Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Paola Gallo · Francesco Alberti · Antonio Labalestra ·
Hasim Altan · Eric J. Strauss *Editors*

Technological Innovations and Emerging Approaches for the Built Environment and Smart Cities

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Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

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The Editors warmly thank all the Reviewers who have contributed their authority to the double-blind review process, to ensure the quality of this publication.

Preface

The 9th Edition of the *Urban Planning and Architectural Design for Sustainable Development (UPADSD)* conference, held in Florence, Italy, was another important step in the ongoing debate on how architecture and urban planning can actively contribute to building more sustainable, resilient, and inclusive cities. As urban challenges become more complex—driven by climate change, digital transformation, and rising inequalities—professionals and academics in the built environment are called upon to rethink existing paradigms and develop actionable strategies founded on research, innovation, and cultural awareness.

This book is part of the peer-reviewed Advances in Science, Technology and Innovation (ASTI) series, presenting the IEREK Interdisciplinary Series for Sustainable Development. This is an edited collection of papers from the 9th International Conference on Urban Planning and Architectural Design for Sustainable Development (UPADSD), covering a wide range of issues on contemporary urban and architectural research across two volumes.

Volume 1 focuses on multidimensional approaches to urban regeneration, addressing environmental, social, and cultural dimensions of urban transformation, including topics such as green infrastructure, urban mobility, community engagement, and heritage preservation.

Volume 2 addresses technological innovations and new methodologies to the built environment and smart cities, highlighting the crucial role of smart and inclusive technologies in promoting sustainable urban development. The contributions—collected into four thematic parts—address critical issues such as the development of advanced building materials and techniques aligned with circular economy principles, strategies for enhancing energy efficiency and climate resilience in urban contexts, and the deployment of advanced tools and data-driven methods for urban analysis and decision-making. Furthermore, the volume analyzes the potential of digital technologies such as smart infrastructures, digital twins, and automation on the development of sustainable, resilient, and inclusive urban of the future.

The chapters in this book highlight the importance of combining technological advancements with environmental responsibility and social justice to address the complex challenges faced by urban environments today. This collection shows the international scientific community's commitment to promoting knowledge and practice that foster adaptive, sustainable, and intelligent cities according to the Sustainable Development Goals.

Florence, Italy

Paola Gallo

Acknowledgements

We would like to express great thanks to all who contributed to the success of the 9th UPADSD Conference and this publication. We express our sincerest appreciation to authors and researchers who shared their expertise and thus enriched this volume with new and stimulating insights.

Special thanks go to the IEREK Scientific Committee and peer reviewers for their valuable input and commitment to academic excellence. We also extend our appreciation to the editorial and production teams for their helpful assistance in coordinating the publishing process, as well as the Editor, for their support in bringing this volume to publication.

This book is the result of a collective effort. We hope it serves as a valuable reference and source to inspire and guide those working for more sustainable and inclusive urban futures.

Introduction

As global cities face mounting pressures from climate change, energy crises, population growth, and digital transformation, the built environment stands at the intersection of urgent challenges and unprecedented opportunities.

These criticality that characterize our world, pose fundamental questions: How can we design cities that are not only beautiful and functional, but also just and sustainable ad mindful to the vision for carbon neutral urban cities? What principles should we adopt to ensure that our developments respect the environment and promote the quality of life for citizens? How can we involve local communities in the design process to create spaces that really meet their needs?

The 9th Edition of the Urban Planning and Architectural Design for Sustainable Development provided the opportunity to listen to researchers, experts, urban planners and professionals who will share their experiences, ideas, and innovative projects. Case studies of cities that have successfully implemented sustainable development strategies were analyzed and pioneering technologies that can help us make architecture and urban planning more environmentally friendly were discussed.

Thanks to the contributions of all the participants of the event, deep reflections were stimulated on how urban design and planning can evolve to address today's challenges and build resilient and sustainable communities. So in this context, Volume 2 of UPADSD, conference focuses on the transformative role of technology and innovation in shaping more intelligent, efficient, and sustainable urban environments.

The contributions in this volume reflect the growing importance of interdisciplinary research and experimental practices that bridge architecture, engineering, data science, and environmental studies. Each section offers insights into how emerging tools and methods are reshaping the processes, materials, and infrastructures that define the cities of today and tomorrow.

The volume is structured into four thematic parts:

Innovative Building Materials and Techniques
This part explores the development and application of new materials and construction systems aimed at minimizing environmental impact and enhancing building performance. Topics include circular economy principles, biomimetic strategies, albedo-sensitive surfaces, and traditional passive techniques adapted to contemporary needs—highlighting a growing attention to resource efficiency, climate responsiveness, and environmental compatibility.

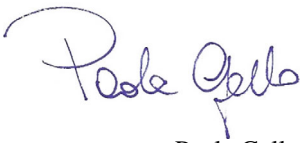
Energy Efficiency and Climate Solutions in the Built Environment
Addressing the intersection between architectural design and environmental responsibility, this part examines strategies for improving the energy performance of buildings and urban spaces. From retrofitting existing structures to implementing green facades and vertical gardens, the authors present evidence-based approaches to reduce emissions, enhance thermal comfort, and promote the integration of renewable energy and low-impact technologies.

Advanced Tools and Methods for Urban Analysis, Evaluation, and Decision-Making
Urban complexity requires data-driven and multi-scalar approaches. This part presents cutting-edge methodologies—from digital simulation and geospatial analysis to

performance-based planning models—capable of informing better decision-making in urban design. Contributions address issues such as urban resilience, environmental risk, public space usage, health-oriented planning, and heat vulnerability, reinforcing the need for adaptable and context-sensitive strategies.

Digital Transformation and Smart Cities. Envisioning the Urban Future
The final part reflects on the ongoing digital revolution in urbanism and architecture. It shows the potential of digital twins, smart infrastructure, robotic systems, and BIM-integrated workflows to improve the efficiency and resilience of urban environments. Beyond technological capabilities, these papers emphasize the importance of inclusive design, human-centered technologies, and participatory models in shaping future-ready cities.

The contributions collected in this volume highlight the value of cross-disciplinary cooperation in addressing the complex challenges of contemporary urban development. The 9th UPADSD Conference placed particular emphasis on the integration of scientific rigor, innovative thinking, and social responsibility in the pursuit of cities that are livable, equitable, and environmentally sound. In order to improve the built environment's performance, resilience, and inclusiveness, the studies presented discuss the use of innovative materials, energy-efficient techniques, sophisticated data analytics, and smart technologies. The volume shows a growing commitment within the scientific community to use technological innovation in support of flexible and sustainable urban futures.



Paola Gallo

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Sustainable Urban Design and Energy Efficiency Strategies to Regenerate the Italian Inner Area. The REACT Workshop Experience

Rosa Romano, Antonio Lauria, Eletta Naldi, and Claudia Mezzapesa

Abstract

Despite significant challenges to their survival, villages in marginal areas serve as vital reserves of biological and cultural diversity. These regions nurture deep connections between people and the environment, shaped by centuries of co-evolution. In the context of ecological and pandemic crises, these villages present unique opportunities for innovative development models that prioritise sustainability and resilience and focus on human-environment harmony. In Italy, Inner Areas face challenges such as depopulation and socio-economic vulnerabilities but are rich in cultural and natural heritage, offering fertile ground for community-centred initiatives. The REACT research project, funded by NextGenerationEU and the Italian National Research Programme, adopts an interdisciplinary approach to revitalising the Casentino Valley through cultural landscapes. This approach integrates settlements, natural systems and community practices into a comprehensive vision for sustainable development, emphasising the active participation of local communities. This paper presents the outcomes of an interdisciplinary workshop held between July and November 2023 involving four departments at the University of Florence (Architecture, Economics, Education and Industrial Engineering). The workshop was designed to develop innovative regeneration strategies for historical villages and rural territories within the Casentino region, focusing on sustainable urban design and energy efficiency technologies. The workshop combined lectures, on-site fieldwork and stakeholder engagement, emphasising the integration of interdisciplinary perspectives. Three key projects emerged: *Cub.Labora is* a modular mobile unit supporting local commerce; *L'Elica del Pratomagno is* a climate education hub in a repurposed building; and *Trans+Humus is* a trail integrating cultural heritage with ecological exploration. These initiatives demonstrate the potential of flexible, participatory and community-driven approaches to addressing depopulation and promoting sustainable territorial development. By focusing on public spaces and landscape infrastructures, the outcomes contribute to the social, environmental and economic revitalisation of the Casentino area, offering replicable models for rural regeneration.

Keywords

Active learning · Interdisciplinary thematic seminar · Cultural heritage · Inner areas · Sustainable development

1 Introduction

Although they often face problems that threaten their survival, villages in marginal areas usually serve as genuine reserves of biological and cultural diversity. These villages possess resources that underscore the sense of integration and harmony between places and the people living there, forming an inextricable whole consolidated in a long, co-evolutionary process (Lauria 2022; Pazzagli 2021).

In Italy, "Inner Areas" studies and addresses issues in marginal territories through a dedicated national policy framework. These areas, marked by socio-economic characteristics that render them peripheral and vulnerable, are defined by their considerable distance from major urban centres where vital services are concentrated (Agenzia per la Coesione Terri-

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toriale 2024). This remoteness leads to a lack of educational, healthcare and transportation services, resulting in population decline as residents move to urban areas in search of better infrastructure and social opportunities. Despite these challenges, Inner Areas are essential for maintaining the country's balanced and sustainable development (Nigrelli 2021). They are pivotal for preserving cultural and economic identity, traditions, natural resources, and valuable cultural heritage (De Rossi 2018; Marchetti et al. 2017).

In a time when traditional development models and social structures are increasingly questioned for their inability to address past and ongoing crises, particularly ecological and pandemic-related, the inner areas present an opportunity to explore innovative development models that prioritise the human element in its relationship with environmental components (Bogataj and Del Gobbo 2015; Tantillo 2023).

Various national and European initiatives have been implemented to regenerate these areas, promote sustainable development and ecological territorial cohesion, and address the population decrease. A significant effort in this regard is the 2014 National Strategy for Inner Areas, introduced by the Italian Government, which has initiated several projects (Barca et al. 2012). Nevertheless, these efforts face significant hurdles and demand innovative, place-based and people-focused solutions to ensure effective development and revitalisation (Barbera et al. 2022; Cersosimo and Donzelli 2020).

2 The REACT Research Project

The REACT research project, titled "Regenerate the cultural landscapes of the inner areas in a people-centred perspective. Historic villages and rural areas of Casentino as a laboratory of creativity and innovation," is an interdisciplinary initiative led by the University of Florence. Funded by the European program NextGenerationEU and the National Research Programme (PNR), this research project focuses on the inner areas of Italy, with special attention to cultural landscapes as dynamic and evolving resources that represent both tangible and intangible expressions of human–environment interaction (Council of Europe 2000). These landscapes, including built environments, cultural heritage sites, cultivated landscapes, natural systems, and community practices, play a crucial role in societal well-being and identity (Council of Europe 2005).

The REACT project is based in the Casentino Valley in Tuscany (Fig. 1). It aims to develop a theoretical-practical regeneration model that can be broadly applied to other inner areas. Adopting a holistic and interdisciplinary approach, the project seeks to revitalise the building environment and local economy by directly involving residents and leveraging the area's natural, real estate, and human resources to mitigate depopulation and improve the resilience and adaptivity of the building spaces to climate change.

The REACT research addresses the challenges faced by inner areas through a strongly interdisciplinary approach, utilising the concept of cultural landscape to integrate various dimensions of the problem. This comprehensive vision includes settlements, architectural heritage, cultivated landscapes, natural systems and community practices and experiences. By harnessing the available cultural and human resources, seen as a driving force for development, the project aims to establish novel strategies and actions that promote territorial development in ecologically sustainable, socially inclusive and economically viable ways. This process is grounded in the active and conscious participation of local communities.

The REACT research team, which includes experts from the University of Florence's Architectural Department (DIDA), Science and Business Department (DISEI), Department of Education, Languages, Intercultural, Literature and Psychology (FORLIPSI) and Department of Industrial Engineering (DIEF), has initiated collaborative efforts with public administrations, associations, and small and medium enterprises to achieve these goals (Fig. 2). These efforts include dedicated training sessions, thematic seminars, workshops and conferences to engage local stakeholders (Fig. 3).

The project's long-term vision is to transform the cultural landscapes of inner areas into incubators of innovative ideas, also in the frame of environmental design. By doing so, REACT seeks to create conditions that revitalise building environments, landscapes, and the local economy, curbing depopulation and attracting new residents. The sustainable regeneration of these areas is approached with an innovative perspective that views the territory as a complex ecosystem composed of natural resources, tangible cultural heritage, local economy and human and social capital. This revitalisation is achieved by integrating community activism with appropriate design strategies and public policies, ensuring the development process is sustainable and beneficial for all stakeholders.

3 The Thematic Seminar

A University Thematic Seminar, a structured workshop that combines theoretical and practical activities (lectures, on-site inspections, stakeholder meetings and design stages) focused on a specific academic or research theme (Fig. 4), was organised as part of the REACT project. It offered an immersive experience to explore Casentino's cultural landscape and develop regenerative projects aimed at social, environmental and economic transformation. Held from June to November 2023 in Florence and Casentino, the Seminar engaged 18 students from the Architecture, Economics and Education departments at the University of Florence, including both undergraduate and postgraduate participants. The interdisciplinary activities encouraged students to collaboratively

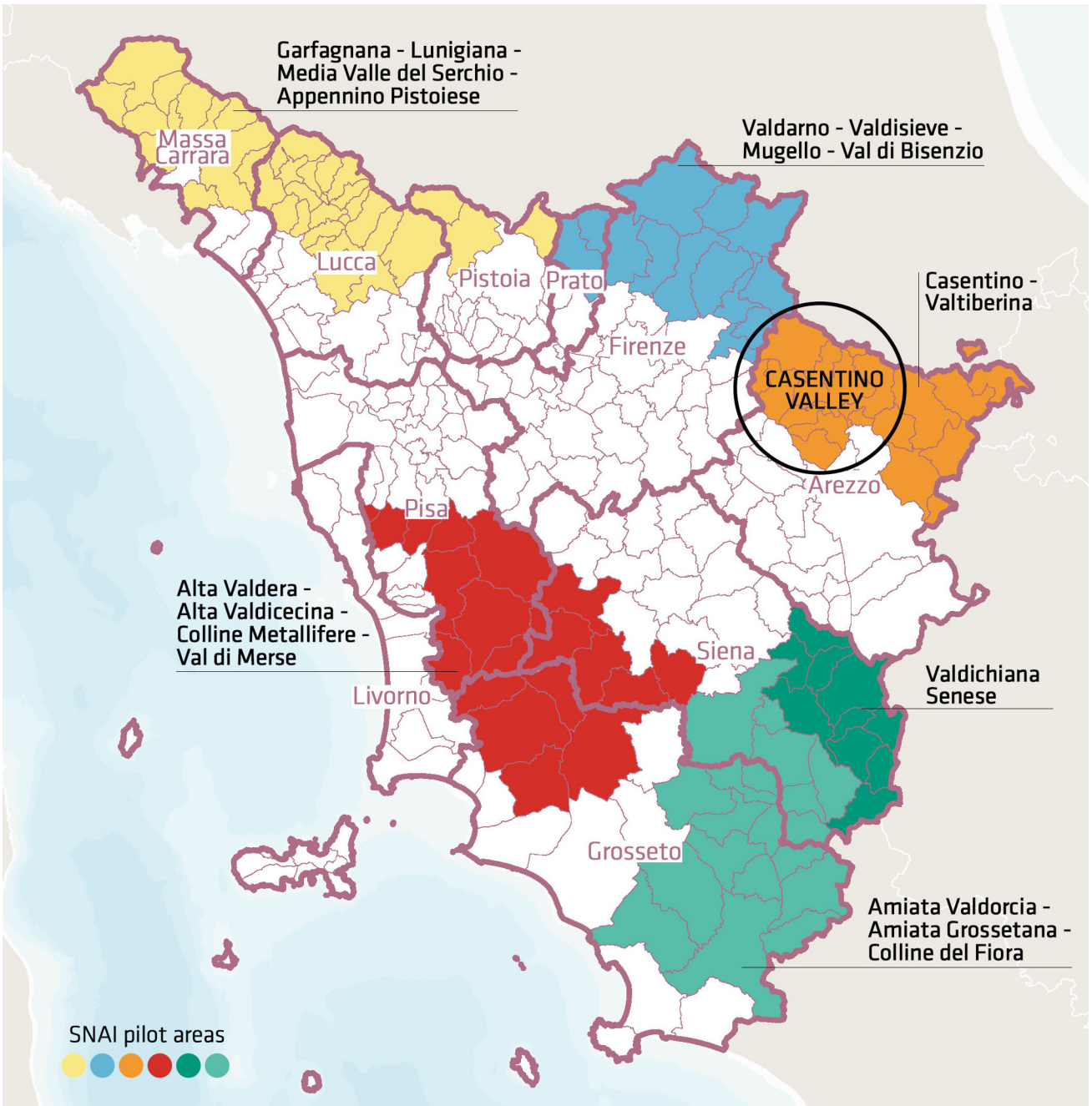

Fig. 1 Location of the Casentino Valley in Tuscany, Italy, as part of a SNAI pilot area for inner areas (authors' elaboration based on Regione Toscana 2021)

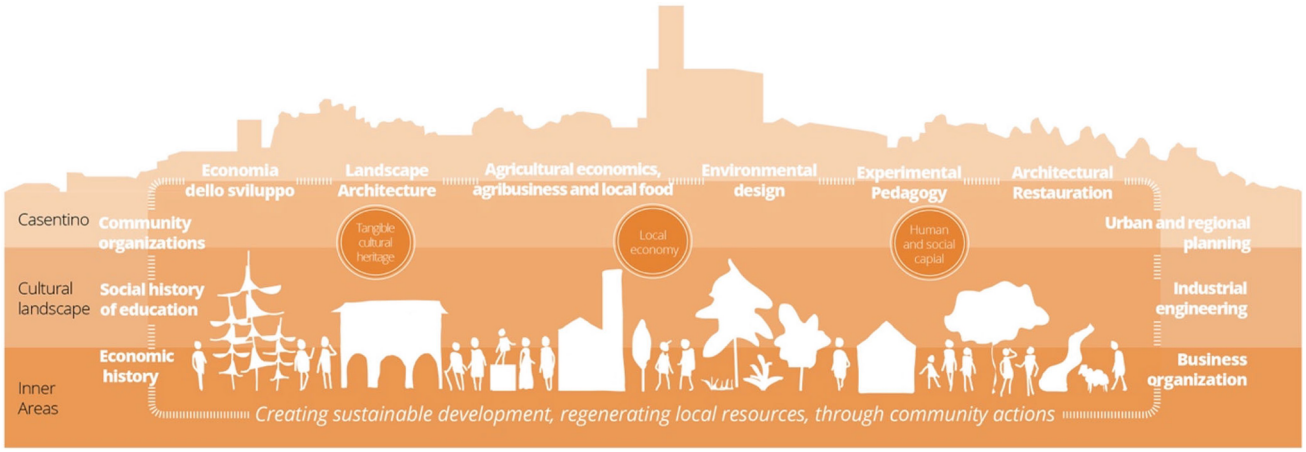

Fig. 2 The REACT Casentino research (by authors)

Fig. 3 Some moments of the REACT research activities (by authors)

Fig. 4 REACT Casentino—interdisciplinary thematic seminar (by authors)

design innovative proposals for revitalising the Casentino area, focusing on its environmental, anthropic and physical aspects, reviewing past and ongoing initiatives and analysing strategies to identify areas for sustainable improvement.

Under the guidance of tutors and professors, students were divided into interdisciplinary groups. They worked to create project proposals that were later presented to the local community. These projects aimed to enhance Casentino's cultural and natural heritage, promote sustainable tourism, and involve local communities in the development process. The seminar also included video interviews with participants and stakeholders to assess its impact and broaden the dialogue on inner-area regeneration. This approach fostered skill exchange, enriched learning experiences and demonstrated the potential for meaningful regional transformation.

The training activity was structured around in-depth study sessions and group work, focusing on social, environmental and economic sustainability, continuing education, and community participation. Initial lessons introduced key concepts like cultural landscape, sustainable development, ecological design, mobility and community identity, with particular attention to Casentino's intangible heritage. A comprehensive case study in the Casentino region focused on immersive educational and cognitive activities to enhance the understanding of local landscapes and promote regional bio-products. As part of this study, students participated in exploratory walks, including visits to the village of Raggiolo's ancient pathways, a chestnut grove, and a hiking trail in the Pratomagno Mountains. These activities provided practical learning opportunities to study the local ecosystems, facilitating interactions with diverse stakeholders.

Discussions with stakeholders—public administrations, local associations, producers and educational institutions—focused on environmental knowledge, local bio-product promotion, tourism potential and community management. These interactions mapped existing networks and ongoing projects to strengthen connections between seminar themes and regional activities.

Practical proposals included designing a sustainable mobile store for local products, converting an abandoned building into a nearly zero education centre on ecological topics, and creating a landscape knowledge trail. The seminar's project development phase, which continued at the University of Florence, involved close collaboration between students, researchers and local actors, fostering community growth and collective learning.

In the final phase, students, organised into interdisciplinary groups, developed proposals on priority themes identified in collaboration with the community. This phase required students to address the territory's needs by transcending their specific knowledge areas. This resulted in regeneration proposals from social, environmental and economic perspectives. Discussion and review sessions allowed for evaluating and refining these proposals, ensuring their validity and potential for real-world impact.

4 Projects Derived from Seminar Case Studies

The Thematic Seminar conducted as part of the REACT project focused on the village of Raggiolo and the Valteggina Valley within the Casentino region. These areas were prime locations for implementing innovative participatory design models that could leverage existing educational, entrepreneurial and political initiatives. The seminar offered students first-hand experience in understanding the region's eco-physical and anthropological context through direct engagement with the local community and its environment.

Three specific projects were developed during the seminar:

- **CUB.LABORA**. Enhancing Raggiolo's Village. This project proposed the creation of a sustainable modular technological unit to serve as a small mobile store to support local short-chain eco-commercial activities. This initiative was designed to bolster local economies and maintain cultural and commercial vibrancy within the village. See Project 1: CUB.LABORA. A small store 2.0 for Raggiolo.
- **L'ELICA DEL PRATOMAGNO**. This project aimed to renovate an abandoned public building in the Pratomagno area. Its goal was to convert the building into a permanent education centre focused on climate change. The centre is intended to serve as a hub for learning and engagement on environmental issues affecting the region and beyond. See Project 2: L'ELICA DEL PRATOMAGNO. Learning ecosystem on the environment and climate change.
- **TRANS+HUMUS**. Creation of a landscape knowledge trail. This trail, stretching from Raggiolo to Pratomagno, was designed to commemorate historic transhumance routes, integrating cultural heritage with natural landscape exploration. It is an educational resource highlighting the area's ecological and historical significance. See Project 3: TRANS+HUMUS. Through the landscape between Raggiolo and Pratomagno all three projects, aligned with the REACT research initiative's overarching goals, contribute to achieving the 2030 Agenda for Sustainable Development objectives. They focus on empowering the community, ensuring sustainable development and management, implementing sustainable forest management and biodiversity protection strategies, and fostering innovative collaborations for entrepreneurial growth. These initiatives aim to create resilient, well-

managed, environmentally sustainable and economically vibrant territories.

4.1 Project 1: CUB.LABORA. A Small Store 2.0 for Raggiolo

This proposal emerges from an analysis of the local context. The village of Raggiolo faces significant challenges due to a lack of essential services, compounded by its geographical isolation (Fig. 5). The economy, primarily based on agriculture and seasonal tourism, and the limited availability of job opportunities exacerbate these issues. To enhance the quality of life for residents, it is crucial to attract investment and develop sustainable tourism services by leveraging the landscape and cultural assets of the Casentino region.

In response to these needs, the working group has designed an eco-temporary structure that provides essential services while promoting local bio-products. This modular unit, constructed entirely using platform frame technology, serves as a multi-functional space: it can house a store, host cultural events, and operate as a mobile clinic offering healthcare services. Additionally, the mobile structure can facilitate training events to promote an understanding of local production chains focusing on food, economic and environmental sustainability.

The design of this mobile structure was inspired by the life cycle assessment, which involved local SMEs that produce wood living structures using local materials. Furthermore, the store's subcomponents were designed as modular elements that can be connected without glue and entirely managed and recycled at the end of the system's useful life.

The specific objectives for this project were:

- Attracting green investment will enhance the quality of life, improve local living conditions and develop sustainable tourism services.
- Promote local products, utilising a temporary, modular wood structure to provide essential services, promote local products and host cultural events.
- Support ecological education and training, facilitating training events focused on local production chains and sustainability and providing mobile healthcare services.
- Foster community empowerment, encouraging the preservation of local cultural and natural heritage through eco-sustainable innovation and community-driven initiatives.

The project seeks to increase awareness and appreciation of the area's natural and cultural heritage, both tangible and intangible. It also aims to provide educational support to strengthen traditional local supply chains through eco-sustainable innovation. By fostering co-empowerment within the community, the proposal encourages the preservation of local legacies, aligns with sustainable economic goals, and develops coherent educational initiatives.

4.2 Project 2: L'ELICA DEL PRATOMAGNO. Learning Ecosystem on the Environment and Climate Change

This project proposal (Fig. 6) outlines the establishment of an eco-community cooperative to manage a new permanent training centre on environmental issues. The centre will be located in a repurposed abandoned public building in Pratomagno.

The primary objectives are to enhance sustainable tourism initiatives and ecological education in the region while promoting employment opportunities and social cohesion. The project emphasises energy-efficient redevelopment, aiming to convert the educational facility into a versatile Nearly Zero Energy Building (nZEB), a structure characterised by exceptionally high energy performance and minimal energy consumption. Additionally, the building will function as a meteorological station and provide spaces for the consumption and sale of local products, thereby fostering a hub for innovative social interaction and scientific outreach.

The "Pratomagno Helix" Community Cooperative was designed to leverage local environmental and atmospheric knowledge by revitalising a former Radiotelevisione Italiana (RAI, the Italian national public broadcasting company) building at the summit of Pratomagno. The cooperative enables the communities of Casentino and Valdarno to engage in dialogue and co-design initiatives related to sustainable tourism and environmental education, thereby advancing employment and social cohesion.

The proposed renovation involved replacing the existing roof with an ecological, bioclimatic design to maximise energy efficiency. A greenhouse is integrated into the structure to create a new public space usable throughout the year without a thermal system. Furthermore, the project involves constructing a photovoltaic system to produce renewable energies and reduce building energy consumption. This renovated structure serves as the primary venue for the cooperative's projects, becoming an 'ecosystem' that exemplifies energy self-sufficiency and sustainability while preserving elements of historical significance.

The building functions as a multipurpose space for meetings and scientific dissemination. Visitors can also purchase

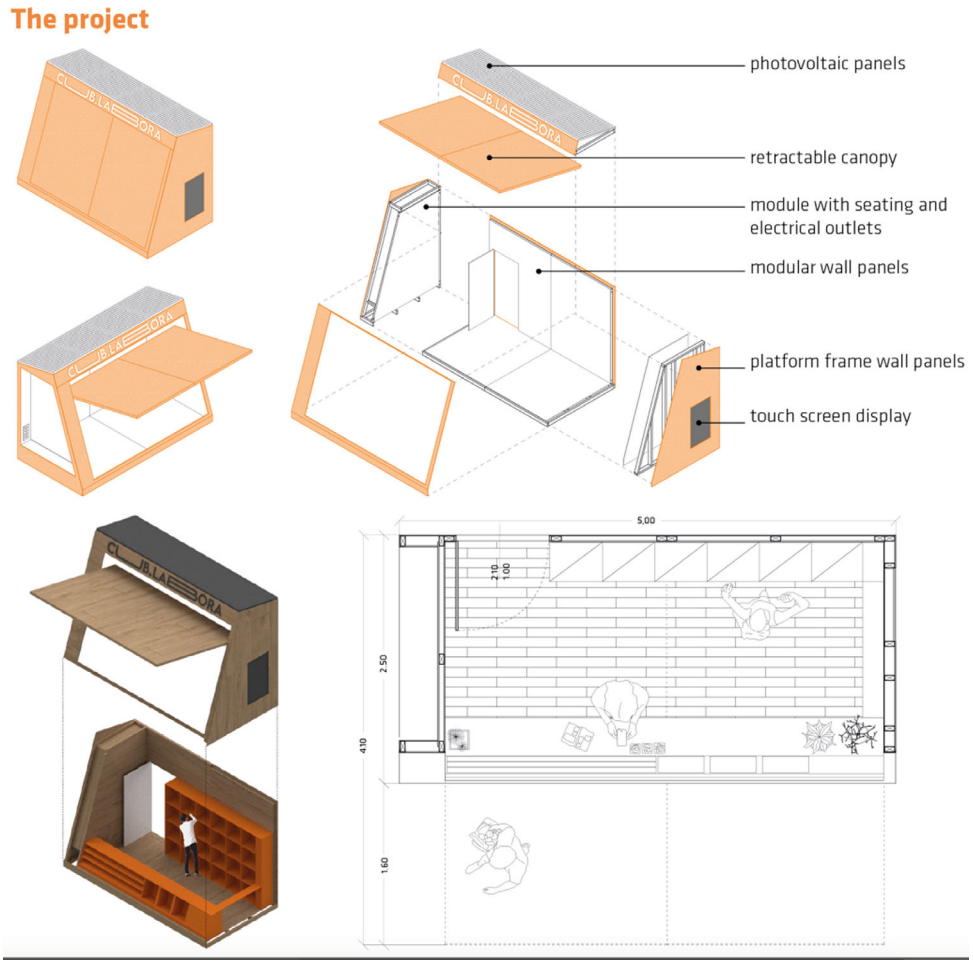

Fig. 5 Project 1: CUB.LABORA. A small store 2.0 for Raggiolo (by Cub.Labora team)

and consume bio-local products, gaining insights into the culinary traditions of the surrounding valleys. A portion of the building is dedicated to meteorological instruments, which the 'Pratomagno Helix' cooperative can use to design environmental education and scientific outreach initiatives involving the local community, promoting events, workshops, cultural initiatives and activities for locals and tourists. Specifically, the cooperative offers educational programs on environmental and atmospheric topics (targeted at schools, residents and tourists) within the sustainable facility at the Pratomagno Summit. These programs focus on renewable energy use and protecting landscapes and biodiversity. The cooperative's training experts will assess the skills required to ensure the quality of the proposed activities, identify the training needs of employees, and provide appropriate training and refresher courses.

4.3 Project 3: TRANS+HUMUS. Through the Landscape between Raggiolo and Pratomagno

This project proposal (Fig. 7) begins by addressing several critical challenges: the underutilisation of existing trails as an integrated ecological network at both local and regional levels, the degradation of the landscape mosaic and biodiversity due to inadequate forest and pasture management, and internal conflicts within the Raggiolo community stemming from the lack of hospitality services and the seasonal concentration of tourist flows.

The drawing inspiration for this project can be found in the etymology of 'transhumance,' derived from the Latin 'trans' (through) and 'humus' (earth). For this reason, the project aims to promote two key concepts: traversing the landscape as a fundamental practice for reclaiming and enhancing the territory and revitalising the land as a fertile space for cultivating new, positive practices in hospitality.

Accordingly, the project seeks to regenerate hiking infrastructure sustainably, encouraging the return or arrival of residents who can contribute entrepreneurial knowledge and

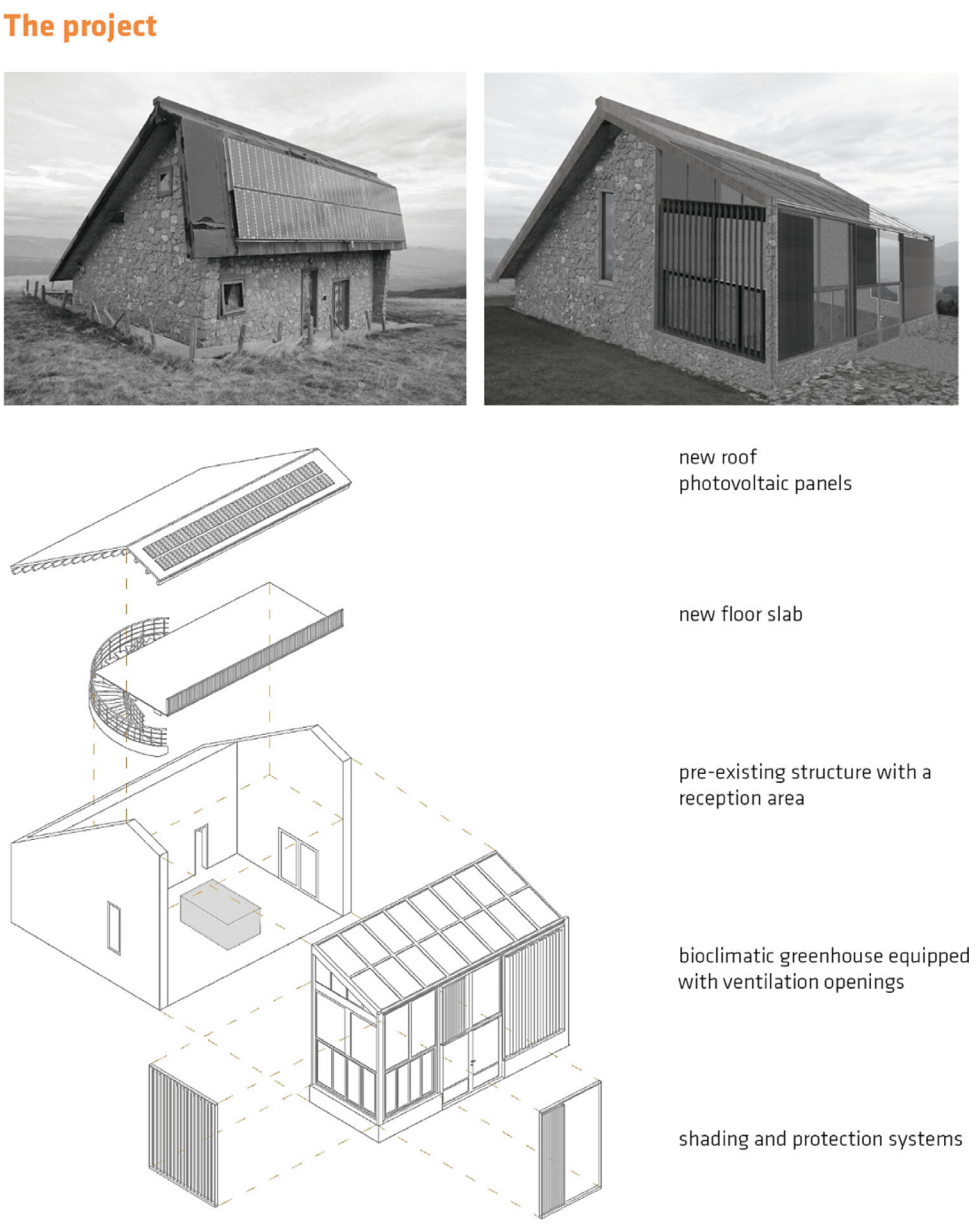

Fig. 6 Project 2: L'ELICA DEL PRATOMAGNO. Learning ecosystem on the environment and climate change (by L'Elica del Pratomagno team)

promote innovative learning within the local community. This approach empowers the community to take an active and responsible role in its development, fostering a renewed connection to the land and its cultural and ecological heritage.

The project is structured around different scales, from the territorial level of the Transhumance trail through Tuscany, which spans from Raggiolo to Alberese (Action T), to the development of chestnut groves around Raggiolo (Action H) and the ring road connecting Raggiolo with the Pratomagno Cross (Action TH). In detail:

- Action T1 is focused on creating the Transhumance Route as a Catalyst for New Walkers and Landscape Users, Subject to a Territorial Pact, and it is finalised to a) Enhance and network existing work and ongoing projects, b) Develop an appropriate signage system, c) Implement actions aimed at protecting and increasing biodiversity.
- Action T2 is finalised to create a driving event (Casentino Ultra Rail) to generate long- and short-term benefits, attracting visitors and generating local economic benefits.
- Action H promotes Raggiolo as a Stopover/Departure Point for New Hikers and Amplifies the Landscape Value System. It is finalised to a) Mapping abandoned chestnut groves around Raggiolo, b) Establishing a land association for managing chestnut groves and developing alternative accommodations (e.g., cabins, tree houses, temporary camping platforms), c) Creating a platform to integrate hospitality services (extended hotels, agritourism, alternative housing) and developing territorial marketing

Fig. 7 Project 3: TRANS+HUMUS. Through the landscape between Raggiolo and Pratomagno (by Trans+Humus team)

strategies, d) Initiating a mediation process within the community to address conflicts.

- Action TH aims to create an Art Trekking, utilising contemporary art to transmit community knowledge and create opportunities for reflection and landscape observation along the route from Raggiolo to the Pratomagno Cross.

The core of the TRANS+HUMUS project is the Raggiolo community, which will be engaged through visits and valuable meetings during dedicated planning seminars. In detail, this design proposal aims to improve eco-services and enhance well-being by promoting the return or arrival of inhabitants who can activate entrepreneurial environmental skills. Accordingly, a community training program is proposed

to facilitate listening, recognition, and dialogue on cultural and natural heritage preservation, conscious tourism development, and new employment opportunities. In detail, the proposed training will involve the community in problem-solving by leveraging local resources. This will be facilitated through 'Study Circles'—small groups of 8–10 participants, including village residents, local guides, environmental managers and hospitality professionals, coordinated by a mentor. Each group will focus on different aspects of the identified challenges, aiming to consolidate and develop learning from community knowledge and practices to drive sustainable, active and responsible development.

The redevelopment project aligns with the 2030 Agenda for Sustainable Development objectives, particularly in empowering the community to create resilient territories, ensuring sustainable development and management, implementing strategies for sustainable forest management and biodiversity protection and fostering innovative collaborations for entrepreneurial growth.

5 Conclusion

One of the key takeaways from the REACT Seminar was the immense value of interdisciplinary collaboration to develop sustainable proposals for the regeneration of inner areas. The seminar brought together students from architecture, economics, and education to foster a richer, more holistic approach to problem-solving. Each discipline brought its perspective, allowing the group to address complex challenges in the Casentino region with innovative and well-rounded sustainable solutions. In particular, this experience highlighted how collaboration across different fields can lead to more creative and effective outcomes in addressing the multifaceted regional development issues.

Another significant lesson was the importance of engagement with local communities. By directly interacting with local stakeholders, ranging from public administrators to local producers and community associations, students gained a deeper understanding of the environmental, socio-economic, and cultural landscape of the Casentino area. These interactions ensured that the projects developed were grounded, addressed the actual needs and challenges faced by the community, aimed to serve and made community involvement a crucial component of successful regional sustainable development initiatives.

The seminar also underscored the value of fieldwork and immersive experiences. Activities like exploratory walks, on-site inspections, and direct engagement with the local environment proved vital learning tools. These hands-on experiences allowed students to connect more deeply with the physical and cultural aspects of the Casentino region, providing insights that cannot be gained from classroom learning alone. Immersion in the local context enriched the students' understanding and inspired more thoughtful and relevant project proposals (Fig. 8).

A particularly impactful lesson was the effectiveness of participatory design in empowering communities. By involving residents in the design and development process, students learned how to co-create solutions that genuinely reflect the community's needs and desires. This can increase the resilience of urban spaces and territories and reduce the negative effect of climate change on the building environment. Furthermore, this approach ensures that projects are more sustainable and well-received and fosters a sense of ownership and pride among community members.

Finally, the seminar highlighted the potential of modular and mobile solutions as flexible, adaptable tools for regional development—for instance, the CUB.LABORA project, which proposed a modular mobile unit to support local commerce, illustrated how such infrastructure can effectively address service gaps in remote areas. These solutions offer the flexibility needed to meet the evolving needs of rural communities, making them particularly valuable in regions like Casentino, where geographic isolation can pose significant challenges.

Overall, the Seminar provided valuable insights into the power of interdisciplinary collaboration, community engagement, the importance of immersive learning, and the benefits of adaptable, participatory design in fostering sustainable regional development.

The Thematic Seminar within the REACT project successfully integrated academic learning with practical, community-driven initiatives, resulting in tangible proposals that address the specific needs of the Casentino region. The experience highlighted the importance of interdisciplinary approaches, community engagement, and field-based learning in creating sustainable, resilient communities. The projects developed, from mobile stores to educational centres and landscape trails, demonstrated a precise alignment with broader sustainable development goals, particularly in promoting environmental stewardship, economic vitality and social cohesion.

These initiatives offer a model for future efforts in rural regeneration, emphasising the need for flexible, context-sensitive solutions that empower local communities and preserve cultural and natural heritage. The seminar's outcomes illustrate the potential for academic institutions to contribute meaningfully to regional transformation, fostering long-term sustainability through education, innovation and community collaboration.

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Fig. 8 The participants in the research working group 'REACT. Regenerating the cultural landscapes of inland areas in a people-centred perspective'—Croce del Pratomagno—Casentino—October 2023 (by authors)

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