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Regeneration of the Built Environment from a Circular Economy Perspective

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Contents

New Paradigms for the Urban Regeneration Project Between Green Economy and Resilience

Elena Mussinelli, Andrea Tartaglia, Daniele Fanzini, Raffaella Riva, Davide Cerati and Giovanni Castaldo

Abstract Starting from a PRIN 2015 study, the paper addresses the themes of adding value to public spaces, quality to the urban landscape, redeveloping degraded areas and proposing a sustainable and resilient design approach to cope with the effects of climate change. Specifically, this study focuses on the key role public space can play in urban resilience processes, with the aim of not only providing results in qualitative terms, but also measuring the feedback in environmental and economic terms.

Keywords Nature-based solution · Green infrastructure · Public space · Environmental design

1 Climate Change and Urban Crises

The intense urbanisation processes that have characterised the development of human settlements in recent decades have played a decisive role in the modification of the mankind–environment relationship: cities are in fact one of the most significant sources of impact, with relevant effects in the consumption of natural resources, in polluting emissions and in the overall alteration of natural and climatic balances. It is therefore necessary to start from the cities, from their management and operating models in order to define policies, strategies and concrete action that can guarantee more sustainable forms of development, including from a social and economic point of view. As clearly stressed in a recent publication by the European Political Strategy Centre (2018), the climate change issue, which was perceived as a long-term danger, is instead already showing its impact all over the world, in Europe as well (European Commission 2006). In most of the European Countries, the increase in temperature from the last century is almost of one degree, with a trend that, as a minimum, will soon double the limit of the Paris Agreement signed in 2016. Climate-related catastrophes—such as floods, storms and droughts—have become more and

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more recurrent in our territories, with negative impacts also on urban environments and health. Flooding and urban heat islands sum their negativities to other issues, such as air, soil and water pollution, land-use change and soil sealing increasing the criticalities of life in urban areas.

The progressive awareness of these increasingly evident criticalities pushed the European Union to develop new policies and actions, initially aimed at urban sustainability,[1] later at urban resilience[2] and now stressing the role of urban robustness.[3] Within the broad panel of policies and instruments that can now be used to combat the deterioration of urban environmental quality and climate change, in recent years, the so-called nature-based solutions (NBS) have emerged. NBS are a set of technical solutions based on natural resources (vegetation, water, soil, etc.) to regenerate buildings and urban spaces in a resilient key, even with the formation of real "ecological corridors" (green and blue infrastructures GBI) able to reconstitute, through suitable reconnections, the continuity of environmental systems. NBS and GBI are in fact configured as multifunctional tools, capable of generating environmental and economic benefits, of delivering ecosystem services and, at the same time, of contributing to the formation of more functional, comfortable and healthy built spaces.

2 The Role of Public Spaces: Environment and Life Quality

Hence, the interest of this research in exploring the applicative potential of these solutions in relation to a specific dimension of the city, that of public spaces, which—for various reasons and for several years now—is experiencing a process of significant delay (Mussinelli 2018).

[1] *"According to the European Commission (2006), urban sustainability is defined as the challenge to 'solve both the problems experienced within cities and the problems caused by cities', recognizing that cities themselves provide many potential solutions"* moreover *"sustainable urbanization is a dynamic process that combines environmental, social, economic and political-institutional sustainability. It brings together urban and rural areas, encompassing the full range of human settlements from village to town to city to metropolis, with links on national and global level"* (Shen et al. 2011: 18).

[2] *"Urban resilience is the capacity of urban systems, communities, individuals, organisations and businesses to recover, maintain their function and thrive in the aftermath of a shock or a stress, regardless of its impact, frequency or magnitude"* (Urban Resilience. A concept for co-creating cities of the future URBACT Resilient Europe).

[3] *"Robust systems include well-conceived, constructed and managed physical assets, so that they can withstand the impacts of hazardous events without significant damage or loss of function. Robust design anticipates potential failures in systems, making provision to ensure failure is predictable, safe, and not disproportionate to the cause. Over-reliance on a single asset, cascading failure and design thresholds that might lead to catastrophic collapse if exceeded are actively avoided"* (The Rockefeller Foundation and Arup 2014:5).

The research unit of the ABC Department has been involved in the PRIN 2015 study entitled "Adaptive design and technological innovations for the resilient regeneration of urban districts under climate change"[4] which intended to investigate, also through experimental demonstrating projects, the applicability of strategic guidelines and technological and environmental design solutions able to obtain positive repercussions from the reduction in exposure to climate risks and from the socio-economic sustainability of cities. Specifically, the local unit of the Politecnico di Milano focused on the topic of identifying tools and defining and implementing actions for revamping and redeveloping the public space. In fact, the environmental quality and usability of public spaces are still a too much underrated aspect of the urban project, which tends to focus mainly on the morphological configuration of the settlements and the functional and energy performances of the buildings with poor outcomes with regard to the open space structure. These spaces—squares, roads, urban gardens, etc.,—often become a "result", frequently achieved in significantly dilated timeframes compared with the construction of buildings, to be functionalised ex-post, through furnishings and object layouts that support its use.

Public spaces—if approached through a multidisciplinary lens that considers its formal, environmental and user values—pave the road towards a way in which to cope positively with climate change issues and the needs of social cohesion. Within this mindset, this study has systematically integrated multidisciplinary inputs and structures relating to methods and tools for the design and implementation of NBS in the ecological requalification of public spaces, with criteria and indicators for monitoring and evaluating their multifunctionality and environmental effectiveness; models and tools to manage and enhance public spaces as a common cultural heritage, endowed with identity values, supporting full and conscious accessibility in physical (multisensorial) and cultural terms; strategies, planning criteria, name and technical solutions for the promotion of liveability and psycho-physical well-being and for the containment of risk and the management of public space safety (UN Habitat 2004).

The area of cross-fertilisation amongst the various disciplinary contributions derives from the use of research action and co-design methodologies that combine analysis/programming strategies and spontaneous forms of bottom-up participation (SWOT analysis, strategic planning and good demonstrative practices and projects) and from the common goal of achieving the development of integrated tools for the qualitative-quantitative evaluation of the expected benefits and the effectiveness of the proposed solutions, measurable by their cultural, social and economic value.

[4]PRIN 2015 principal investigator: M. Losasso, Università degli Studi di Napoli "Federico II". Local unit Politecnico di Milano, ABC Department: E. Mussinelli (coordinator), R. Bolici, G. Castaldo, D. Cerati, D. Fanzini, M. Gambaro, M. Mocchi, R. Riva, A. Tartaglia.

3 Solutions and Indicators

Nowadays, all European policies are characterised by targets (as in those focused on climate and energy) and by impact assessment tools and methods used to estimate the possible economic, social and environmental impacts of decisions and laws. This approach works quite well on the macro-scale and can lead and control the effects of policies on a territorial and urban scale, but it is not suitable to support the decisional process related to local and specific single interventions.

At any rate, on this same scale, "the role of analytical-assessment processes is central for verifying the achievement of goals aimed at ecological improvement and greater resilience through nature-based solutions" (Mussinelli et al. 2018:120). This is essential in the transformation of urban settlements and public spaces in which contemporary needs found in the NBS and GBI are one of the most requested and applied solutions. Even if NBS are not the only tool and cannot alone solve climate change-related issues,[5] because of their multifunctionality they have a strategic role in European policies. In fact, in 2013, the EU adopted the Communication on GI[6] and, amongst the eight actions listed in the strategy on adaptation to climate change, stressed the importance of a "full mobilisation of ecosystem-based approaches to adaptation". Moreover, the report entitled Towards an EU Research and Innovation policy agenda for Nature-Based Solutions and Re-Naturing Cities published by the European Commission specifies that "enhancing sustainable urbanisation through nature-based solutions can stimulate economic growth as well as improving the environment, making cities more attractive, and enhancing human well-being" (Directorate General for Research and Innovation 2015:4). In particular, NBS and GBI are considered cost-effective alternatives to traditional grey infrastructure, capable of producing direct and indirect economic and financial advantages and, in the meantime, bringing about environmental benefits, well-being for people and an improvement in social cohesion. The use of these solutions in public space has the potential to activate or reactivate a wide panel of ecosystem services that represent a major element of cities' resilience.

The analysis of almost 50 case studies around the world stresses that in the majority of cases, decisions have been taken with a poor level of quantitative assessment or even with no attention at all given to the environmental impacts deriving from design alternatives, often focusing only on a single specific benefit related to the use

[5]The European Commission stresses that *"forests and agricultural lands currently cover more than three-quarters of the EU's territory and naturally hold large stocks of carbon, preventing its escape into the atmosphere. EU forests, for example, absorb the equivalent of nearly 10% of total EU greenhouse gas emissions each year. Land use and forestry – which include our use of soils, trees, plants, biomass and timber – can thus contribute to a robust climate policy"* (https://ec.europa.eu/clima/policies/forests_en). However, considering this value, it is also evident that a widespread action of forestation and urban forestation will never be enough to compensate the European emission of CO_2 related to human activities and to invert the trends in climate change.

[6]Communication from the Commission to the European Parliament, the Council, the European Economic and Social committee and the Committee of the Regions "Green Infrastructure (GI)—Enhancing Europe's Natural Capital"—COM/2013/0249 final.

of NBS and often not applying any monitoring of ex-post results of the interventions. In particular, the case studies analysed by the study (38% in Europe, 12% in Asia and 50% in North America) stress that: in 40% of the cases, the interventions were carried out for socio-cultural purposes (regenerating the landscape and providing new green spaces); in 38%, to create a particular regulatory ecosystem service (specifically for the management of water and the prevention of floods). Moreover, only 50% of the interventions were supported by quantitative data about possible obtainable environmental benefits (they were mostly North American cases; only in three European projects, there was a quantitative anticipation of the researched benefits).

This scenario contradicts the fact that "the long-time sustainability of decisions can be pursued only by following performance-based approaches capable of integrating environmental, economic, productive and socio-cultural components" (Tartaglia 2019). For this reason, the research activities were carried out first by identifying and, when necessary, developing performance indicators, able to both support the decisional process during the project activity for public spaces on a local scale and monitor and assess the benefits obtained.

4 Environmental Design and Measurement of the Impact of Alternatives

The understanding and anticipation of the potential results, their scalability and the ex-post assessment relating to local and punctual interventions are essential to build a link that connects European policies, national and regional programming, urban planning, local action and single projects. The environmental design, based on a systemic approach to problems and solutions, finds in the quantitative measurement of the impacts which is a necessary tool for its theoretical armoury. It is not only a problem of state indicators as the attention must be focused on performance indicators to have a complete operative design tool, easily applicable and not limited to highly specialised researchers. In particular, the research has focused on a core set of environmental indicators able to synthesise the effects of the decisions in terms of direct and indirect environmental benefits, also in indirect economic outcomes (avoided costs). In fact, as already anticipated, the ecological reconstruction of an urban environment is an economic opportunity both to reduce the costs of adaptation and management and to stimulate the birth and the development of companies in the field of green economy. From this perspective, there are interesting North American cases in which the increase of NBS in urban settlements and the application of GI instead of grey solutions have been estimated from an economic standpoint as well.[7]

[7]Particularly interesting are the experiences of the city of Philadelphia described in the report "Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds" by Stratus Consulting (2009).

The green reconstruction of urban environments instead of the existing brownfields, open and public spaces, mobility infrastructures and in general grey infrastructure is finalised to a better use of soil, to a multifunctional usability of public resources and to increase the robustness of urban environments.

5 Experimental Case Study: South Milan

In this scenario, the south-east sector of the metropolitan area of Milan has been identified as an applicative case for design experimentation and the testing of the evaluation model proposed and defined by the study. This choice is related to many factors: indeed, this urban sector has undergone important transformation processes, is well equipped with infrastructure for local and supra-local mobility (Mussinelli and Castaldo 2015) and is also directly connected to the rural fringes and the Agricultural South Milano Park (Schiaffonati 2019; Tartaglia and Cerati 2018). Moreover, in this sector, in coherence with the strategic view of the Municipality (VVAA 2017) regarding urban resilience, many experimental projects and activities have been funded and activated.[8] In the meantime, it shows the main environmental criticalities that characterise the city territory and the Po valley, such as air pollution, the sewage system during acute meteorological phenomena, periods of drought and an increase in temperatures during the summer period, with urban canyons as well.

The whole sector has been analysed to identify areas of criticality where regeneration interventions can be proposed through the use of NBS (Fig. 1).

Specifically, the activity carried out concerned the morphological/typological and functional aspects (building heights, green areas and trees presence, public and private assets, presence of urban canyons, relationships between green areas, total surface area between permeable and impermeable surfaces, etc.), together with reliefs on the materials characterising the paving and vertical fronts of buildings and other structures above ground, as well as the solar exposure of open public spaces (streets and squares) during the summer period. All the analyses have been codified through the GIS tool, in such a way as to conform to the modelling tool of the urban microclimate (with ENVI MET software), according to stratigraphy and materials that characterise the open spaces and buildings (Mussinelli et al. 2018b).

[8] Among the different initiatives, the project "Sharing cities" for the experimentation of smart and integrated solutions in the area of Porta Romana; the competition "Reinventing Cities" (area of via Serio) for the realisation of an innovative building with regard to the reduction/zeroing of the carbon footprint in which the ABC Department was involved in a participating team as environmental experts (Andrea Campioli, Elena Mussinelli, Monica Lavagna, Andrea Tartaglia, Davide Cerati, Giovanni Castaldo, Anna Dalla Valle, Serena Giorgi and Tecla Caroli); the project "OpenAgri: New Skills for new Jobs in Peri-urban Agriculture" in the area of Porto di Mare-Parco della Vettabbia; the "100 Resilient Cities—Urban cooling" resilient workshop to explore resilient urban cooling solutions and technologies appropriate and coherent with communities' expectations with the participation of the ABC Department (Elena Mussinelli, Davide Cerati).

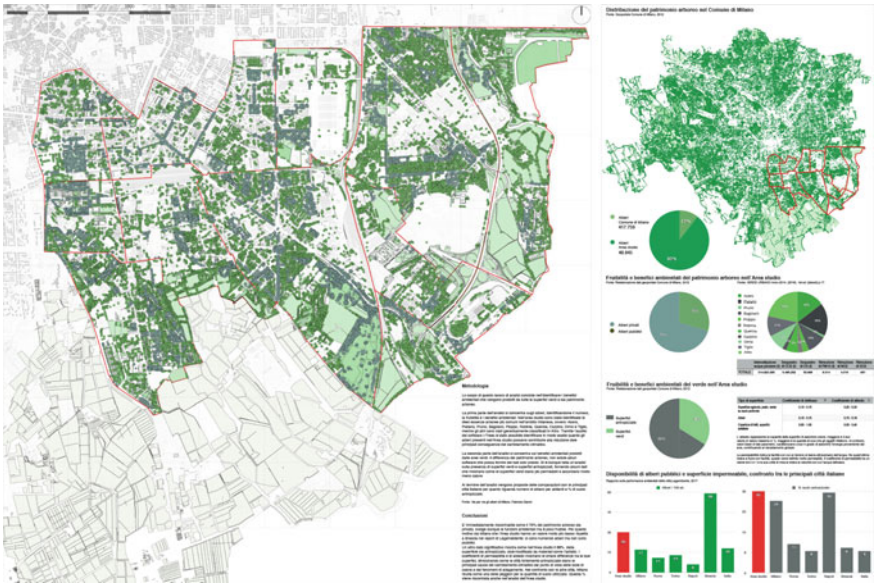

Fig. 1 Environmental values in the area of the applicative case

Elements such as the presence of green areas, accessibility, pollution, temperature and predicted mean vote (PMV) during the summer period have been used both to select the design case studies and to evaluate the possible results of the natural/natural and artificial alternatives for the construction of green infrastructures. The design proposals involved different kinds of public spaces to cover the alternative which can commonly be found in an urban settlement (avenues or lineal systems, squares or point systems, brownfields and infrastructure to be revamped). The parallel use of parametric evaluations and modelling tools has been used to assess the benefits related to air pollutants and greenhouse gases, direct and indirect absorption of CO_2, urban heat islands and rainwater management, arriving at an economic evaluation. Specifically, the quantification of indirect economic benefits, defined as lower costs for the implementation of other services that are essential for the functioning of the city, has in fact confirmed to the involved stakeholders (municipalities four and five of the city of Milan) that the savings obtained can be compared with the costs for the maintenance of new green infrastructures. In particular, the test areas have been the two linear systems of Corso Lodi and of Via Brenta; the punctual system of the San Luigi Square; the brownfield of Via Toffetti; the building and related open spaces of the project for the call "Reinventing cities" in Via Serio.

6 Conclusions

In a phase characterised by a narrowness of public resources and a limited capacity in managing the time–cost–quality ratio of public works, the project action should be strongly based on principles of necessity and rationality. In this scenario, the urban green project can find its proper integration within the overall regeneration actions, enhancing, where necessary, the use of trees, hedges, green walls and parterres and bio basins as multifunctional elements able to offer ecosystem services, to contribute to a comfortable use and to architecturally connote urban space. The design and management of these components must therefore be based on a principle of necessity, which means acting as a correct response to the demand for use, comfort and decor, ease of maintenance, high durability, reliability and safety, integration and environmental efficiency. The pursuit of these objectives cannot be achieved by involving actions that are reduced to the "tactical" dimension, but by activating processes of social and design re-appropriation that can really raise the level of knowledge, awareness and competence of citizenship, in order to produce structural and lasting results.

The study has allowed us to benefit from a more in-depth view of the ways in which to transform public spaces, to produce lasting socio-spatial effects and to contribute environmental improvement. In fact, the goal is to trigger virtuous processes of renewal of both contents and containers for the production of new culture and spatial regeneration. A central aspect of the intervention on public spaces concerns in fact the methods of triggering regeneration processes: further research developments are looking at new approaches that combine real estate investments and the creation of social value to move from typically compositional and "regulatory" design logics to logics of a promotional and "experimental" type, to create a trading zone within and to initiate demonstrations to accompany the processes. A new design paradigm for urban regeneration combines two levels: the long-term strategic vision and the short-medium term experimental vision.

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