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Technological Imagination in the Green and Digital Transition

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Chapter 52
Environmental Design for a Sustainable District and Civic Hub

Elena Mussinelli, Andrea Tartaglia, and Giovanni Castaldo

Abstract The paper presents the results of a design-based research focused on a specific context in the city of Milan (Municipality 4), where a holistic approach to a fruitive and environmental regeneration was experimented. The proposed design-based approach integrates the functional and fruitive reactivation of public space with analysis, simulations and assessments on the possible application of nature-based solutions (NBS) to increase urban resilience, comfort and public space usability. In addition to increasing the environmental benefits (ecosystem services) at the district scale, the project aims to strengthen the ecological connections at the wide area, stressing the necessity of a systemic approach in the GBI's development. The paper illustrates both the methodological and framing aspects of the experimentation and the project results, verified through a consolidated methodology for the assessment of the expected environmental benefits. The research project contributes in developing new approaches to the deep renovation of public space in urban and peri-urban contexts, that are a priority in the current Italian scenario.

Keyword Smart sustainable district · Civic hub · Environmental design · Nature-based solutions · Public space regeneration

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52.1 Introduction

The design of the public space based on the principles of environmental sustainability, for the mitigation and adaptation to climate change and for the improvement of well-being, health and safety conditions has assumed a crucial role in the agendas of local administrations. The accessibility and usability of public space are in fact key-factors for the regeneration of the public city: ensuring qualified access to places, services and information is a primary challenge (DIAUD 2017) with multiple cultural, social and economic implications (AA.VV. 2013). The possibility of using the public space meeting individual and collective needs is in fact essential to guarantee an independent life for citizens and allow the development of adequate social relationships, promoting freedom, the well-being of communities (Hansen 1959) and social cohesion, according to an inclusive cultural model (Conti 2015). The full accessibility of the urban environment also derives from a complex set of factors that, in addition to allowing the overcoming of physical-spatial barriers, provide a healthy, safe and comfortable usability of urban space, rich in multisensory stimuli.

The research described in this contribution is part of this framework, experimenting a holistic approach to the fruitive and environmental regeneration of the urban public space. An approach that aims to improve the environmental characteristics for the use and accessibility of open spaces, according to a design-based methodology (Mussinelli and Tartaglia 2021). The adopted methodology is based on site-specific design simulations—characterized by the use of natural solutions (nature-based solutions—NBS and low impact development systems—LID)—and on an accurate assessment of the environmental, microclimatic and fruitive benefits deriving from the redesign of public space.[1]

The applied methodological approach is structured into the following phases:

- urban scale analysis in order to identify critical issues and opportunities for intervention for the improvement of the environmental ecosystem quality;
- definition of a study area at the district scale, identifying a sufficiently homogeneous context, albeit with variable geometry, in terms of settlement, morpho-typological, functional, environmental and infrastructural characteristics and having dimensions such as to present and/or allow the establishment of proximity relationships and territorial connections of significant social and eco-systemic value (Poliedra 2022; Mussinelli et al. 2021);
- study of the environmental, microclimatic and fruitive characteristics of the study area and identification of site-specific criticalities;
- definition of alternative intervention proposals;
- evaluation/quantification of the environmental, microclimatic and fruitive benefits generated by the proposals.

[1] The design experimentation was developed through the collaboration between the cultural associations Urban Curator TAT and Resilience Lab, with the patronage of the Municipality 4 of Milan, on the occasion of a scientific dissemination initiative held in November 2021.

52.2 Materials and Methods

52.2.1 Analysis of the Reference Urban Context

The research activity was focused on the South-East quadrant of Milan,[2] within the Municipality 4, a large-scale context with relatively homogeneous settlement, environmental and fruitive characteristics. It has been investigated through analyzes of the morphological structure of the built and open spaces, the land uses, the average surface temperature of the soils, the provision of public and private green areas and accessibility to public green areas.

The results of these analyzes are summarized through thematic maps highlighting the encountered criticalities and opportunities.

First of all, a limited presence of settlement sprawl phenomena emerges, with the persistence of large portions of agricultural land and wide-open spaces, unlike what happened in other quadrants of the city. This condition highlights a high potential for ecological reconnection both on a large scale and in the local area. In particular, it is analysed the relationship between the built systems of the urban fringe and the area of the *Parco Agricolo Sud Milano* (Peri-urban Agricultural Park), with significant service values with respect to the residential system and the large public housing districts of Corvetto and via Ripamonti (Fig. 52.1).

The analysis of the average temperature of the soils (Land Surface Temperature) shows lower values in correspondence of the *Parco Agricolo Sud Milano* which contributes to the mitigation of the urban heat island even in neighboring urban blocks and higher values, in some cases also critical, in the central areas of the urban sector characterized by high building densities and scarce green areas.

With reference to the analysis of urban greenery (Fig. 52.2), in addition to the mapping and analysis of green areas and the tree heritage[3]—which showed an overall endowment higher than the city average—attention was paid to the study of pedestrian accessibility to the so-called "neighborhood parks" (Zhang et al. 2011). Through the accessibility indicators to the green areas measured according to the buffer techniques and the time < 15 min. (Mussinelli et al. 2021), considering the population for each block of the quadrant, it was possible to define the road axes used mainly by the population to access these parks. Axes that therefore require a timely verification of their fruition and environmental quality (Fig. 52.3).

[2] The South-East sector of Milan has been studied by the Research Group ENVIREG—Environmental Regeneration of ABC Dept. of Politecnico di Milano since 2015 (e.g., PRIN 2015 "Adaptive Design and Technological Innovations for the Resilient Regeneration of Urban Districts in Climate Change Regime). ENVIREG Research Group: Elena Mussinelli, Andrea Tartaglia, Davide Cerati, Giovanni Castaldo, Daniele Fanzini, Roberto Bolici, Matteo Gambaro, Raffaella Riva.

[3] GIS analyzes of the green heritage were conducted using the database of Comune di Milano (years 2012 and 2014) referred to public green integrated with databases of private green heritage. For the tassonomy aspects, the main references of the classifications were ISTAT (2013) and ISPRA (2014).

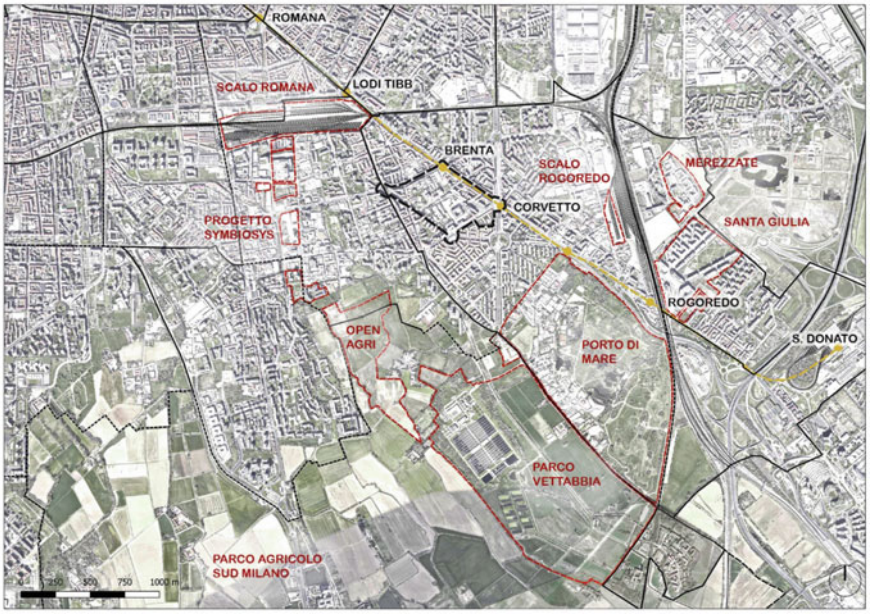

Fig. 52.1 Reference urban context—Authors' Elaboration

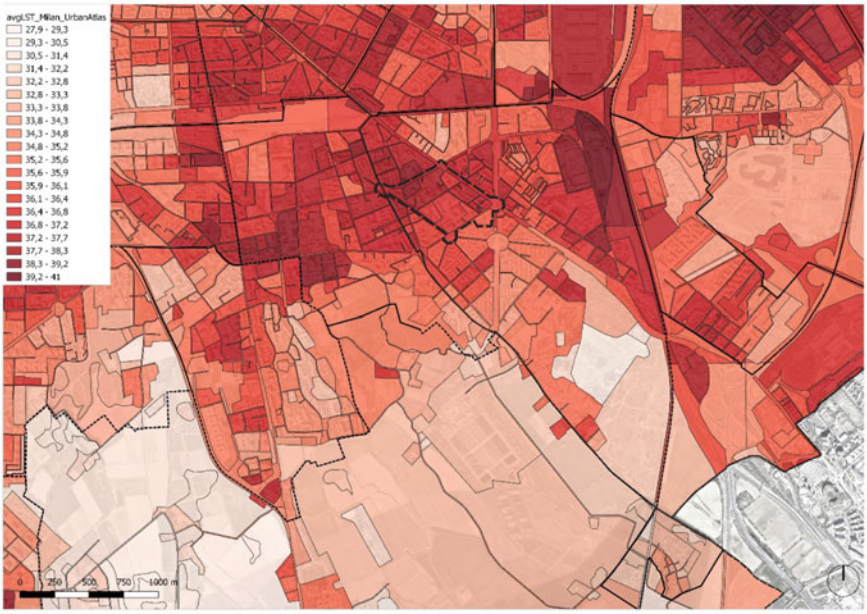

Fig. 52.2 Land surface temperature map—Authors' Elaboration. *Source* Sistema InformativoTerritoriale—SIT, Comune di Milano

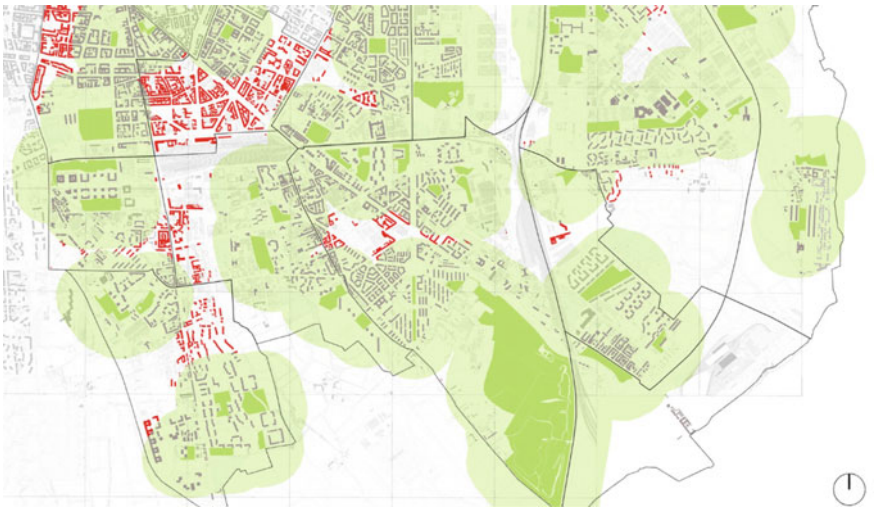

Fig. 52.3 Accessibility indicator according to the buffer technique—Elaboration by Arch. PhD. Davide Cerati

In broad terms, it emerged that the green heritage, albeit extensive, presents multiple discontinuities, with entire large urban sectors without gardens and neighborhood parks and with numerous roads completely devoid of trees. The analysis of the tree-lined/non-tree-lined roads and that of the most used roads to access the neighborhood parks has made it possible to identify the roads that would need priority interventions to improve their environmental quality and to face the local phenomena of urban heat islands (Fig. 52.4).

52.2.2 Site-Specific Analysis of the Study Area (District) and Design Proposals

The design experimentation was conducted on a specific study area, identified on the basis of the evidence of the large-scale environmental analyzes above described[4] as well as on the recognition of the potential transformation of this area into a smart and sustainable district (Poliedra 2022).

The potential district identified is bounded by viale Brenta, corso Lodi, via Polesine and via Mincio, for a total land area of approximately 23 hectares. Inside there are five blocks defined by secondary crossing roads. The area is homogeneous from a

[4] In particular, due to the presence of high average surface temperatures, the absence of proximity parks, the consistent presence of road axes without trees.

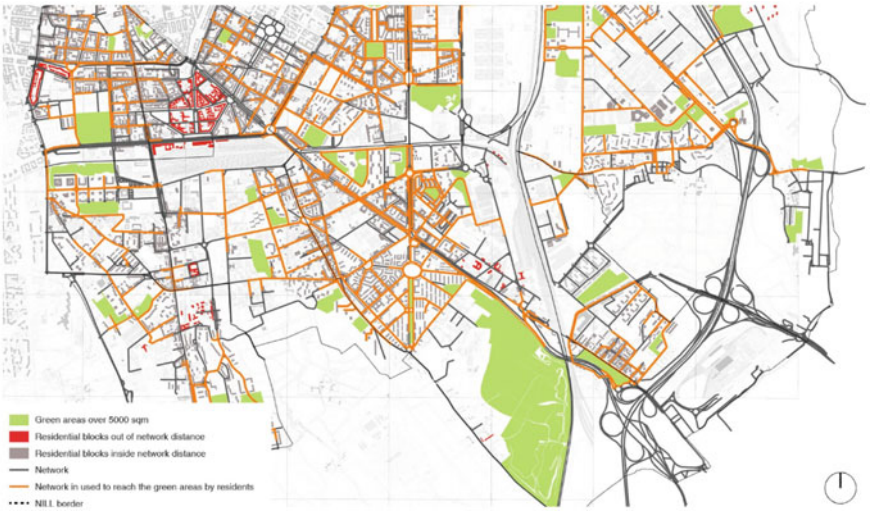

Fig. 52.4 Measurement of accessibility to parks on the basis of ≤ 15 min. by walking—Elaboration by Arch. PhD. Davide Cerati

morpho-typological and functional point of view and is characterized by a particularly significant concentration of public and civic services.[5]

At this scale, environmental, microclimatic and fruitive site-specific analyzes were carried out aimed at pointing out the main critical issues to which the project proposals refer. About 40% of the land is occupied by buildings and 60% by open spaces, only 16.5% of which is devoted to green areas, while 21% is occupied by roads and parking lots and 23% is made up of equipped areas pertaining to the buildings. The analysis of the permeability of soils showed a clear prevalence of impermeable soils (83.5%). The arboreal heritage consists of 372 trees, of which 353 deciduous and 19 evergreen, mainly located along the road axes of Corso Lodi and Via Polesine and within the schools' gardens (therefore limitedly accessible) (Fig. 52.5).

The analyzes developed with reference to the microclimatic aspects concerned the land surface temperature and the level of sunshine of open public spaces, evaluated with the Lindberg and Grimmond methodology (2011). In addition to the average temperature of the soils, the characteristics of materials and the albedo of the portions of soil exposed to sunshine for more than 70% of the hours of the daylight were analyzed, identifying the public spaces and paths open to high use with the greatest criticalities (high land surface temperature, high and prolonged sunshine, low albedo of materials): viale Brenta, via Polesine and via Mincio (Fig. 52.6).

[5] In the study, area is located the following public buildings/services: Headquarter of Municipality 4; Headquarter of the Municipality of Milan; Primary School "Vittorino Da Feltre/M. Carlo Lorenzini", Middle School "Lombardini", School "Marcello Candia", Regional School Department Office, Municipal Swimming Pool "Mincio", Social Center "Arci Corvetto", Polifunctional Center "Polo Ferrara".

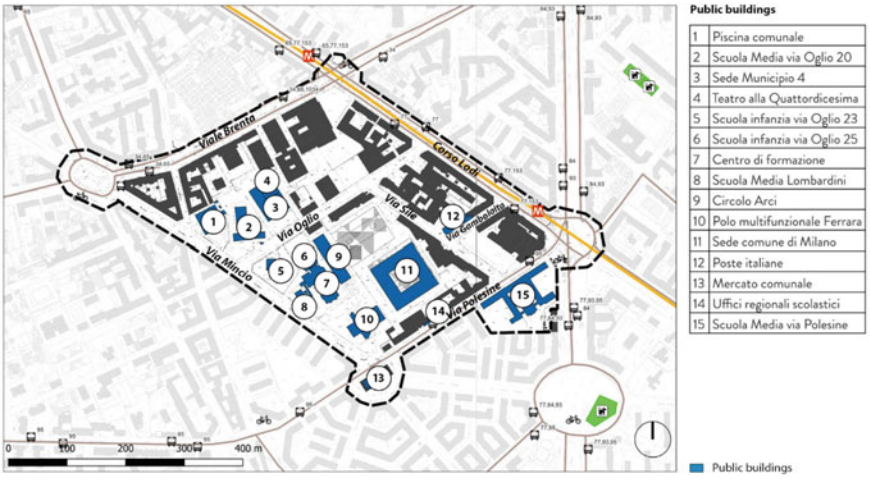

Fig. 52.5 Study area perimeter—Authors' Elaboration

Fig. 52.6 Albedo analysis and portions of public space with high percentage of sunshine—Elaboration by Ing. Alessandro Grimaldi

With reference to the fruitive quality of the public space, the pedestrian and vehicular flows within the district were analyzed, with particular attention to the four schools present in the area; the extent and characteristics of user flows were then directly detected (by way of travel: pedestrian, cycle, public transport and vehicular traffic).[6] Analysis highlighted an overall prevalence of pedestrian transits to and from

[6] In the period 05/10/2021—08/10/2021, site surveys were conducted aimed at gathering information on the flows of users of the schools of the district. The data was collected in the time slots of

schools and limited vehicular traffic along the internal roads of the study area (via Oglio, via Sile and via Gamboloita).

Through site surveys, other characteristics of the public space were qualitatively assessed too, in relation to the state of maintenance of the sidewalks, the urban equipment (benches, baskets, racks, etc.), also by identifying specific critical situations and/or neglected points (e.g., via Mincio, via Gamboloita and viale Brenta, with the presence of waste and damages to the asphalted surfaces) and noting the absence of equipped and protected public spaces near the schools entrances.

Based on the conducted analyzes and the encountered critical issues, the experimentation identified and developed the following design proposals (Fig. 52.7):

- establishment of traffic-restricted zone (ZTL 30/10 km/h) within the district, with redefinition of road sections, extension of sidewalks and their equipment in correspondence of the school centers (benches, baskets, racks, etc.);
- improvement of the permeability of soils through high-reflectance draining asphalts along via Sile, Gamboloita and Oglio (about 24,500 sqm.) and bio-basins along via Oglio, Sile, Mincio and Brenta (about 1550 m^2);

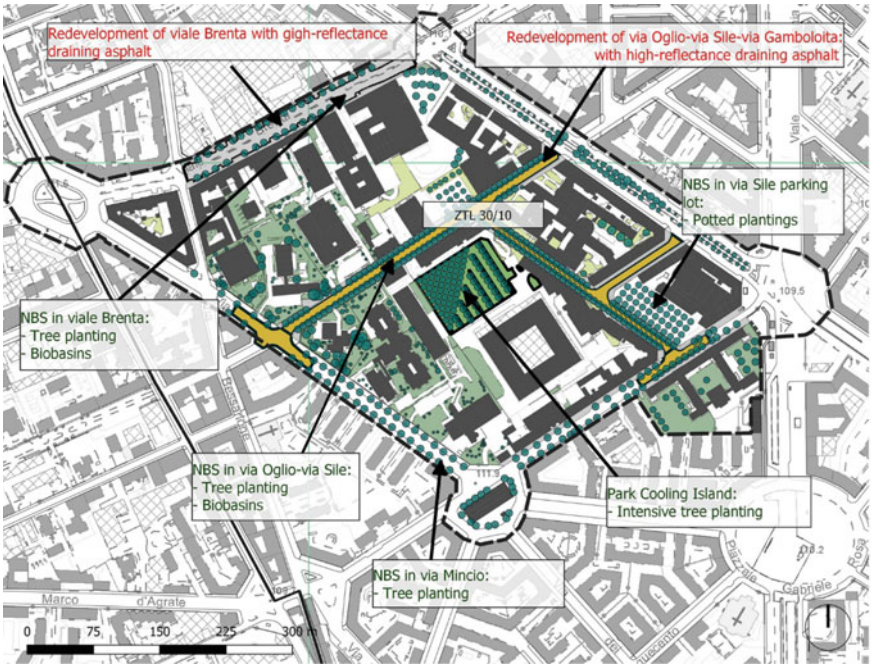

Fig. 52.7 Design proposal for the study area—Authors' Elaboration

entry/exit from schools or the beginning and end of the working day, sampling the number of users in transit at intervals of 30 min.

- increase in the arboreal heritage with the planting of 373 new trees, partly distributed along the road axes, partly concentrated in the intensive planting (Park Cooling Island) of a semi-enclosed free area (about 6,800 m^2) owned by the Municipality and currently neglected, located near the new Municipal Office Complex. There are also 39 potted plantings located in an area currently used as parking lot in via Sile.

52.3 Results

The environmental, microclimatic and usability benefits generated by these proposals were then evaluated.

First, the multiple benefits provided by tree planning have been assessed. The new trees along the road axes and the intensive tree-planting of the new Park Cooling Island allow the sequestration of 75.14 tons/year of CO_2 and the capture of 47.28 kg/year of O_3, of 38.25 kg/year of PM10, of 87.05 kg/ ear of SO_2 and 34.77 kg/year of NO_2. This reduction of air pollutants due to this vegetation (through deposition, absorption, etc.) directly improves the air quality at the local level (Silli et al. 2015) and contributes also to the reduction of rainwater run-off, with the interception of 432,450 L/year.[7] The interception of rainwater implies direct environmental benefits such as flooding risk mitigation and reduction; at the same time, the avoided management of rainwater in the sewer system entails savings in public expenditure (indirect benefit). In the meantime, plantations, through shading and evapotranspiration, significantly contribute to improve the thermos-hygrometric comfort conditions of public space, mitigating the effects of the urban heat island. The simulation carried out for the viale Brenta—developed through the application of ENVI-Met software—led to an estimation of a betterment of the perceived temperature (Universal Thermal Climate Index-UTCI) of approximately − 6 °C.

Secondly, the adoption of high-reflectance draining asphalts along the carriageways and sidewalks of the central streets of the district generates additional benefits. The approximately 24,500 m^2 of draining asphalt contribute to improve the run-off of the area, with the interception of approximately 4.3 mil. liters/year. In addition to this value, about 2.5 mil. of liters/year of rainwater intercepted by the bio-basins envisaged in the redesign of the road sections, as well as approximately 6.8 mil. of liters/year intercepted by the new green area must be considered.

[7] With respect to the reduction of air pollutants and the capture of CO2, models (UFORE) developed through specific software (i-Tree and i-Tree Design) were applied. The findings contributed to the production of table values defined according to a time scale of growth of trees. With regards to the water retention capacity of the bio-basins, an average runoff index of 0.6 was assumed, while for the air pollutants reduction, the values expressed by the Forest Service Tree Guides were used, considering the bio-basin enriched with low and medium stem shrubs. The algorithms employed for the quantification are those proposed by the Center for Neighborhood Technology (CNT 2010), to assess the value of ecosystem services associated with green infrastructures in urban areas (Mussinelli et al. 2021).

The use of asphalts with high albedo plays an important role in facing the urban heat island effect, specially identified in some portions characterized by high sunshine exposure and low albedo pavements. Different studies investigate the correlation between albedo of pavements in urban environments and microclimatic characteristics, showing a difference, in specific conditions, of approximately 5–6 °C between dark colored asphalts and light-colored materials (Chudnovsky et al. 2004).

Finally, the benefits provided by proposing a traffic-restricted zone with 30/10 km/h speed limit can be considered as well. This sort of traffic measure entails different advantages in terms of urban and environmental quality such as traffic reduction, improvement of the road safety, noise pollution reduction, air pollution reduction, improvement of the multifunctionality of urban streets (Staricco 2011).

52.4 Conclusions

In the presented case, the improvement of the environmental and microclimatic quality of the public space represents a key factor for the establishment of a real Smart and Sustainable District & Civic Hub,[8] based on full accessibility and usability of the articulated system of public spaces and services and cultural and civic venues already present in the area. The proposed set of site-specific solutions contributes to overcome the so-called "climatic-environmental barriers" (Tartaglia et al. 2019), that are the limitations in the usability of public space due to environmental risks and adverse microclimatic conditions. The use of NBS and the reorganization and equipping of the public space contribute to increase the quality, decorum and attractiveness of the places of collective use, while generating substantial ecosystem services.

Further research developments, currently being developed, aim at integrating the quantification of the environmental and microclimatic benefits generated by the proposal for the Hub of the Municipality 4 with the evaluation of the benefits obtainable through ecological reconnection interventions extended to the vast area of the peri-urban quadrant, thus recomposing some discontinuities currently present in the green and blue infrastructure system (environmental reconversion of the Corvetto overpass and regeneration of the Corso Lodi-Via Marocchetti axis, with the previsione of new green square in front of the Rogoredo station; strengthening of the green system along the axis of viale Omero toward the Vettabbia Park and the Porto di Mare Park).

The proposed methodology—based on the tight correlation between environmental local conditions and public spaces fruition—can represent a possible approach for a deep renovation of public spaces in urban and peri-urban contexts. This is a

[8] The Smart Sustainable District and Civic Hub is defined as "sustainable" with reference to all the social, environmental and economic aspects that contribute to the achievement and maintenance of conditions of quality of life, health and well-being of the communities and good environmental status with reference to mitigation/adaptation to climate change and the conservation of natural capital, while creating equity and equal opportunities for its inhabitants (Poliedra 2022).

priority in the current Italian scenario, with the presence of many urban areas characterized by poor environmental conditions worsen by increasing climate change effects.

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