, energy performance and overall environmental sustainability of products placed on the EU market. It aims to replace the current Ecodesign Directive and introduce more comprehensive sustainability measures, with the aim of addressing the most pressing environmental issues related to product design and manufacturing and setting new standards for product design and environmental responsibility. However, the regulation still doesn't present clear sustainability criteria for the new classes of materials and products to which it applies, and it will be further developed in the coming years. Currently, with the imminent adoption and further development of the ESPR Directive on Ecodesign by the Euro-

pean Commission (EC, 2022), which makes it mandatory to carry out LCA together with other environmental management systems, Ecodesign will play an increasingly important role, especially for companies.

2.2 Quantitative assessment tools

This section delves into the quantitative assessment tool in architecture and design, with the goal of exploring the concepts and definitions, as well as the strategies and tools used in both disciplines. Quantitative tools for sustainability assessment allow the environmental, social and economic performance of a project to be evaluated and optimised over its life cycle.

The tools that are analysed in this section can be divided into two large groups: tools that can help streamline the calculations that are required for life cycle assessment evaluations and tools that offer models that predict the behaviour of said projects in a real environment (Rossi et. al, 2016).

In the field of architecture, the most relevant tools are those that help designers comply with regulations, such as the LEED and BREEAM platforms, and those that offer virtual models for a building's behaviour during its lifecycle by integrating Building Information Modeling (BIM) with energy, water, and carbon emission analyses, such as IES VE, EnergyPlus, and Tally. While BIM

is a powerful tool in architecture, it remains deeply rooted in architectural workflows and is rarely adopted in product design. A more cross-disciplinary comparison could involve software platforms used across both domains. For instance, Rhino is widely employed by both architects and product designers, and its plugins — such as Ladybug, Honeybee, and Karamba — offer environmental analysis capabilities, enabling sustainability assessments in a parametric design context.

Among these, LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) are two of the world's leading sustainability certification platforms for buildings. Both provide structured frameworks to assess and certify the efficiency and environmental impact of buildings, promoting sustainable practices in the construction sector. LEED, developed in the United States by the Green Building Council, assesses aspects such as energy efficiency, resource use, indoor environmental quality and sustainability of materials.

BREEAM, originating in the UK, is one of the oldest rating systems and certifies buildings based on criteria such as land use, waste management, occupant well-being and energy. Both platforms are instrumental in pushing projects towards higher standards of sustainability, providing international guidance and recognition for environmentally friendly building practices. The IES VE, EnergyPlus, and Tally tools

are advanced tools used to analyse sustainability and environmental performance in buildings. IES VE (Integrated Environmental Solutions Virtual Environment) is an energy simulation software that can assess the energy consumption, lighting, ventilation and thermal efficiency of an architectural project, integrating with BIM models to provide detailed and predictive analysis. EnergyPlus, developed by the US Department of Energy, is one of the most comprehensive and customisable simulation engines for building energy analysis, capable of calculating heat balance, heating and cooling energy demand, and HVAC system efficiency.

Tally, on the other hand, stands out for its ability to perform life cycle analysis (LCA), focusing on the environmental impact of the building materials used, allowing designers to assess and reduce the carbon footprint of their projects at an early stage. Together, these tools provide an integrated and holistic view of building sustainability, covering both operational efficiency and material impact.

The field of design, being a more backward terrain than architecture from a regulatory point of view, has fewer quantitative tools for sustainability assessment. Most of the tools related to carrying out the LCA procedure are declared mandatory by the ISO 14040 standard, such as SimaPRO and GaBi.

SimaPro is known for its versatility and

ability to create complex LCA models, which are supported by a vast database of environmental data. It allows each stage of a product's life cycle to be analysed, from raw material to production, use and disposal, offering detailed information on CO2 emissions, energy consumption and environmental impact. GaBi, also a leading LCA tool, provides a wide range of data libraries and advanced modelling capabilities that can be used to analyse complex industrial processes and support sustainable design decisions. It is particularly valued for its ability to integrate industry-specific data and support compliance with international environmental regulations.

Both tools represent the largest share of LCA tools sold in the market and are the most commonly used by researchers (Hermann and Moltesen, 2015; Speck et al., 2015), but they require skilled practitioners. Overall, despite the accuracy and reliability of quantitative tools, their application has certain limitations. Indeed, these tools mainly focus on scientific and quantitative evaluations, analysing technical aspects such as the environmental impact of materials, energy consumption and CO2 emissions. However, they do not take into account qualitative factors such as socio-cultural context, user preferences or design aesthetics, which often influence design decisions. Furthermore, their effectiveness depends on the quality and completeness of the data entered, which may vary between sectors and regions, limiting the overall representativeness of

the analyses. Although tools such as these provide critical information to improve product sustainability, it is crucial to recognise that their scientific approach does

2.3 Strategic assessment tools

This section delves into strategic sustainability assessment tools that are distinguished by their ability to provide formal and operational suggestions early in the design process.

Unlike scientific tools, which offer detailed analyses and quantitative data on various environmental impacts, strategic tools transform these data into concrete actions, proposing practical solutions that can be immediately implemented in the design. These tools can be clustered based on the way that they can guide design through their outputs.

The first group can be constituted by those tools that help designers streamline and visualise the assessment phase through diagrams, making it more accessible for non-technical users to evaluate the sustainability of projects; a second group can be constituted by tools that provide strategies in the form of checklists, lists of actions that can be applied pragmatically to the project.

Lastly, a third group is constituted by tools that help with the communication of said evaluations to the public, producing repor-

ts that highlight the main characteristics of said projects in relation to their sustainability impact.

Among the software that helps to visualise the sustainability evaluation graphically, we find GaBi Envision, an extension of GaBi software dedicated to eco-design and life cycle analysis (LCA), designed to help designers integrate sustainability strategies early in the product development process. This tool visualises and models the environmental impact of different design options, providing a detailed analysis of key metrics such as CO2 emissions, energy consumption and natural resource use. GaBi Envision allows users to explore alternative scenarios, compare materials and processes, and optimise design decisions based on ecological criteria.

Thanks to its user-friendly interface, the software makes the implementation of sustainable design more accessible, supporting designers and engineers in reducing the ecological footprint of products. It also helps comply with environmental regulations and obtain certifications such as LEED or BREEAM, facilitating a more holistic and responsible approach to sustainability.

Furthermore, Greenfly is another eco-design platform that stands out for its intuitive interface and user-friendly approach, making it accessible even to those without a specific technical background. Among the tools that provide strategies in the form of checklists, we can find Ecodesign PILOT, a practical tool designed to support

companies and designers in integrating sustainability into their design and product development processes.

The tool provides a series of ecodesign strategies divided into categories such as resource reduction, material optimisation, energy efficiency and durability improvement, helping professionals to identify key areas where action can be taken to reduce environmental impact.

Ecodesign PILOT makes it possible to evaluate projects according to ecological criteria and to compare different design alternatives in terms of sustainability.

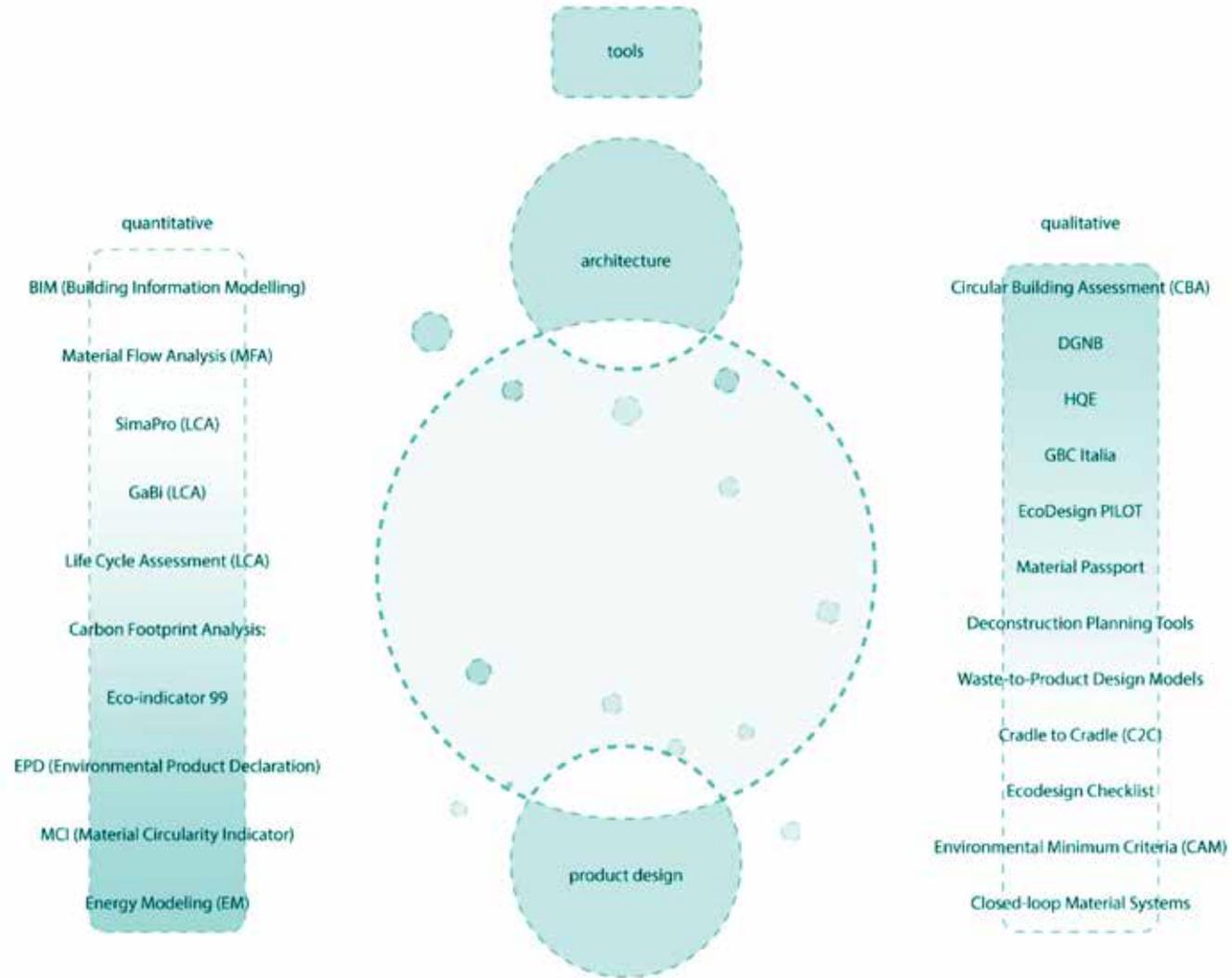
Among the tools that focus on producing reports for the communication of sustainability, we can find Okala Practitioner, a widely used educational and reference tool in the field of eco-design.

The tool is based on the concept of Life Cycle Thinking (LCT), and other than providing practical guidelines for integrating environmental considerations throughout a product's life cycle, the tool includes a set of environmental indicators that help designers quantify and compare the ecological impact of their choices, fostering a systemic approach to sustainability. Using scientific and easy-to-apply metrics, the tool helps identify strategies to reduce resource use, carbon emissions and energy consumption, promoting more environmentally conscious design. In addition to quantitative analysis, Okala Practitioner also offers an educational approach, contributing to the dissemination of sustainable design

culture in industry and design. Overall, these tools offer a more qualitative approach to Ecodesign that is of great interest to both design and architecture, but some limitations undermine their efficacy. Due to the high level of generality that characterises these types of guidelines, they can be applied to many different products.

Still, it is difficult to translate them into design choices. They can be used as alerts, but they do not provide possible solution strategies (Rossi et al., 2016).

As such, even if their strategic nature represents a step toward bridging the quantitative and qualitative aspects of Circular design, their efficacy is still to be tested in specific design scenarios.



Fig_02
A synthesis of qualitative and quantitative tools for eco-design in architecture and design.
Created by the authors.

3 Case study analysis/ reference cases

3.1 Case study selection and criteria

In addition to the quantitative tools that have emerged in recent years, there are aspects of sustainability and design that numerical methods cannot fully capture. In many instances, the solutions are not measurable and necessitate a qualitative analysis of both the existing conditions and the potential solutions.

This qualitative approach permits a more nuanced and contextualised comprehension of the multifaceted nature of sustainable design. In this context, the principles of the circular economy, as outlined by Ellen MacArthur (2013), emphasise the necessity for systems thinking and the integration of the environmental, social and economic dimensions of sustainability.

This section of the analysis will be aimed at identifying strategies that allow for a common framework of selected case studies, with a particular focus on the similarities and differences between the standard tools used in architecture and design in the context of the circular economy. The research is grounded in Groat's (2013) case study methodology. It critically examines the use and effectiveness of sustainability assessment tools in both disciplines. The

objective is to identify patterns that encapsulate shared processes between the two fields with the aim of developing an interdisciplinary shared framework for qualitative evaluation.

3.2 Case study for architecture

This section explores the reference case of Blue City in Rotterdam, with the aim of drawing lessons from a space that is already integrating various disciplines around circularity and strategies. The conversion of the former Tropicana discotheque into BlueCity's office wing provides an exemplar of a pioneering approach to integrating circular economy principles in architectural design. The project saw the repurposing of an existing leisure facility into a functional workspace for businesses focused on circular economy solutions. The transformation of a subtropical swimming pool and discotheque into 100 circular workspaces serves to demonstrate the potential of adaptive reuse to align urban spaces with sustainability goals. Furthermore, the design fosters innovation and collaboration among businesses committed to sustainable practices (Strauss, 2017).

The transformation followed a circular design methodology, prioritising the reuse of materials and minimising the introduction of new resources. In collaboration with COUP, Superuse, and Workspot, the

project achieved minimal environmental impact, ensuring that 90% of the design was circular. The strategy involved retaining the building's original construction while adapting it for modern office needs. The design facilitated the articulation of spaces that promote community engagement and sustainable business development.

Superuse Studios' work is not merely a qualitative analysis. It is a comprehensive and multifaceted approach to understanding and evaluating the subject. The process entails a dynamic reconceptualisation and material re-visioning, whereby existing elements, despite constraints in dimensions, material conditions and wear, have been re-evaluated to align with new functional requirements and spaces. This approach serves to extend the lifespan of products while simultaneously introducing new qualitative dimensions to the project's implementation. Superuse Studios employed a range of analytical and quantitative tools, including Material Flow Analysis (MFA), Life Cycle Assessment (LCA), and Carbon Footprint Analysis, in order to quantify and assess the environmental impacts of their processes. To exemplify this strategy, the window frames were transported at a distance of 136 km, the steel profiles 61 km, and the wood was sourced from a local supplier (Strauss, 2017). Despite the project's primary objective of maximising material reuse, the current market's limitations in providing entirely

recycled materials necessitated mapping potential suppliers aligned with the circular economy model. Integrating reclaimed and recycled materials into the calculations further contributed to reducing the project's carbon footprint. By employing a hybrid qualitative-quantitative process,



Fig_03
Blue City's Impressions.
Photos: Christian Corral

the project was able to achieve a 68% reduction in CO2 emissions compared to conventional office refurbishments (Strauss, 2017).

In 2022, a comprehensive photographic field investigation (see Figure 03) of BlueCity was conducted under the direction of Jan Jongert, an architect and partner at Superuse Studios. This study built upon the case study analysis by employing more qualitative explorations, including observational analysis, photo documentation, and conversations with people working at BlueCity. The visit yielded crucial insights into the circular processes integrated during the construction and operational phases of the project. The architect underscored the strategic significance of circularity in design and the employment of sustainability instruments to reinforce the impact of the project. The fieldwork furnished an invaluable close experience for expanding the project's understanding and its contributions to sustainability and circular process thinking. The visit explained methods and strategies for the reuse of materials, construction techniques and the incorporation of sustainable practices into the building's spatial-functional transformation.

The documentation process, illustrated in Figure 03, captures critical perspectives of BlueCity, emphasising the dynamic interplay between existing structures and newly implemented strategies. This juxtaposition serves to illustrate the thoughtful integration of reused materials within a new functio-

nality or space (see Figure 04). The images taken during the visit illustrate the physical characteristics of the space, the materials used, the functionality, the form in which it has been transformed, and the manner in which all of these elements are integrated into the project. The project shows the ways in which existing components can be incorporated into the modernisation and new spatial transformation of existing structures, with an emphasis on circular practices.



Fig_04
Blue City's Office.
Photo: Christian Corral

3.3 Case study for Design

This section examines the case study of the “Generative Circularity” exhibition by Materieunite and ATI Projects, which was initially presented during Milan Fuorisalone in 2022 at Fonderia Napoleonica Eugenia. It serves as an illustrative example of a design process that integrates both quantitative and qualitative evaluations, aiming to reconcile the often-competing considerations of needs, aesthetics, practice, and sustainability. The objective of the project was the creation of a reusable and dynamic exhibition design system that is capable of replicating itself based on the context in which it is inserted. This system was designed to address both the functional needs of an exhibition, including feasibility, production, transportation and structural integrity, and the qualitative needs of an exhibition, such as aesthetics, materials and the relationship with the location. These needs were analysed and processed through the use of parametric design software and quantitative life cycle analysis tools. Such a result could only be achieved through an interdisciplinary approach to eco-design, whereby the collaboration between different actors with specialised expertise in various fields proved to be the key innovation. The initial stages of the project were undertaken by ATI Projects, a company that specialises in integrated design for the field of architecture and engineering. Parametric software was employed by ATI Projects to

develop a parametric modular system that could be adapted to different spaces. The subsequent phase was undertaken by the Italian design studio Materieunite, which specialises in the creation of sustainable and circular exhibit design solutions. This phase saw Materieunite act as a ‘translator’ of the design proposed by ATI Projects, ensuring its alignment with the practical requirements of the exhibition’s construction and implementation. These decisions entailed a wide range of qualitative choices, which were relevant in all of the subsequent executive phases of the project. Cardboard was selected as the material for production to ensure that the entire exhibit could be recycled, and a layering technique



Fig_05
The assembly technique of
Parametric Circularity.
Photo: Materieunite

was chosen as the assembly technique to enhance the structural capability of the material (see Figure 05). Four distinct types of cardboard were selected to distribute weight throughout the module more evenly, reducing the weight in the upper portion of the pieces to facilitate the assembly phase. Furthermore, the assembly phase was meticulously designed to be carried out in a specific sequence, ensuring a harmonious balance between the pieces.

The project suggests that the design process was not solely quantitative or qualitative; instead, it encompassed a symbiotic relationship between the two approaches, leading to the selection of qualitative solutions based on a quantitative evaluation.

The final system comprised 123 honeycomb cardboard modules, each comprising nine layers. A total of 1,107 pieces of cardboard were cut, processed and assembled in the shape of bio-inspired architecture, which represents the human-environment relationship and the potential for replicating this connection on a daily basis through systems of circularity and innovative data management processes, as applied to the world of design and planning. The modular nature of the exhibition permitted the implementation of two distinct iterations: the first in April 2022 during Milan's Fuorisalone (See Figure 06) and the second in July 2022 as part of Lucca's LubiCA event within the city's Palazzo



Fig_06
Parametric Circularity at
LubiCa.
Photo: Materieunite



Fig_07
Parametric Circularity at
Milano's Fuorisalone 2022.
Photo: Materieunite

There are aspects of sustainability and design that numerical methods cannot fully capture. In many instances, the solutions are not measurable and necessitate a qualitative analysis of both the existing conditions and the potential solutions. This qualitative approach permits a more nuanced and contextualised comprehension of the multifaceted nature of sustainable design

Cason Villa, Corral, De Chirico, Digiorgio Giannitto

4 Results and discussion

This section introduces the first attempts at developing a collective framework based on standard practices, tools, and concepts derived from previous sections. It aims to foster a cohesive articulation between architecture and design in the context of the circular economy. The primary goal is to contribute to academic discourse by proposing a unified approach to eco-design strategies as a foundational framework for future research, with particular attention to the shared methods in both fields and the qualitative dimension.

The diagram (see Figure 08) illustrates the main idea of the collective methodology proposed by this paper.

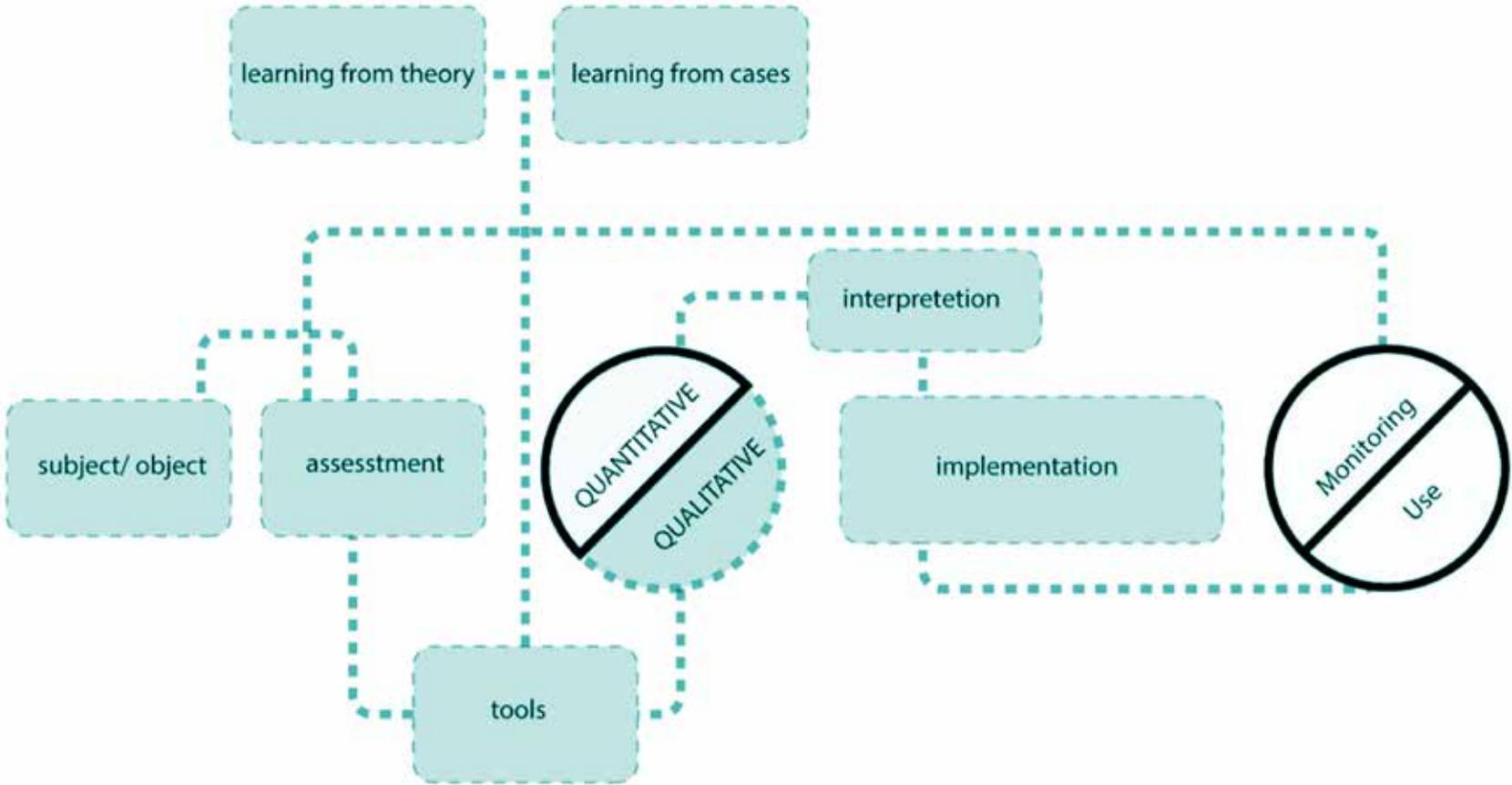


Fig_08
Cross-disciplinary articulation.
Created by the authors

The proposed framework is an open-ended, cyclical, interdisciplinary interaction of three major stages: Assessment, Implementation, and Monitoring. However, the proposed structure is further elaborated into six stages (see Figure 09), which offer a more detailed structure for the closed-loop interactions in the proposed system.

The stages are defined as follows:

- **Object selection:** This step involves identifying the specific design or architectural subject for analysis.
- **Assessment:** The selected object is evaluated through a blend of qualitative and quantitative criteria.
- **Tool application:** This phase involves the practical selection of eco-design tools tailored to evaluating the project's environmental impact.
- **Interpretation:** The collected data and results are interpreted qualitatively to generate directrices for the project.
- **Implementation:** The findings are then applied to concept building, design, and planning, and later, they are used for construction or fabrication based on the requirements for new functionalities.
- **Monitoring and use:** This final stage emphasises the importance of continuous evaluation, ensuring that the eco-design strategy remains flexible and adaptable to changing environmental and contextual conditions.



Fig_019 Integrated Eco-Design Framework: A Multi-step Approach for Architecture and Design. Created by the authors

The methodology provides a foundational interpretative approach to eco-design that extends beyond the scope of numerical analysis and disciplines for both fields. This research argues that the framework's qualitative dimension is essential for ensuring its adaptability and long-term success. The framework aims to integrate qualitative and quantitative dimensions in one system, supporting a systematic and responsive framework adapted to real-world challenges and conditions. This adaptability of the system permits the continuous development of sustainable architectural and design strategies that can be adjusted to evolving needs and unforeseen changes for a specific project. Furthermore, the framework's cyclical nature facilitates iterative improvement, where feedback loops retrofit the system, and the different stages, like the monitoring phase, inform new cycles of assessment and implementation. This continuous feedback loop enhances flexibility and functionality, allowing the process to evolve in parallel with spatial and societal changes.

Conclusion

The study concludes that while quantitative methods are helpful in assessing the numerical and environmental impact of a project, they can also be limited due to the absence of the qualitative dimension. In some cases, a project may be created with a clear concept to achieve the best possi-

ble development despite being numerically inferior. This is done with the integration of a hybrid process, interpretation, and re-evaluation of the current and future states of a project, integrating spatial, functional, and socioeconomic dimensions, ensuring that the project evolves with environmental and social conditions as closely as possible. This research contributes to the academic discourse by offering a new perspective on the commonalities in eco-design strategies across architecture and design. This exploration encourages a reconsideration of how sustainability tools can be tailored, reused, and reinterpreted to address new challenges. Furthermore, the research offers insights into the current state of the art in eco-design, encouraging further investigation into the potential of qualitative methods to complement quantitative tools in sustainability assessments. This approach emphasises that metrics can be limited in some situations, and the support of qualitative tools does not solely drive eco-design processes but also creativity, innovation and the capacity to reimagine spaces and products. During this research, by identifying common patterns through qualitative analysis, this study proposes a circular framework that incorporates both qualitative and quantitative tools across architecture and product design. The main contribution of this paper is the collective foundational framework for eco-design practices (see Figure 10), opening to the broader discussion on the development of a system that offers an open-end and a close-loop interaction that is cross-disciplined to be further developed

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Bridging Circular Design and Territorial Planning through rice waste enhancement

The Ricehouse case

Ambrogio F., Gomez Paz F., Lêdo Marques A., Morpurgo E., Varanda L.

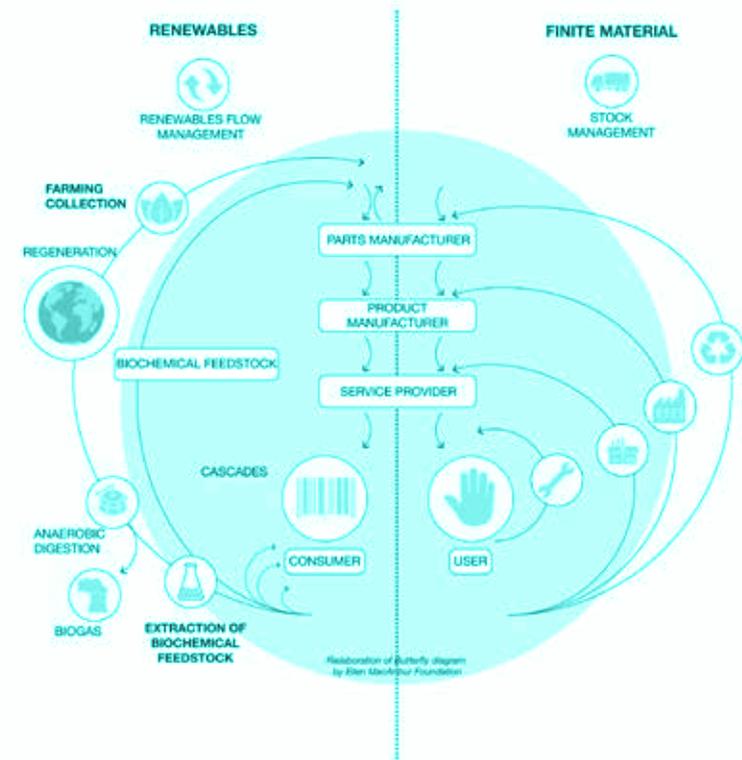
1. Introduction

Design choices at both micro and macro scales - from product design to interior design to landscape planning - play a crucial role in managing input materials and disposal chains, shaping the circularity and sustainability of processes and territories. These decisions profoundly impact material selection, waste generation, product longevity, urban infrastructure sustainability (De Luca et al., 2017; Bistagnino, 2016), and space. As such, this article explores the intersection of territorial planning and circular design, investigating how these concepts can be integrated in order to promote circularity. Based on the Ricehouse case, a startup enterprise that produces byproducts and promotes collaboration among stakeholders within a circular economy approach, the article aims to identify key overlaps, gaps, and opportunities that arise from the intersection of bioproduct design and territorial planning.

The environmental and climate crises have forced the development of frameworks centered on sustainability across various disciplines. These configurations challenge the traditional take-make-waste industrial model and expose the complexity of interconnectedness and interdependence. The concept of Circular Economy (CE) came into play as a viable tool to shift from the current linear production model, recognised as economically, environmentally, and socially unsustainable, to the adoption of a

circularity framework that has considered “any waste stream as a resource that can be used by sharing, reuse, repair or recycling” (Furlan et al., 2022, p. 32). Over recent decades, circular production systems have been developed to foster “healthier urban and territorial metabolisms” (Amenta et al., 2022). However, achieving circularity remains challenging, especially when it involves applying circular principles at the territorial level (ibid.). According to Arsova et al. (2022), current academic literature on CE implementation addressed strategies across three different levels: the micro (i.e., a single company or an individual consumer), the meso (i.e., an eco-industrial park, a supply chain), and the macro (i.e., a city, a province, a region, a nation). From a design perspective (the micro), industrial ecology and symbiosis concepts emerged as having spatial implications and are, therefore, connected to territorial planning (the meso and the macro). According to Van Berkel et al. (2009), “industrial symbiosis” has focused on creating more sustainable systems by closing the loop on material cycles. In this sense, the waste from one facility has been a resource or input for another. Within that notion, geographic proximity has been essential, as it could optimize material flow and has created a network of industries that have worked together to minimise waste and share resources. In other words, industries that traditionally operate independently are brought together to work collectively (ibid.) (Figure 1).

Contemporary research on building materials increasingly moved toward regenerative solutions that complement traditional extractive materials and are centred on environmental sustainability. This focus is based on the ability of the resources used for such materials to regenerate rapidly and offer competitive economic and environmental advantages over conventional



Fig_01
Circular economy systems.
Elaborated by the authors

materials (De Luca, 2019). The concept of regeneration, in this context, implies the adoption of natural resources that, through short life cycles, can be reintegrated into the ecosystem without long-term negative impact.

Within the broad framework of sustainability - understood as the ability to meet the present human generation's needs without compromising future generations' (Brundtland, 1987) - regenerative concepts emerged as central to the relationship between circularity and territory. Various authors have discussed ways to regenerate the territory through sustainable development strategies based on a multidimensional perspective (Alvim et al., 2022; Ceschin & Gaziulusoy, 2019). These approaches highlight that sustainability is not merely a sectoral response to environmental challenges; instead, sustainable development addresses a broader relational issue: the disconnection between civilization and its habitat or territory.

Shifting this paradigm requires a process that Magnaghi (2005; 2011) describes as re-territorialisation. This theory called for local communities to reclaim and manage their territories with autonomy and sustainable practices, moving away from extractive, centralised, and homogenised planning models toward a more self-determined and ecologically aligned perspective.

The reappropriation of territory and the recovery of the capacity to plan space sustainably or circularly also provoked discussion

about the role of spatial planning in transitioning to circular urban and regional developments. As has been stated by Williams (2020), "looping, regenerative and adaptive actions have been central to circular development [and] have designating space and infrastructure supportive of these three circular actions in the city-region is essential for the socio-ecological transition." However, as Furlan et al. (2022) pointed out, it remains unclear how urban and regional planning could incorporate a circular approach to urban and territorial interventions. The authors have acknowledged that spatial planning must recognise the importance of scales and locations within the circular economy to ensure structural continuity and systemic flexibility for a future economic system with a "still unknown territorial morphology" (p. 38).

In this context, the contributions of Magnaghi (2005; 2011; 2020) have stood out. The author elaborated a specific approach to the formulation of sustainable development linked to the importance of the territory, integrating issues such as basic needs, self-sufficiency, and eco-development with the growing and relevant role of local and regional development. Within this approach, two concepts are worth highlighting: the 'bioregion' and 'local self-sustainable development,' which reestablish a harmonious relationship between the environment, culture, and history through innovative approaches that have strengthened society's ties to the territory (Magnaghi, 2005; 2011). Both are widely debated within the Territorialist

School and recently at the forefront of the Design discipline.

A bioregion is delimited based on natural characteristics, such as river basins, ecosystems, and landscapes, rather than administrative divisions disconnected from the environmental dimension. In this way, territorial governance is established on respecting and valorising natural cycles and biodiversity, aiming to close biochemical cycles at a regional level, and promoting self-sufficiency in food production, energy, and other resources necessary for everyday life. The latter involved recognising local economies and short production and consumption cycles (Magnaghi, 2020). The bioregion concept articulated the idea of “local self-sustainable development,” derived from the territory’s potential and social participation in a constant process of exercising citizenship.

According to Thackara (2019), bioregions have reconnected “us with living systems”, such as watersheds, foodsheds, fiber-sheds, and food systems. The same author also pointed out that a significant challenge for the design process was the shift from a linear to a holistic, socio-ecological approach to agriculture when re-localizing regional food and fiber systems. In this context, farmers were not just producers of agricultural commodities for the city; they became “stewards” of an agroecological system in which water, soil, landscape, energy, and biodiversity are interconnected (ibid.), creating a sustainable agrifood supply chain. A sustainable agrifood supply chain re-

quires an open, circular system that optimises internal and external output-input processes (Bistagnino, 2012). In this model, reusing agricultural waste became a pivotal opportunity to develop sustainable supply chains, foster local micro-economies, and strengthen the regions and communities from which these byproducts originate. The primary sector and industry have formed new synergies by enhancing agricultural byproducts and promoting sustainability and innovation (European Commission, 2020).

Consequently, “bioregional design” has created value by caring for living systems and reinforcing new local development networks that have enhanced existing resources (Tackara, 2019). Under the bioregion design concept, using agricultural waste materials reduces waste dependence on non-renewable resources. The transition towards circular economic models, in which agricultural waste has become a resource, has been a crucial step towards a more sustainable and resilient economic system (Kirchherr, Reike, & Hekkert, 2017) and, therefore, more sustainable urban and regional developments.

As such, based on a real case study in Italy, where a company connects biomass input producers (rice farmers) with building product manufacturers (among others), this analysis seeks to explore how circularity in bioproduct design and production processes can be incorporated by territorial planning.

Design choices at both micro and macro scales – from product design to interior design to landscape planning – play a crucial role in managing input materials and disposal chains, shaping the circularity and sustainability of processes and territories. These decisions profoundly impact material selection, waste generation, product longevity, urban infrastructure sustainability, and space.

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Morpurgo E., Varanda L.

1.1 Methodology

This research proposes a methodology combining a literature review of theories related to circular and bioregional design with a qualitative case study analysis, focusing on the intersection between territorial planning and circular design.

Specifically, the article examines the case study Ricehouse through a semi-structured interview with the case study's CEO and co-founder Tiziana Monterisi (conducted in August 2024), the analysis of territorial data from the Piedmont region and spatial data on rice crop locations. Diagrams and infographics serve as a shared tool for interpreting and narrating the context under investigation, supporting the overall research aim and providing a higher level of insight.

The analysis results are approached from the perspective of micro, meso and macro scales, with the meso scale being the point of intersection between circular design and territorial planning. The micro-scale addresses the bio-product condition and the circular design perspective; the macro scale explores circularity in planning instruments, and the meso scale accounts for bioregion as the intersection between the concepts.

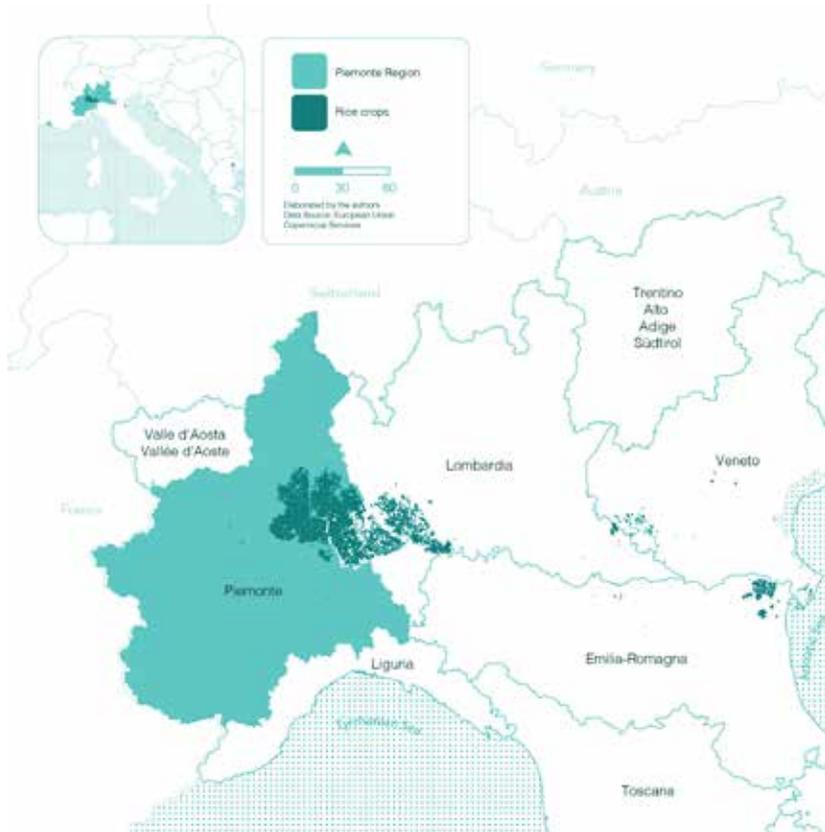
2. The case study: Ricehouse

Rice is the primary source of nutrition for 66% of the world's population and is cultivated in more than 120 countries, covering all five continents (FAO, 2020). Italy is the largest rice producer in Europe, with a production volume of 1.5 million tons, corresponding to 229.000 hectares (Regione Piemonte & UNISG, 2022).

Figure 2 shows the main areas of rice crops, which are in the Northern region of Italy between the regions of Piedmont and Lombardy, where 92% of rice production is concentrated in approximately 3,400 farms in the districts of Vercelli and Novara (Regione Piemonte & UNISG, 2022). Although rice is an important food source, its cultivation has a negative environmental impact. According to the Centre for the Promotion of Imports from Developing Countries (CBI), rice cultivation is one of the most significant sources of methane emissions, contributing 10 to 12% of global emissions (CBI, 2021). Additionally, irrigated rice farming significantly impacts water use and accounts for 20-40% of the world's freshwater consumption (ibid.).

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Fig_02
Location of rice crop areas in Italy (2018).
Elaborated by the authors based on satellite data from Copernicus, a component of the Earth Observation and Monitoring of the European Union Space Programme.

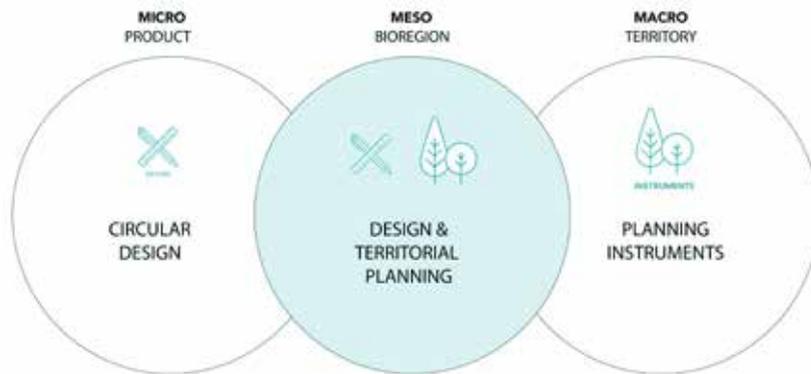
Company	Rice house
Location	Piemonte (Biella) - Italy
Founding year	2016
Typology	Società Benefit
Type of by-product	Rice hay, rice husk, clay from rice fields, chaff, starches, ashes and waste water from rice boiling
Original supply chain	Rice supply chain
By-product source	Rice farmers and rice processing industry
Waste derivation phase	Rice supply chain
Waste re-use supply chain	Construction supply chain
Stakeholders	Farmers in the rice sector; Building companies; Polytechnic University of Turin;
Values	Building as the 'third skin' of individuals; Sustainability of the process;
Goals	Product competitiveness Extension of the process for the replacement of polluting components in the building industry; Finding other applications for reusing rice husk
Output	Finished products and semi-finished products
Type of output	Panels for thermal and acoustic insulation
Scale	Italy and Europe
Impact	Reducing polluting building products; Recyclable products; Reduction of CO2 emissions from waste combustion

Table_01
Ricehouse's analysis. Elaborated by the authors.

3. Integrated analysis: bioproduct design and territorial planning

The integrated analysis proposed here considers three scales: micro, meso and macro.

The micro perspective dives into the scale of the circular material and product, the macro takes the territorial perspective, and the meso, represented by the bioregion, is where the two disciplines, design and territorial planning, meet, theoretically and in practice.



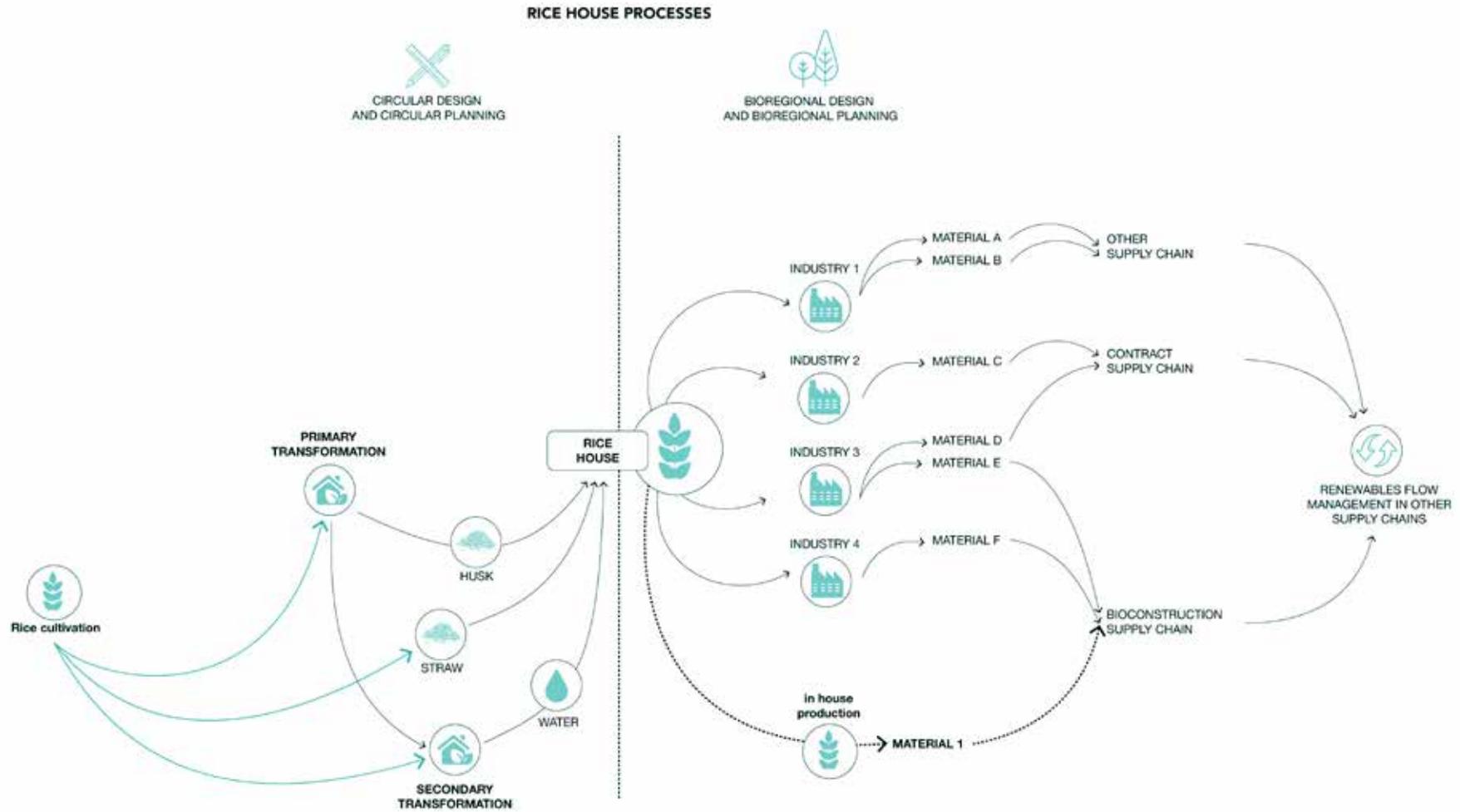
Fig_03
Proposed Integrated Analysis

3.1 micro perspective: Bioproduct Circular Design

Over the years, Ricehouse has built a resilient network of companies, collaborating with small and medium-sized rice producers who supply raw materials such as rice husks, hay, and clay, forming the foundation of Ricehouse’s supply chain. This interconnected network enables Ricehouse to collect resources from various stages of rice production for more than twelve companies that process them into materials and components for the construction and design industries. The hay and clay are left in the fields after the harvest. Partner processing companies that clean, cook, and refine rice provide other valuable byproducts: husks, chaff, starches, ash, and wastewater from rice boiling (Figure 4).

Figure 4: Ricehouse conceptual processes. Elaborated by the authors.

The collaboration between research centres and specialised companies has played a crucial role in transforming agricultural byproducts into materials suitable for industrial production. A representative case is the partnership between Ricehouse and Sanmiro, an Italian company based in the province of Lecco, which led to the creation of the RiceUp project in 2020. Through this initiative, rice husks are repurposed within the production of pot handles in a co-branding and co-design effort, ultimately reaching a broad consumer base, in-



Fig_04
Ricehouse conceptual processes.
Elaborated by the authors.

cluding large retailers like Lidl. This example highlights how agricultural by-product valorisation can foster synergies between the primary sector and industry, advancing sustainability and innovation (European Commission, 2020).

Ricehouse is also sensitive to the environmental impact of the technologies employed, favoring the so-called “cold processes,” which effectively reduce energy consumption in the production and fabrication of building components. These processes, in which elements are dry-assembled, promote sustainable production and easy disassembly and recycling of buildings at the end of their life cycle (Gupta et al., 2021). The above is crucial for reducing the ecological footprint during the production phase and facilitating the life-cycle management of buildings, possibly extending their lifespan to 70 years before dismantling (Mazzarella & Pasetti, 2021). Additionally, as Tiziana mentioned, when rice waste is used as insulation material, the CO₂ captured during the plant’s growth cycle is retained for decades, contributing to the reduced climate impact of buildings and the plant itself.

For the farmers, collaborating with Ricehouse means an innovative income opportunity. Traditionally, straw and clay are low-value byproducts of rice cultivation, with straw often burned in the fields to regenerate soil fertilisation - a practice now prohibited due to its high CO₂ emissions. Given the limited commercial value

of straw, the primary income for farmers comes not from selling the biomass itself but from providing services related to its storage and delivery to industries that use it in construction materials for Ricehouse. This partnership allows farmers to derive value from materials that would otherwise go to waste, fostering a more sustainable and profitable agricultural model.

From a design perspective, shifting toward regenerative materials and energy-efficient production processes is essential for addressing the challenges of climate change. The construction and design industries are increasingly urged to prioritise renewable natural resources and integrate sustainable technologies to reduce CO₂ emissions and promote a circular, regenerative approach across the sector. This shift mitigates environmental impact and supports long-term resilience and innovation in the built environment.

3.2 micro perspective: Bioproduct Circular Design

The region of Piedmont, which hosts most of the rice farms, coincides with Ricehouse having two of its three headquarters. The area is quite heterogeneous and is home to 4.2 million inhabitants. According to the Voluntary Local Review, a document drafted by the Piedmont Region and the Metropolitan City of Turin, the northeast quadrant (Verbania, Vercelli, Biella, and

Novara) stands out as a logistics hub, with companies specialising in valves, taps, fittings, and textiles, as well as vast rice fields.

The region's territorial planning policies provide guidelines for spatial development supported by strategic plans and initiatives. For instance, the Voluntary Local Review (VLR) aims to ensure coherence among various planning instruments to effectively integrate the 2030 Agenda for Sustainable Development goals into local contexts. An example is the Regional Sustainable Development Strategy (RSDS), which established a circular economy in Piedmont's agri-food sector (GOLD, 2022). This initiative closely aligns with the Prosperity goals of the 2030 Agenda, where circular economy mechanisms are considered essential for reducing waste, fostering a market for secondary raw materials, and "dematerialising" the economy to drive sustainable growth (ibid.).

Another instrument is the Circular Economy and the Agri-Food System Report, presented in 2022. It deepens the understanding of certain aspects of the RSDS by focusing on five key food chains within the Piedmont region, analysing their current state, and offering public policy recommendations. In the case of the rice supply chain, the report identifies waste as a significant challenge facing the rice industry. It also highlights the urgent need to valorise waste and byproducts to improve sustainability and resource efficiency within the sector (Regione Piemonte & UNISG, 2022).

In this regard, Regione Piemonte and UNISG (2022) argue that the private sector has developed a byproduct chain for generating construction materials; however, substantial challenges remain in guiding rice producers on sustainable waste management practices within a circular economy framework. As a public policy response, the report proposes valorising rice straw, husk, and chaff, which requires further research on byproduct traceability, development of local innovation, promotion of participation in European projects, and support for rice producers in establishing a sustainable byproduct and waste supply chain (ibid.).

The transformation of rice husks into a competitive building material, which required extensive testing and eventual acceptance across Europe (Fava & Parmigiani, 2019), is an excellent example of this transformation. A major obstacle has been meeting Italy's Minimum Environmental Criteria (CAM) for sustainable materials in public projects. Initially, natural byproducts like rice husks were not CAM-compliant; however, with an important role played by Ricehouse lobbying for this amendment, recent regulatory updates now allow by-products, fostering the use of regenerative materials in construction (Ministero della transizione ecologica, 2022).

Notably, Ricehouse is applying for a European fund to establish its first plant in Biella. By situating the production plant near these rice plantations, Ricehouse aims to cut costs by minimising transporta-

tion needs.

The analysis of the existing territorial plans reveals that the Piedmont region has made significant efforts to integrate circular economy principles into its territory. The Piedmont Regional Territorial Plan (Ptr) was approved in 2011, and the Regional Landscape Plan was approved in 2017. These plans are complementary and were developed within a single process. They share common strategies, emphasising research, innovation, and economic-productive transition strategies (Regione Piemonte, 2011). Despite the progress described above, full implementation is still pending. Mapping the stakeholders involved in circular processes can enable the creation of localised instruments and incentives, fostering synergies across sectors. During the interview, Tiziana emphasised the importance of network-building among all stakeholders, from the farmers at the beginning of the supply chain to those involved in the final product manufacture.

3.3 micro perspective: Bioproduct Circular Design

One of Ricehouse's main characteristics is its "open-minded mission". Instead of focusing exclusively on the production phase of bio-based materials, Ricehouse creates cooperation (synergy) with various companies.

In addition to developing biomaterials and low-energy production processes,

Ricehouse has been addressing sustainability by questioning the scale of its supply chain and its impact on the territories in which it operates. Indeed, enhancing agricultural waste represents a crucial opportunity to promote local microeconomies and strengthen the specific supply chains and the territories from which waste originates (Vezzoli & Manzini, 2007).

Aligned with bioregional design principles (Thackara, 2019; Boelen & LUMA Arles A c. Di, 2023; McGuirk, 2024), Ricehouse establishes specific limits on transportation distances for sourcing and distribution, which vary according to each product. This approach reflects a commitment to minimising environmental impact by prioritising local supply chains.

For instance, transporting prefabricated houses over long distances is economically and environmentally unsustainable due to their substantial weight. For that reason, Ricehouse sets a maximum distance of 250 km between resource extraction, production, and consumption for such products. For lighter products, which are more efficient to transport, Ricehouse targets a maximum radius of 2.000 km from Biella, covering much of the European market. While bioarchitecture traditionally advocates a 100 km radius for sourcing, processing, and applying raw materials in construction, Monterisi highlights that in a globalised market - where resources can travel up to 15.000 km - striving for a 2.000

km radius for sustainable construction materials is already a significant accomplishment (Figure 5).
To expand its market and increase revenue,



Fig_05
Ricehouse location and buffers of sourcing and distribution.
Elaborated by the authors based on satellite data from Copernicus, a component of the Earth Observation and Monitoring of the European Union Space Programme.

Ricehouse is exploring activating multiple bioregional supply chains based on the know-how acquired and developed in Biella. In line with this approach, Ricehouse is currently in discussions with a potential industrial partner in Puglia to produce bricks and plaster walls locally made from rice husk sourced from farmers no farther than Sicily. Such a setup would replicate the 250 km radius supply chain model for heavy products already tested in Biella. This approach can allow other markets to develop additional production hubs in different regions. During the interview, Tiziana stressed the potential for replicating the Ricehouse model worldwide based on rice waste enhancement. This model can, for instance, positively affect the territory of rice producers like Asia, where 90% of the world's rice is produced (Bhandari, 2019). Setting territorial boundaries has influenced the evolution of the company. As such, for the first time, Ricehouse has chosen to invest in developing its own facility to produce a specific insulation material, thanks to LIFE project funding. The reason behind this choice is the nonexistence of companies with the capacity to produce this specific material, which Ricehouse believes has immense potential in the construction market for distribution within a radius of 400 km. The product is expected to become more economically accessible, thanks to the reduced transportation costs. The factory will be installed in Biella, where Ricehouse's headquarters is located, and the straw will be sourced within a radius of 15

km directly from the “field to the factory.” Tiziana details some key suppliers associated with Ricehouse in the interview. The primary raw material supplier for Ricehouse is Gallo Riso, based in Robbio, 67 km from the Biella warehouse. As for the manufacturing of products, bricks are produced in Verona, Veneto region, located 261 km from the Biella warehouse. Vimark and Sarotto Group process the rice husk and green binder used in production in Cuneo, approximately 204 km away. Additionally, the pot handles are manufactured by Sanmiro, a plastic production company located in the province of Lecco, in the Lombardy region, 135 km from the Biella warehouse. For example, with the Verona-based company specializing in concrete bricks, Ricehouse has introduced the production of bricks made with rice husk. This product currently covers 10% of the company’s production. Still, it has the potential to gradually increase following market demand, helping to mitigate economic risks associated with transitioning to the biomaterial market. In another cooperation, the transition has been accomplished: initially, this company produced prefabricated houses with concrete and polystyrene. However, since working with Ricehouse and incorporating materials such as husk+vikrat (at Ricehouse’s request), the company has fully transitioned, and its operation is exclusively focused on sustainable and renewable alternatives.

In short, Ricehouse plays a valuable role in fostering local innovation and sustainable

transition in the region by creating synergies and collaboration with companies from both sides of the circular economy system: renewables flow management and product manufacturing (finite materials).

4. Conclusions

The transition toward circular economic models, where agricultural waste becomes a resource, is a crucial step toward a more sustainable and resilient financial system (Kirchherr, Reike, & Hekkert, 2017). Enhancing agricultural waste materials reduces waste, decreases dependence on nonrenewable resources, and cuts carbon emissions associated with production processes.

The analysis of the Ricehouse case reveals not only the environmental benefits of biomaterials but also the territorial dynamics that shape their production and implementation across multiple scales. At the micro scale, Ricehouse stands out as a pioneering model, illustrating how waste-based biomaterial processes have the potential to transform local economies and promote spatial sustainability and regional circularity. By converting agricultural byproducts into market-valuable building materials, the company strengthens local economic networks, reduces waste, and lowers environmental impacts at the regional level in Piedmont. At the meso scale, represented by the bioregion, the most significant findings emerge since this is the

scale where the disciplines of design and territorial planning intersect. Ricehouse's approach defines spatial limits for sourcing and distribution based on ecological and logistical reasoning rather than administrative borders. Localising the production of building materials from agricultural waste allows the model to activate regional supply chains, reduce environmental externalities, and align innovation with place-based realities. However, while the company's model is inspiring, at the macro scale, a more structured, policy-driven approach to circular territorial planning could amplify these benefits further, supporting widespread innovation and regenerative regional economies. The Piedmont region has a total area of approximately 215.134 hectares of rice crop with an estimated waste of around 2.151.340 tons for every harvest, a potential that is not fully explored. Research on integrating circular product design and territorial planning is still new and highly interdisciplinary. It faces challenges such as limited data access, the complexity of integrating diverse knowledge and practices, and the need for further research and collaboration to unlock its full potential. From a design perspective, the analysis evaluated the environmental impact of the input materials. It showed that biodesign (i.e., bioproduct design) can reduce resource consumption, enhance agricultural waste, and support circularity. The choice of materials is guided by sustainable criteria, favoring renewable resources with rapid regeneration cycles

(i.e., straw and rice husks). These materials undergo low-impact "cold processes," minimising energy and water use, enabling dry assembly, and simplifying disassembly and recycling at the end of a building's life. Ricehouse's goal is to create long-lasting products that can be easily reused, reducing CO2 emissions and enhancing the sustainability of the building sector. The study of planning instruments from a circular perspective emphasises the importance of advancing research on supply chain traceability as a driver of innovation, highlighting the importance of distances in the production process. In this way, mapping the supply chain is essential for the flow of materials and connecting local farmers with the industry, creating a value chain that optimises agricultural byproducts. Moreover, as the bioregion is defined, these tools should focus on the operational area of the supply chain rather than strictly adhering to administrative boundaries. In line with this approach, fostering local self-sustainable development requires continuous engagement and empowerment of local communities, ensuring their active participation in shaping and benefiting from the transformation. Improving planning in terms of circularity would require new governance frameworks to coordinate efforts across sectors and regions. This article demonstrates how the synergy between bio-based materials and territory design can foster sustainable solutions, advancing the circular economy and regio-

nal regeneration. Centering the research and development of bioproducts around a specific agricultural supply chain allows for envisioning the reproduction of the productive model in other bioregions characterised by the same type of agriculture and opening new perspectives on the path to transition toward a bio-based circular economy.

Finally, a sustainable, just and profitable transition relies on developing territorial governance across multiple scales. This requires a holistic approach, which includes the development of bioproducts and bioregional design, ensuring sustainability across the entire process, accounting for the logistical distances involved in each stage, and fostering collaboration among local actors. As the Riceouse co-founder points out, integrating territorial planning with circular design in bioproducts remains a work in progress.

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