

**iNEST – Interconnected Nord-Est
Innovation Ecosystem:
General Frame of the Project and Activities
of Young Researchers at the University of Trieste**



PNRR project “iNEST – Interconnected Nord-Est Innovation Ecosystem”
developed at the University of Trieste, Italy from 01/09/2022 to 31/12/2025

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Index

Pierluigi Barbieri Introduction to PNRR project iNEST – Interconnected Nord-Est Innovation Ecosystem	8
Spoke 8 - Maritime, marine and inland water technologies: towards the Digital Twin of the Upper Adriatic	10
Alberto Pallavicini, Giorgio Fontolan, Alberto Marinò, Vittorio Bucci, Giorgio Sulligoi, Elena Marchigiani, Luca Manzoni, Pierluigi Barbieri Introduction to iNEST Spoke 8 - Maritime, marine and inland water technologies: towards the Digital Twin of the Upper Adriatic	
Camilla Spoto, Azzurra Tommasi, Beatrice Mezzena Lona, Giulio Bolognini, Piero G. Giulianini, Alberto Pallavicini, Massimo Zanetti, Chiara Manfrin Tracking the Blue Crab Invasion: eDNA Unveils Its Spread in Water Inlands of the Friuli Venezia Giulia Region, Italy	12
Annelore Bezzi, Saverio Fracaros, Carla Garcia Lozano, Cinzia Leccardi, Chiara Popesso Coastal vulnerability assessment and challenges for nature - based solutions (coastal dunes) in the Northern Adriatic sea	15
Chiara Pisoni, Federico Floreani, Elena Pavoni, Stefano Covelli, Gianpiero Adami A comprehensive database on contaminants as decision-support tool for local authorities in environmental management of coastal-marine sediments in the Northern Adriatic	21
Serena Bertagna, Luca Braidotti, Natasha Taucer Marchesi, Samuele Utzeri, Vittorio Bucci, Alberto Marinò Sustainable Applications of HDPE in Boatbuilding: Parametric Design and Experimental Investigations	25
Luca Braidotti, Serena Bertagna, Samuele Utzeri, Natasha Taucer Marchesi, Vittorio Bucci, Alberto Marinò Uncertainty-Aware Emissions Assessment for cruise-ship itinerary planning	31
Elena Marchigiani Integrated Land-sea Maritime and Spatial Planning	36
Ludovico Centis Navigating the future: retracing 20th century inland and coastal mobility visions for the Friuli Venezia Giulia region	51
Tommaso Padoan, Luigi Rovito Evolutionary Algorithms and Cellular Structures for Interpretable Models of Physical and Biochemical Variables	58

Kenza Benjelloun Cellular automata inspired learning with Recurrent Neural Networks for Sea Surface Temperature	64
Lorenzo Bonin, Luca Manzoni Deep Learning Techniques for High-Resolution Coastal Modeling	72
Pierpaolo Scarascia, Sebastian Plehan, Nydia Catalina Reyes Suarez, Alexia Cociancich, Marco Jokic, Alessandra Giorgetti, Marina Lipizer From Static Maps to Dynamic Data: improving the Gulf of Trieste Geoportal	76
Spoke 2 - Health, Food and Lifestyles	80
Pierluigi Barbieri Introduction to iNEST Spoke 2 – Health, Food and Lifestyles	
Paola Sist, Sabina Passamonti, Federica Tramer New analytical methods for the validation of biomarkers in translational and precision medicine	82
Paola Sist, Laura Colomina-Alfaro, Sabina Passamonti, Ranieri Urbani, Antonella Bandiera Elastin-like biopolymers for bioactive interfaces	87
Spoke 4 - City, Architecture, Sustainable design	92
Elena Marchigiani City, Architecture and Sustainable Design in the North-eastern Italian Territories	
Thomas Bisiani Extending Building Life Cycles: Flexible and Adaptable Solutions for Energy Efficiency and Circularity	109
Matteo D'Ambros Water as a Framework for Resilience: Designing Territories for the Ecological Transition	113
Paola Cigalotto Research and innovation on green and blue networks	119
Paola Limoncin Fragility, inclusion, and transformation of the built environment	125
Teresa Frausin De-fragilizing neighbourhoods. Setting a framework for spatial analysis across public space, facilities and the home in a perspective of supporting fragile groups	131

Spoke 9 Models, Methods, Computing Technologies for Digital Twin	142
Francesca Cairoli	143
Advanced Learning and Conformal Methods for Verification and Prediction of Stochastic Systems	
Erica Salvato	147
Advances in Model-Free and Data-Driven Control for Robotic Systems	
Spoke 8 research and innovation topics in the frame of maritime, marine and inland water technologies: towards the digital twin of the upperAdriatic – Call for projects year 2023 and 2024	152

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City, Architecture and Sustainable Design in the North-Eastern Italian Territories

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⇒ ABSTRACT

The involvement of the University of Trieste in iNEST Spoke 4 offered a valuable opportunity to address environmental, energy, social, and economic challenges in the north-eastern Italian territories. Through an interdisciplinary planning and design approach, research explored three main fields: smart networks for biodiversity and water; innovative technologies and solutions to transform the construction sector and retrofit existing buildings; and new urban policies and design strategies to tackle growing conditions of poverty and social vulnerability.

► INTRODUCTION

Since 2022, a multidisciplinary team from the Department of Engineering and Architecture (DIA) at the University of Trieste has been participating, as an affiliated project partner, in iNEST Spoke 4, *City, Architecture and Sustainable Design*, led by the University IUAV of Venezia.¹ The research focuses on north-eastern Italy, particularly Veneto and Friuli Venezia Giulia regions. Stretching from the mountains to the sea, this area is especially vulnerable to climate change. However, despite being exposed to similar climate-related hazards, the interaction of settlement patterns, landscapes, environmental features, and socio-economic dynamics produces a highly differentiated picture that calls for context-specific actions.

The geomorphological and territorial structures of the North-East are organised into “stripes” running parallel to the coast: the Alpine area and pre-Alpine hills, with significant landscape, environmental, and cultural-historical value; foothills and plains, shaped by ancient centuriation, rivers, and infrastructure corridors, alternating denser urban areas with more rural and dispersed settlements; and coastal and lagoon systems, dominated by reclamation patterns, wetlands, and river mouths.

Since the 1960s, urbanisation in Veneto – and to a lesser extent in Friuli Venezia Giulia – has intensified, producing cross-regional continuities of urban fabric and an often-conflicting proximity of diverse land uses, rural landscapes, and natural areas. Production systems are most concentrated along the central stripe, although there are marked differences between the two regions. Within a predominantly fine-grained spatial organisation of production and settlements, the impacts of the energy crisis are expected to grow, necessitating a rethinking of supply and consumption chains. At the same time, local economies in “slower” and more “peripheral” contexts – such as mountain and coastal tourism, and agri-food – are highly exposed to climate change and required to align their activities with the protection of environmental systems and the maintenance of ecological services. ISTAT (Italian Institute of Statistics) data also highlight a sharp demographic contrast: while areas around major urban centres and infrastructure hubs show relative stable trends, mountain, hill, lowland, and coastal sectors are experiencing depopulation.

In this context, over the coming years, adaptation to climate-related impacts, as well as to hydraulic, geological, and seismic risks – along with energy retrofitting of buildings and the maintenance of a widespread architectural historical heritage – will increasingly shape the construction market. The risk, however, is that the North-East could become a vast, diffuse construction site, with many small-scale interventions lacking a broader territorial vision.

Spoke 4 takes on the ethical and technical responsibility of addressing these complex conditions by developing sustainable design strategies for the care and regeneration of the built environment, working across multiple scales and domains – from territorial and urban planning to architecture, construction, and industrial design. Its main references are the international commitments outlined in the Paris Agreement and the European Green Deal – the shared strategy aimed at achieving carbon neutrality by 2050 (European Council-Council of the European Union, 2025). The key challenge lies in translating this call to action into a coherent territorial strategy – one that tackles environmental, energy, social, and economic issues while also embracing a profound renewal of technical and technological approaches.

¹ The scientific coordinator of the overall Spoke is Lorenzo Fabian. In addition to the University of Trieste, the scientific coordinators for the other project partners are: Massimiliano Condotta (University IUAV); Luciano Gamberini (University of Padova); Alberto Sdegno (University of Udine); Lorenzo Bellicini (CRESME – Consortium for the coordination of research activities concerning the Venice lagoon system); Pierpaolo Campostrini (CORILA – Centre for economic and social market research on construction and the territory). At the University of Trieste, the coordinator of the DIA research group is Elena Marchigiani (spatial planning and urban design). The team includes: Sara Basso, Ludovico Centis, Paola Cigalotto, Matteo D'Ambros, and Teresa Frausin (spatial planning and urban design); Giuseppina Scavuzzo, Gianfranco Guaragna, Thomas Bisiani, and Paola Limoncin (architectural composition); Ilaria Garofolo and Carlo Antonio Stival (technical architecture).

Specifically, Spoke 4 seeks to identify and test inclusive and radical solutions that accelerate and intensify the transformation of existing infrastructures and real estate assets with respect to their functionality, performance, sustainability, and responsiveness to emerging social needs. This objective is advanced by fostering alliances among researchers, innovators, and supply chains within territorial economies, and by promoting a broader “movement for change” across the planning, design, and construction sectors (iNEST, 2025).

⇒ A RANGE OF INTERCONNECTED TOPICS

Alongside specific, coordinated cross-cutting activities, Spoke 4 is organised into a series of Research Topics (RTs), which have evolved and integrated throughout the course of the project (Bertin et al., 2024).

RT1, *Strategic plan for the development of the construction and sustainable design sectors*, provides the overall framework for the Spoke and defines the Research & Innovation issues underpinning its Cascade funds. It addresses a variety of fields: environmental, energy, and mobility challenges; innovative technologies supporting the evolution of the construction sector towards digitalisation, energy transition, and climate change adaptation; scenario-building through backcasting to envision a liveable built environment; strategic planning to transfer innovations and methodologies to the building supply chain – the main output of RT1.

RT2, *Technological solutions for the construction and sustainable design sectors*, focuses on applied research aimed at achieving carbon neutrality. Activities are organised across several domains: the identification of innovative building and furnishing materials that enhance user well-being and are based on circular economy and green design principles; the planning of smart networks for energy, mobility, water, and green spaces ((EMWG), along with the supply chains that support these resources; the integration of heritage recovery and conservation with new technologies and materials; the improvement of usability and accessibility in buildings and urban environments from a “design for all” perspective, and in the light of ongoing demographic and socio-economic change; the enhancement of urban and territorial resilience through standardised repair models after extreme weather and climate events; and, finally, the application and testing of these innovations in pilot projects, which constitute a tangible legacy of RT2 and the Spoke as a whole.

Finally, RT3, *Interaction between environments and human beings in the construction and sustainable design sectors*, is dedicated to social innovation in support of urban resilience. Its activities place at the centre the complex relationships among spatial configurations, human behaviour and emerging social needs. These include: examining how spatial forms can foster meaningful interactions between people and places; exploring the role of the urban environment in influencing behaviours; and, in combination with the pilot projects, developing architectural and urban design solutions to enhance the social use of space and improve the quality of life of vulnerable groups – particularly the elderly, migrants, and individuals with sensory, physical, or cognitive impairments.

As the following paragraphs will illustrate, participation in all Spoke 4 RTs enabled DIA researchers not only to share and integrate diverse approaches and expertise, but also to investigate innovative topics and methods, across varying scales and thematic areas.

⇒ GREEN AND BLUE NETWORKS

As part of RT1 and RT2 activities on regional planning and spatial design, the contribution of DIA focused on developing smart networks for biodiversity and water in the North-East.²

In these territories, weather and climatic events often produce converging impacts: desertification, drought, hydrogeological instability, degradation of terrestrial and aquatic ecosystems, rising energy demand, and disruption to transport, urban areas, and economies. Their cumulative effects undermine

² The involved researchers are: Elena Marchigiani, Sara Basso, Paola Cigalotto, Matteo D’Ambros, and Teresa Frausin.

ecological functions, reduce spatial and resource efficiency, and place strain both on natural and human environments. In particular, dysfunctions in “green” and “blue” networks highlight the need for integrated planning approaches tailored to local geographical characteristics.

The research begun with the mapping and assessment of these networks. Data and projects were gathered to examine current perspectives and tools for the management of ecological, water, and hydrographic systems, with the aim of identifying critical issues and potentials for their review towards carbon neutrality and climate adaptation (Cigalotto & D’Ambros, 2024).

Cartographies of *Natura 2000 areas* – EU Sites of Community Importance delineated by Regions and Provinces in accordance with the “Habitats” (92/43/EEC) and “Birds” (79/409/EEC) Directives – reveal a north-east to south-west diagonal axis, which indicates the backbone of a still latent, large-scale ecological network. In addition, peripheral “nodes of naturality” suggest potential connections with neighbouring regions and countries. However, extensive areas of the foothill sector and intermediate plain remain excluded. Regional datasets from Veneto and Friuli Venezia Giulia, interpreted through the *Carta della Natura* developed by ISPRA (Italian Institute for Environmental Protection and Research), confirm these uncovered areas as ecologically weak and highly fragile under intense anthropogenic pressure, in contrast to mountain zones and parts of the coast which retain the highest ecological value (Fig. 1).

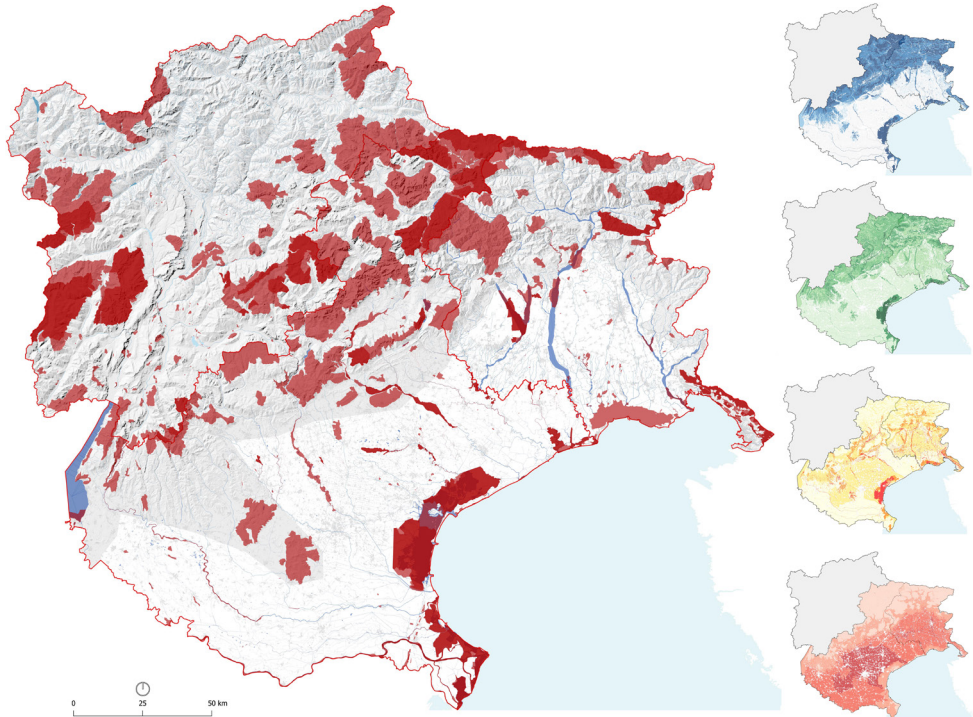


Figure 1

Environmental networks in the North-East. On the right: *Natura 2000 areas*. On the left: *Carta della Natura*; from the top, ecological value, sensitivity, fragility, and anthropic pressure.

Edited by P. Cigalotto. Sources: <https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/6fc8ad2d-195d-40f4-bdec-576e7d1268e4>; <https://irdat.regione.fvg.it/consultatore-dati-ambientali-territoriali/home?language=it>; <https://idt2.regione.veneto.it>; <https://www.isprambiente.gov.it/it/servizi/sistema-carta-della-natura/cartografia/carta-della-natura-alla-scala-1-50.000/veneto>.

Building on this evidence, cross-sectional territorial analysis in relation to geomorphological configurations allowed both the identification of settlement and land-use interactions with blue and green ecological corridors and the assessment of the differentiated impacts of ongoing weather and climatic change. In upland and hilly areas, habitat simplification is marked by the loss of meadows, pastures, and cultivated fields, with biodiversity declining due to woodland expansion and invasive species. In the lowlands, by contrast, intensive agriculture has largely eliminated woodlands and grasslands, confining biodiversity to marginal zones (Fig. 2).

Despite the transitions underway, spatial and landscape planning tools developed by the North-East Regions and Provinces show considerable delays in the concrete definition and management of environmental networks (Provincia Autonoma di Trento, 2008; Provincia Autonoma di Bolzano, 2018; Regione Autonoma Friuli Venezia Giulia, 2018; Regione del Veneto, 2020). These networks often remain largely theoretical, conceived as abstract, large-scale connections between isolated areas. In practice, their detailed definition is delegated to municipal local plans, where they are frequently confined to connective zones with limited environmental value.

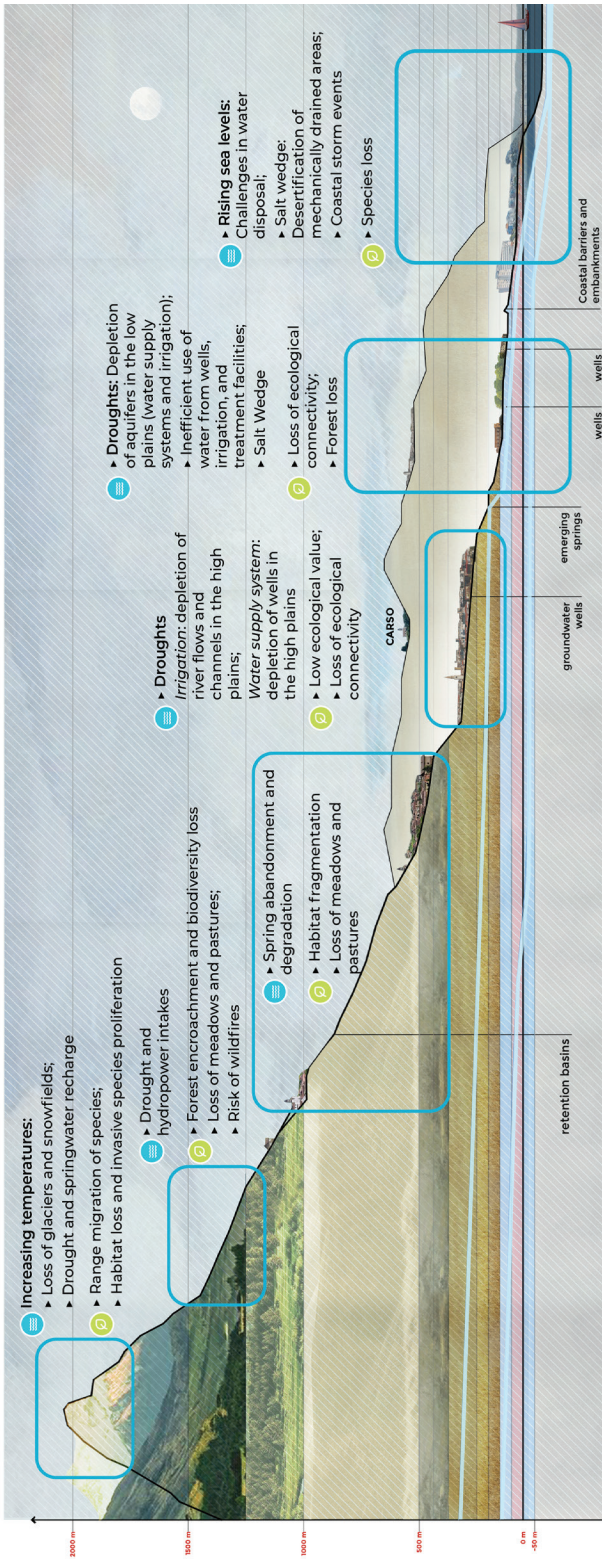
Based on these representations, the contribution of DIA to future scenarios was structured around two main lines: a theoretical reflection on translating the concept of “smart environmental networks” into planning tools; and the practical application of this concept in two pilot areas along the Friuli Venezia Giulia coast.

From the perspective of the “Nature Restoration Law” (European Union, 2024), clarifying the meaning of smart environmental networks is crucial. A simplified enforcement of this regulation risks focusing solely on the restoration of individual habitats – e.g., wetlands and grasslands, riverine, lacustrine, alluvial and riparian areas, forests, and dune environments – without establishing broader, more integrated ecological systems. Equally ineffective are many approaches characterising existing planning instruments: i) treating naturalness primarily as a narrowly applied regulatory constraint; ii) pursuing “spot-rewilding” rather than extensive, context-sensitive interventions suited to the highly anthropised north-eastern territory; and iii) adopting security-oriented strategies focused on risk and climate vulnerability through the construction of grey infrastructure and individual public works.

By contrast, the proposed concept of networks adopts a systemic and relational perspective, replacing sectoral zoning with multi- and trans-scalar strategies that foster spatial continuity and functional interrelations among diverse ecologies. Rather than being conceived as a collection of single spaces with varying degrees of naturalness, environmental networks are therefore recognised as components of a more complex and dynamic system, in which water plays a pivotal role. Natural and protected areas reflect a still fragmented territorial structure, however they constitute only one element of a broader “environmental infrastructure”. Within this infrastructure, the water system functions as a filigree – a primary connective thread weaving through North-East landscapes in various forms.

Consistent with this approach, DIA researchers proposed the “forms of water” as both a key vulnerability factor – due to increasingly extreme events such as floods, intense rainfall, prolonged droughts, soil infiltration, and salinisation – and a unifying element. Through erosion and accumulation, water has historically shaped these territories and continues to influence land uses, economic activities, habitability, and ecosystems (Cigalotto & Marchigiani, 2024). The key message is that environmental networks cannot be planned independently of water, understood both as a hydrographic framework of rivers and canals and as a hydraulic system of extraction, distribution, and disposal, particularly in coastal areas.

Accordingly, the scenarios developed for the pilot areas in the lower Friulian plain and the Monfalcone conurbation explored interconnected themes concerning both the consumption of natural resources and their more sustainable management.



Blue network
Green network

Figure 2
Territorial cross-section and climate-related impacts on the green and blue networks.
Author: P. Cigalotto.
Edited by: T. Frausin.

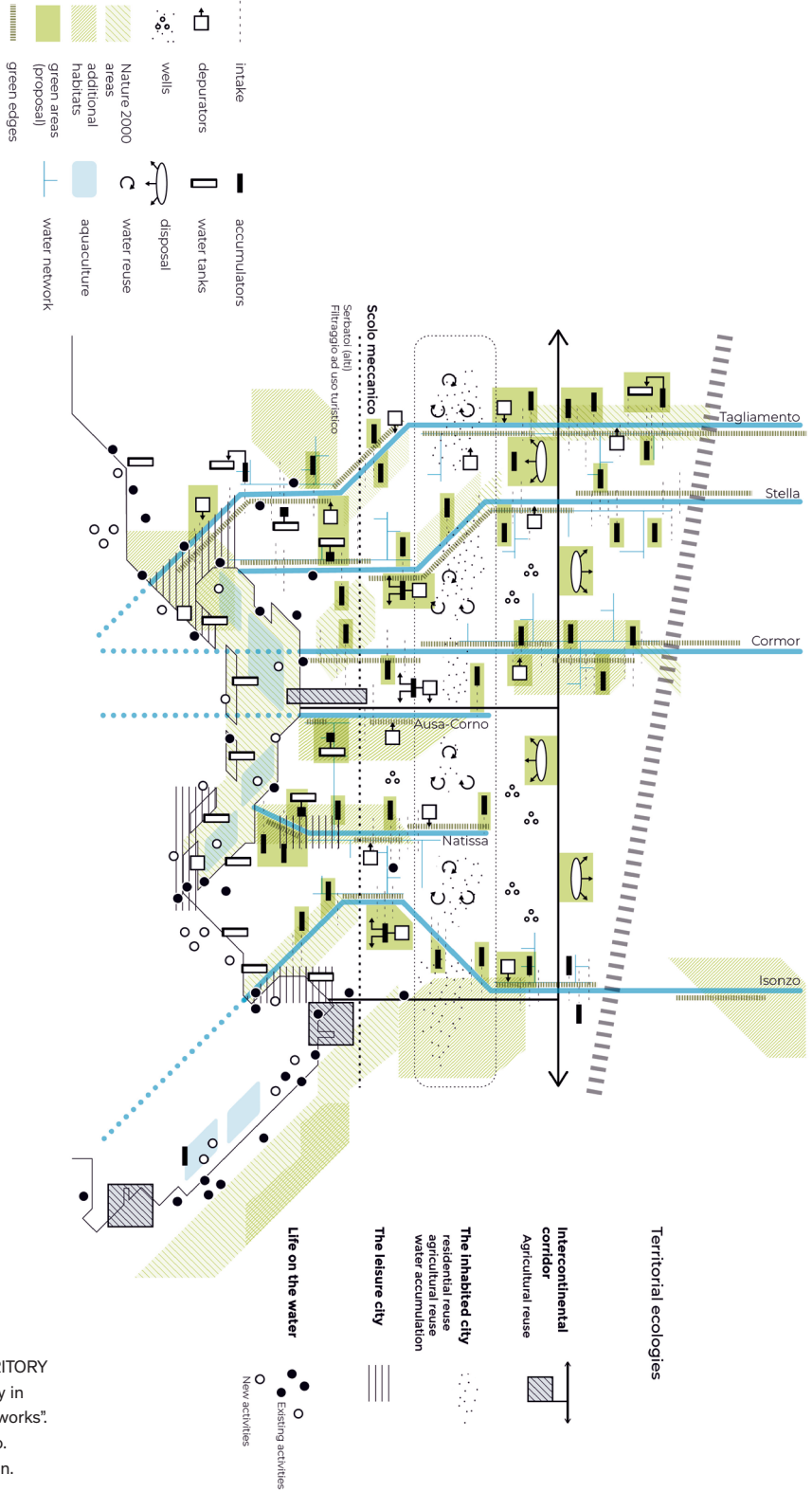


Figure 3
 Scenario "SELF
 SUFFICIENT TERRITORY
 – circular economy in
 environmental networks".
 Author: P. Cigalotto.
 Edited by: T. Frausin.

The first scenario, “BACK TO STORAGE – the new era of scarcity”, highlights environmental networks as key tools for conserving water and biodiversity, as well as producing food and energy. Developing sustainable modes of water extraction and reuse is fundamental, as balancing withdrawal with return to the provisioning cycle represents a central challenge for future territorial functioning and spatial governance.

Complementary to the first scenario, the second, “SELF SUFFICIENT TERRITORY – circular economy in environmental networks”, focuses on hydraulic self-sufficiency at the territorial scale (Fig. 3). Inspired by the concept of Zero Energy Buildings, it envisions north-eastern regions as “Net Zero Water Territories”, where water management is fully optimised. This requires planning instruments that implement measures for progressive hydraulic passivation, while reducing hydrological risks and enhancing resilience to climate change.

In both scenarios, the combination of green and blue networks plays a fundamental role. Green systems enhance ecological efficiency by improving water absorption and filtration, mitigating drought and flood impacts, and connecting habitats. This not only strengthens water resilience but also provides opportunities to rethink the territory holistically, towards the creation of multifunctional landscapes that harmonise nature, infrastructure, settlements, and community well-being.

➤ INNOVATING THE CONSTRUCTION SECTOR AND TRANSFORMING THE BUILT ENVIRONMENT

Still within the scope of RT1 and RT2, DIA undertook further activities aimed at exploring new technologies and design solutions to innovate the construction sector, transform and retrofit the existing building stock.³

The construction industry is a key driver of employment in the North-East, providing a significant contribution to national GDP growth. It is closely linked to other economic sectors, with its outputs directly affecting quality of life. Furthermore, accounting for around 40% of global greenhouse gas emissions, the construction sector plays a strategic role in reducing resource and raw material consumption. However, analyses by CRESME of the north-eastern regions indicate a long-term decline in its productivity.

While recent trends have been positively influenced by tax and economic incentives for building renovation and public investments linked to the National Plan for Recovery and Resilience (PNRR), significant structural challenges remain. These include a shortage of skilled labour – exacerbated by demographic decline and population ageing – as well as limited competitiveness and inefficient use of supplies, particularly energy. As a result, there is a pressing need for innovation in several areas: digitalisation (e-procurement, standardisation of technical information, Industry 4.0 to enhance a smarter and more inclusive usability of residential buildings); sustainable design (especially energy-efficient renovation, climate adaptation, and the reuse of existing structures); and the adoption of life-cycle approaches to both building materials and urban environments (Bellicini & Stemperini, 2024).

The work of DIA focused on two main topics within these themes.

The first concerned the “Internet of Things for a more inclusive space” and examined how the integration of IoT into domestic and urban space could promote safer and more independent living, particularly for vulnerable users. The underlying assumption is that, by providing real-time data, IoT can enable continuous and effective monitoring, including via mobile devices. Such data can support timely and informed interventions concerning both buildings and their occupants.

In the North-East, the growing relevance of these technologies is underscored by a steady increase in the elderly population, which places pressure on the traditional welfare system fostering a shift towards home-based care models. Rethinking domestic infrastructure for individuals with limited autonomy,

³ The involved researchers are: Ilaria Garofolo, Giuseppina Scavuzzo, Gianfranco Guaragna, Carlo Antonio Stival, Thomas Bisiani, and Paola Limoncin.

integrated with the broader housing system, is therefore becoming a priority. This includes the use of next-generation sensors and electronic devices embedded in indoor spaces, furniture, and equipment, interconnected with other intelligent technologies to collect environmental data and communicate with one another. These systems help manage comfort parameters, detect potential hazards, and assist individuals in their daily activities (Evans, 2011; Sobhanbabu *et al.*, 2017). Furthermore, IoT adoption can support the revitalisation of buildings, extending their life cycle and improving usability by adapting them to occupants' needs and profiles.

The second topic explored by DIA concerned the relationships between digital technologies (such as BIM and Digital Twins), material innovation, and design strategies for the sustainable transformation and preservation of the built environment (Limoncin *et al.*, 2024). Research focused on circularity, energy efficiency, and the ecological footprint across the entire construction supply chain. In particular, the theme of "Design for Adaptability, Flexibility and Change" was examined through a survey of international best practices and design case studies from Friuli Venezia Giulia.

In this region, the housing stock includes over 300,000 buildings, more than half of which were constructed before the introduction of seismic safety (1974) and energy efficiency (1976) regulations. The majority (80%) are single-family and two-family houses (ANCE, 2024). However, the rise in single-person households highlights a mismatch between housing needs and the often-excessive size of dwellings. This underscores the necessity to rethink flat layouts to develop adaptable spatial solutions capable of evolving over time with minimal physical intervention. DIA researchers identified the use of self-heating materials and dynamic solar screens, responsive to daily and seasonal cycles, alongside *Envelope Nature-based Solutions* (ENbSS) – such as green roofs, green façades, and solar greenhouses – as a key strategy (Stival, 2024).

Parallel to this, specific design solutions were developed for the Workers' Village in Panzano, Monfalcone (Gorizia), built in the early twentieth century. The selected building typology – morphologically similar to a detached house on a plot but comprising eight housing units – allowed the exploration of various flat configurations and aggregations. The proposed interventions focus on integrating façade elements, particularly solar greenhouses, as a retrofit option compatible with heritage conservation. These elements also provide opportunities to reorganise internal layouts, addressing fragmentation caused by verandas, vestibules, and other added structures. Furthermore, solar greenhouses act as a stabilising buffer for indoor comfort, enhancing energy efficiency by capturing solar radiation in winter and facilitating natural ventilation in summer (Fig. 4).

The development of design proposals was supported by digital technologies, including BIM, which enabled the simulation of different design scenarios, their performance, and the management of the building's life cycle (Fig. 5).

With a view to replicability across the north-eastern territory, the study also identified more general, integrated intervention strategies. These include architectural additions that act as threshold spaces between the dwelling's interior and exterior, enhancing energy performance and mediating the relationship between private areas, introspection, and shared spaces. Such additions can be combined with advanced *Climate Adaptive Building Shells* (CABS), constructed from materials that respond to changing light and temperature. Reversible with respect to the original structure, the new volumes support long-term adaptability. Moreover, solutions that integrate structural, enclosure, insulation, and finishing functions for both the building envelope and internal partitions enable comprehensive structural and energy retrofitting. Finally, the use of lightweight prefabricated components optimises the construction process by shifting operations from the building site to the factory, thereby reducing execution times, energy consumption, and the overall impact of renovation works.

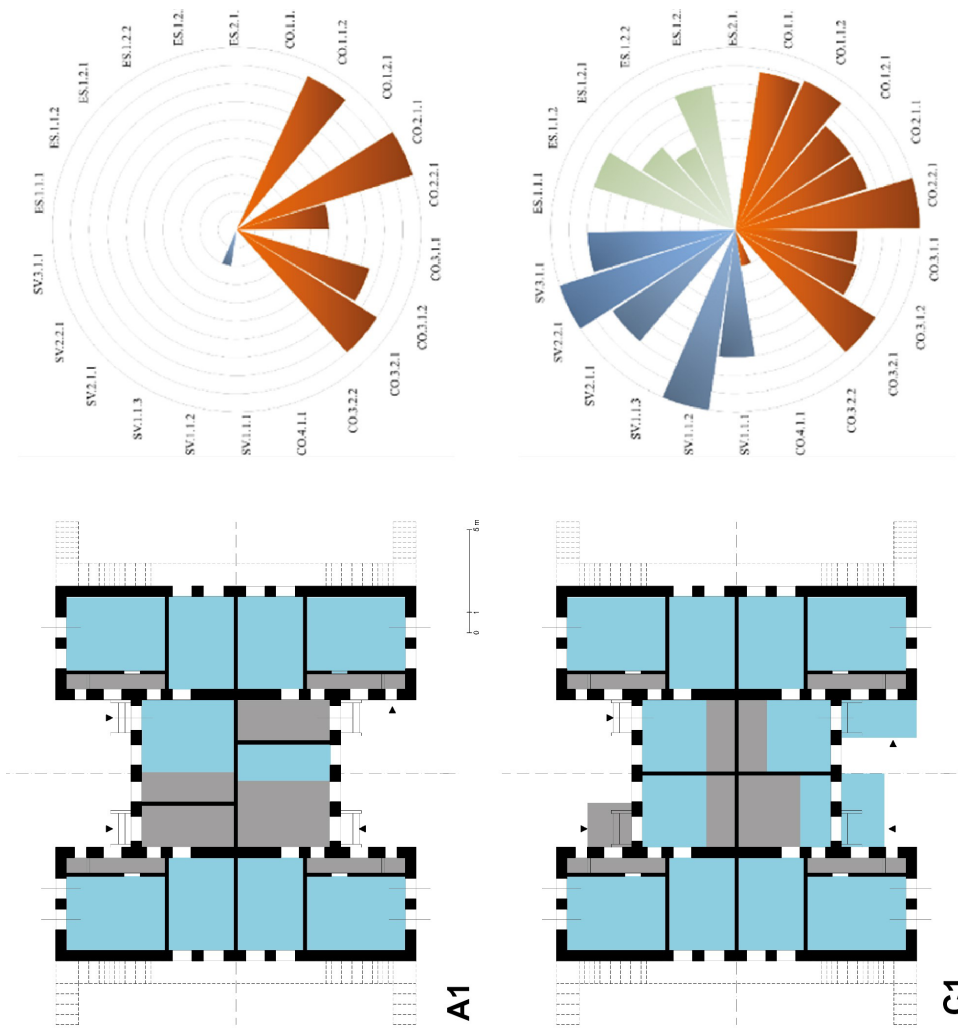


Figure 4

Worker's Village in Panzano. On the left: the original typological layout (A1); and the addition of new volumes (C1). Primary and secondary areas are indicated, respectively, in blue and grey. On the right, corresponding variations in terms of: raw materials (green); typological-technological compatibility with the existing structure (red); and improved living conditions (blue). Authors: P. Limoncin, C.A. Stival.



Figure 5

Worker's Village in Panzano. BIM model for the comparison of different scenarios: existing condition (E0); greenhouse integration (E1); greenhouse integration with photovoltaic panels on the roof (E2). Author: C.A. Stival.

➤ THE SOCIAL USE OF SPACE AND SOLUTIONS TO IMPROVE THE WELL-BEING OF VULNERABLE PERSONS

All the disciplinary competences within the DIA team also converged in RT3 activities, aimed at exploring urban poverty and vulnerability as multi-faceted conditions affecting individuals and households, as well as their spatial manifestations. The focus was on housing and living environments at the intersection of the domestic and urban spheres, in order to investigate physical morphologies, urban policies, and design solutions.

The strategic relevance of these issues is linked to the increasing presence of vulnerable populations in north-eastern Italy. By 2050, as in the rest of the country, people aged over 80 will nearly match those under 20, accompanied by a substantial rise in the 60-79 age group (Fondazione Nordest, 2021). These trends raise concerns regarding the growing share of elderly people living alone, the resilience of pension and healthcare systems, and the need to support ageing in place. Equally concerning is the contribution of population ageing to the rise in persons with motor, sensory, and cognitive impairments. Currently, in Friuli Venezia Giulia, around 20,000 individuals suffer from dementia, 60% of whom have Alzheimer's disease; these figures are expected to nearly double over the next two decades ("Gli psicologi del Friuli Venezia Giulia in campo per le demenze", 2022).

Moreover, approximately 25% of international migrants in Italy reside in the North-East, where the highest proportion of foreign residents is recorded (nearly 11% of the total resident population, compared with a national average of 9%) (ISTAT, 2024a). Friuli Venezia Giulia, in particular, is at the forefront of refugee flows, facing a wide range of legal statuses, and inadequate shelter and housing conditions.

However, today, social and economic precariousness affects a broad and increasingly diverse range of social groups. The latest Caritas report indicates that, in 2024, 277,775 individuals in Italy were supported by Listening Centres (over 4,300 in Trieste alone), a number that has doubled since 2012. Of those, 21.3% experience housing exclusion, with a higher incidence among foreigners (27.2%) than Italians (13.9%) (De Lauso & Nanni, 2024, 2025). In 2023, nearly 5.7 million individuals in the country (9.7% of the resident population) were living in absolute poverty – meaning they lacked the essential resources to meet basic needs. While the South had the highest incidence of households facing these conditions (over 859,000 households, 10.2%), the figure was also significant in the North-East, reaching 7.9% (413,000 households) (ISTAT, 2024b). Key causes of explicit or emerging poverty include economic hardship, employment and housing shortages (especially subsidised housing), health issues, ageing, and family-related problems such as separations and single parenting.

Within this framework, DIA activities focused on Friuli Venezia Giulia, particularly Trieste and Gorizia, where the development of pilot projects was closely integrated with the University of Trieste's Architecture and Urban planning courses. Local stakeholders, such as public institutions responsible for housing and health services, social cooperatives, and associations, were actively involved. A range of tools, including direct observation, data analysis, mapping, indicators, and questionnaires, was used alongside design experimentation.

The research operated across multiple scales, focusing on the spatial configuration of individual and collective spaces, innovative housing models, and environmental networks. The aim was to address vulnerabilities related to social, economic, demographic, motor, and cognitive factors, particularly regarding limited access to essential services such as housing, education, green areas, sports facilities, healthy food, and climate-related comfort. The central premise was that individual fragilities are closely linked to space. Consequently, urban space can be redesigned as a “capacitating and de-fragilising spatial and social infrastructure” (Nussbaum & Sen, 1993; Sen, 1999), enhancing personal opportunities, quality of life, autonomy, and inclusion for the whole population, particularly the most vulnerable groups.

One research topic explored how architecture can meet the needs of individuals with atypical sensory perceptions, autism, intellectual disabilities, or dementia (Scavuzzo, 2024).⁴ The study focused on the design of “therapeutic gardens” as non-pharmacological interventions with proven benefits. It led to the development of general guidelines and the transformation of a car park into a therapeutic garden at the “Ad Miores” care home in the centre of Trieste (Limoncin, 2024) (Fig. 6). The project includes several interventions, such as renaturalisation and the integration of innovative technical and technological solutions, with a focus on sustainable drainage, rainwater harvesting, and misting systems. Aimed at creating optimal environmental conditions, the garden seeks to restore the elderly residents’ connection with nature while ensuring a thermally comfortable, climate-appropriate context tailored to psychological and sensory needs.

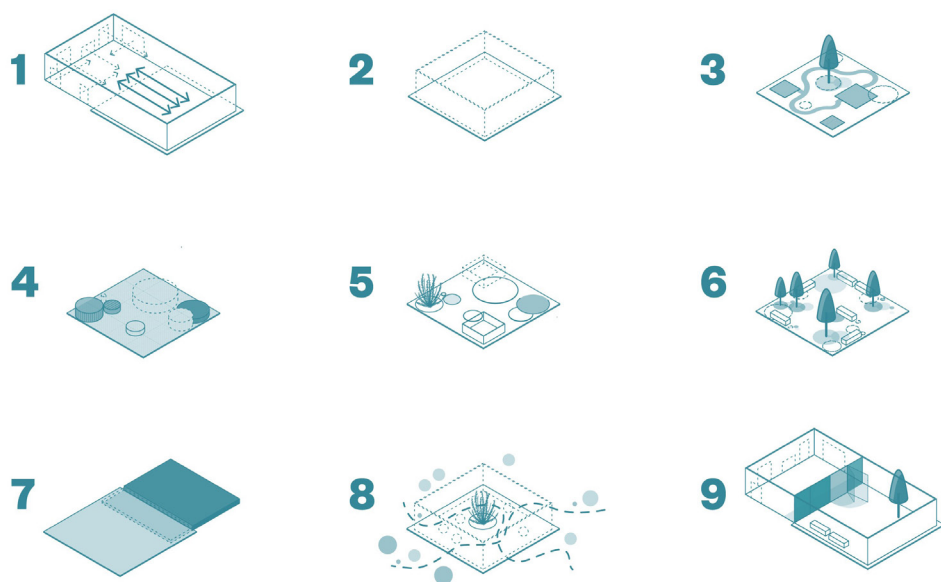


Figure 6

Design guidelines applied to a therapeutic garden: 1) involvement of caregivers and patients in the design process; 2) safe and secure garden; 3) wandering opportunities; 4) use of natural materials; 5) variety of spaces; 6) optimal placement of seats; 7) indoor/outdoor and light/shade continuity; 8) spaces for meeting, social interaction, and participation; 9) various degrees of openness to the surrounding urban context. Author: P. Limoncin.

⁴ The involved researchers are: Giuseppina Scavuzzo, Thomas Bisiani, Gianfranco Guaragna, Paola Limoncin, and Carlo Antonio Stival.

A second research topic was investigated in the pilot project for Campagnuzza, a residential area of Gorizia situated between the Italian-Slovenian border and the Isonzo river.⁵ Historically shaped by migratory flows, from the post-war settlement of Istrian-Dalmatian communities to more recent arrivals along the Balkan route, this urban district was the target of teaching activities and urban design proposals (Basso, Rodani & Venturini, 2024). Based on this larger scale framework, further didactic explorations addressed the renewal of an existing building currently inhabited by migrants and individuals in precarious conditions, with disabilities, and/or without family or social support networks. The project involved the redesign of interior spaces, using movable partitions and furniture to support temporary living arrangements while offering residents with the opportunity to express their individual identities (Scavuzzo *et al.*, 2025) (Fig. 7).

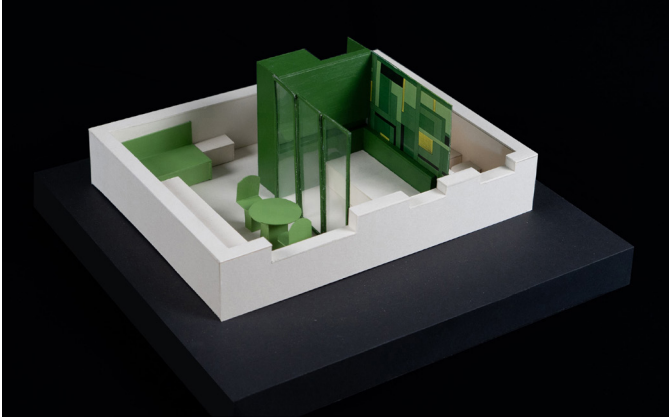


Figure 7

Study model of a dwelling unit in the district of Campagnuzza, Gorizia.

Authors: S. Graciotti, S. Ilas, R. Cerchia, I. Esposito Alaia (students of the Laboratory of Architectural and Interior Design, University of Trieste, A.Y. 2024-25).

Finally, a third line of research addressed the regeneration of the semi-central Barriera district in Trieste, reimagined as a “solidarity neighbourhood” (Marchigiani & Novak, 2024; Marchigiani *et al.*, 2025a, b).⁶ Based on policy analysis and engagement with local stakeholders, the design process developed “datascape” mapping social and housing vulnerabilities. These revealed issues such as overcrowded flats with large families or shared housing among young adults, underscoring the need for collective spaces and stronger links with educational services. Conversely, the prevalence of older people living alone in large dwellings suggested opportunities for intergenerational co-housing and broader social and healthcare support. These findings informed direct observation, detailed urban analysis, and the drafting of a masterplan, which seeks to promote a “just city” by addressing vulnerabilities while empowering residents and strengthening their capabilities (Fig. 8).

The masterplan envisages two strategies. The first, “spatial connections”, aims to transform open spaces into an integrated network of public environments that support walking, cycling, and greening, reinforce physical and social ties between residents and local services, and function as resilient infrastructures against climate impacts such as flooding and urban heat islands. The second strategy, “insertion of new uses and activities”, repurposes vacant or underused spaces. It focuses on reconfiguring areas around public facilities to reinforce the service network and improve its isotropy. This involves activating marginal spaces and reorganising functions linked to existing equipment – food markets, canteens, libraries, gyms, workspaces, and meeting rooms – into a shared and accessible system serving diverse users throughout the day.

⁵ The involved researchers are: Giuseppina Scavuzzo and Paola Limoncin for architectural design; Sara Basso for urban design.

⁶ The involved researchers are: Elena Marchigiani and Teresa Frausin.

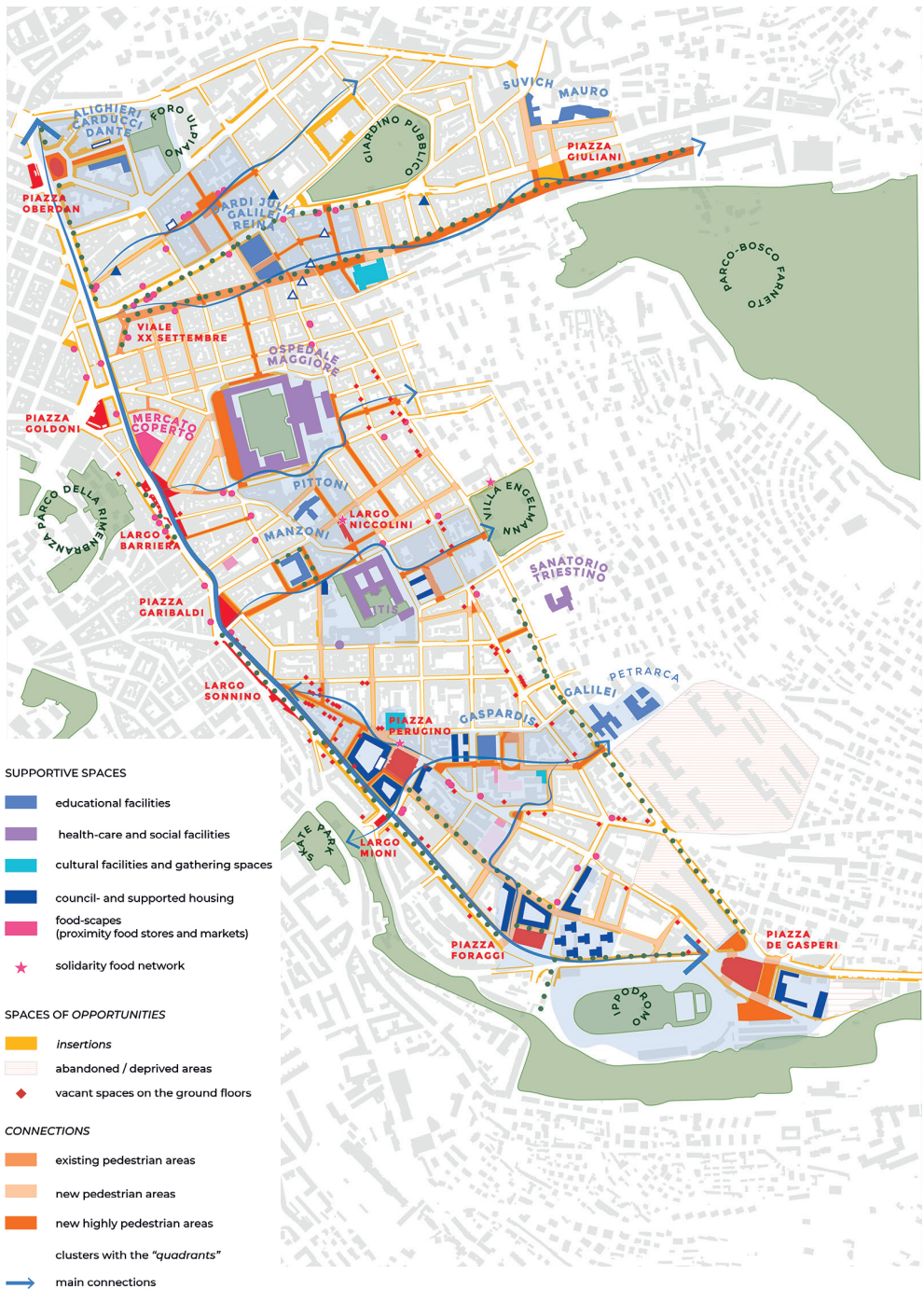


Figure 8

Masterplan for Barriera district in Trieste. Authors: F. Bellantuono, T. Boico, D. Boschin, S. Cappello, M. Carboni, N. Chiarandini, F. Cirocco, M. Conti, M. D'Angelo, G. De Pace, E. Ferrara, A. Kofol, L. Luša, G. Marcon, M.A. Marquez, M. Marussi, E. Milano, E. Novati, A. Paolini, A. Peregina Zennaro, G. Pettoello, M. Porro, E. Scheriani, U. Viviani, E. Zenere (students of the Design Laboratory of Urban Regeneration and Town Planning, University of Trieste, A.Y. 2024-25).

⇒ CONCLUSIONS

Spoke 4 has provided a broad Research & Innovation “umbrella”, fostering synergies across numerous disciplines – from urban planning and design, technical architecture, composition, and restoration, to law, economics, and real estate, and further to environmental psychology, urban ecology, and neuroscience. Bringing together North-East universities (IUAV, Trieste, Udine, and Padova) with key research bodies focusing on lagoon systems (CORILA) and the construction market (CRESME), this interdisciplinary framework has highlighted the strategic value of Innovation Ecosystems in connecting diverse expertise and actors involved in addressing today’s complex environmental, climate, social, and economic transitions. Furthermore, a distinctive strength of Spoke 4 – and of the broader iNEST ecosystem – is its capacity to integrate research and education with citizen engagement and technology transfer, the three core missions of Higher Education Institutions (HEIs).

To sustain these outcomes, however, long-term organisational structures are essential to stabilise the relationship between HEIs, territories, and stakeholders, and to support continuous innovation in processes and products. Beyond iNEST, one of the main expected results is therefore the establishment of lasting institutional networks conceived as place-based “living labs” and “open innovation systems” (European Commission-Directorate-General for Research and Innovation, 2015). These refer to concrete arenas for interaction among institutions, private actors, and citizens, enabling the co-creation and co-design of shared values, goals, and technical and technological solutions.

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