*UPLanD – Journal of Urban Planning, Landscape & environmental Design, 5(1), 37-44* [2020]

UPLanD
Journal of Urban Planning, Landscape & Environmental Design


Research & experimentation
Ricerca e sperimentazione

# Endless Articulations, Environmental Benefits and Dynamic Relationships of Sustainable Infrastructures

Renata Valente
*Department of Engineering, University of Campania Luigi Vanvitelli, IT*

## Highlights

- Meaning of density as an alternative to the result of the quantitative relationship and ratio: multiplicity of values of an urban place as environmental quality.
- Interpretation of density as intensity, through the enhancement of direct and induced benefits.
- Cultural Editorialization: definition of infrastructures as vectors of *memes* (Kullmann).
- Strengthening of places with intensity of performance related to the context.
- Presenting a research through design on adaptive project of mediterranean green street with nature based solutions for performative public spaces.

## Abstract

Comparing critical readings of the concept of density, the paper considers road infrastructures as complex sustainable components, similarly to a dense urban structure containing them. This scalar interpretation prefigures the multiplication of benefits through projects of eco-technological corridors, with networked systems, hybridization of functions, control of the timing of interventions, use of greenery for environmental rebalancing, intensification of social relations.
At a closer scale, green streets offer benefits in addition to the storm-water management, as the improvement of the quality of air and run-off, the increase of ground infiltration, the reduction of the urban heat island, the availability of green pedestrian connections. The paper presents first evidences of the ongoing research on these issues at the University of Campania Luigi Vanvitelli, as part of the PRIN 2015 Project "Adaptive Design and Technological Innovations for Resilient Regeneration of Urban Districts in Regime of Climate Change", experimenting research through design along a state road in Southern Italy. Linking up to the research on intensity-performance spaces, the project investigates complex uses and related design methods for the green streets devices, in order to enhance them in different context conditions.

## Article history

Received: August 02, 2019
Reviewed: December 20, 2019
Accepted: January 29, 2019
On line: June 01, 2020

## Keywords

Polarity
Adaptive design
Environmental benefits
Nature based solutions
Green streets


Email: renata.valente@unicampania.it
ISSN online 2531-9906 | Open access article under CC-BY-NC-ND 4.0 International License

## 1. Density/Intensity

Reflections on the key terms of the doctrines benefit from retracing disciplinary paths that outline the development of meanings, while at the same time inspiring critical reading and the evolution of interpretations; perspective sights suggest how to define concepts useful both for updates and for the evolution of methodological and design processes. Within the discipline of urban planning the term density refers to the numerical ratio between people and spaces, alluding to the crowding value of places and settlements, which must be equipped with services and facilities, sometimes even implying a greater difficulty in meeting requirements and demands. In a somewhat opposite way, from a philosophical point of view the term refers instead to the capacity of an infinite articulation. In this case, by not limiting the decoding to evident meanings, an interpretative dynamic is continuously set in motion, activating new interpretations and expressing an unfinished that opens up additional possibilities (Solla, 2014). Paradoxically, this definition is connected to what, on the basis of physical and theoretical meanings, intends density as the potential intensity of internal relations to materials, objects, buildings or contexts. By following these indications, the scope of the mere algebraic and quantitative weight of the ratio is extended towards the implementation of a qualitative description, to which this contribution is also directed through some international references of theoretical criticism.

Back in 1975 Amos Rapoport, one of the founders of the field of Environment-Behavior Studies (EBS) that integrate design, social and behavioral sciences, investigating the relationships between the built environment, human behavior and application in the design process, offered among the most authoritative historical reinterpretations of the term by introducing the concept of "perceived density", inviting to consider the cultural diversity and contextual specificity of all forms of density, human or architectural.

"[I]t is clearly more than the number of people per unit of physical space. […] There have been several themes:

(a) the great complexity of the concept of density;
(b) the central role of perception in transmitting sensory data to people and hence in their evaluation of density in terms of information processing;
(c) the existence of cultural and other differences in the desire for, and tolerance of, interaction and involvement, in the definition of unwanted interaction and in the ability to control and cope with various levels of interaction, hence the differential judgment of affective density (crowding or isolation);
(d) the presence and use of a large number of physical and social mechanisms which modify density in terms of people per unit area and provide the basis for the cues whereby density is perceived and judged.

It is suggested that density is best seen in terms of its perception and in terms of information processing and that crowding is a specific case of excessively high affective density (excessively high social or sensory stimulation rather than lack of space)." (Rapoport, 1975, p. 152)

The text stressed the need to consider the relationship between different socio-cultural groups and the values of density, the relationship of a particular area with its context, specific activities and their distribution. It also highlighted the need to understand the relationship of various physical signals and the effects of social and cultural factors such as homogeneity and lifestyle on the perception of density and its evaluation. While much of the literature highlights the negative effects of high densities, there may also be undesirable outcomes due to low values as consequences of specific levels of affective density; indicative examples are sensory overload on one hand and sensory deprivation on the other. In between, for each given group and context, there is a limited range of densities that are acceptable and preferred as perceived: any definition of density must allow this factor. The growth of overcrowding conditions in urban areas since Rapoport's writing has since evolved the meaning of density in a negative sense, almost always associating it with conditions of unliveability and unsustainability.

With the beginning of the new millennium, the critical debate on the subject is developing among scholars of the design disciplines; in 2003 Pascal Amphoux, at the opening of the conference entitled "Inside Density, International Colloquium on Architecture and Cities", stressed that the idea of density was an insufficient notion, since it is based on the assumption that the territory is isotropic and homogeneous, the elements counted are immovable and permanent, social behaviour is standard and proportional, while evidently this rarely happens in an urban context. Emphasizing the great gap between density and sensation of density, the author therefore proposed to distinguish three modes of the densification process: polarity, mixing, intensity. Of particular interest is the reasoning with which, by introducing the concept of polarity, a spatial (i.e. geographical) and measurable (i.e. physical) dimension of density

was connoted, referring however to dynamic and relative notions as well as the state of equilibrium of a body between opposite poles. The definition of the mixing refers instead to the reductive idea of a functional mixture by identifying the two possible directions:

- the application of topological, morphogenetic or compositional rules, through the treatment of architectural or urban space;
- the application of chronological rules, too often forgotten, which can increase or decrease the frequentation, interactions or animation of public spaces.

"Par intensité nous proposons donc de nommer cette dimension sensible, troisième dimension de la notion de densité. Le mot signifie le degré d'activité ou d'énergie d'un phénomène sensible (le son, la lumière, le geste); de l'autre il désigne la prégnance ou la vivacité d'un sentiment, d'un regard ou d'une relation. [...] Intensifier la ville, ce sera donc, par des moyens sensibles, intensifier le rapport à la ville, en offrir une meilleure acuité perceptive, renforcer le sentiment d'urbanité ou encore renforcer l'identité du territoire considéré. [...]l'intensité s'écarte et inclut l'identité: [...] D'un point de vue théorique, la proposition est donc double: d'une part redonner à la dimension sensible de la densité le même poids qu'à sa dimension technique et à sa dimension sociale [...]; d'autre part, substituer aux problématiques de la définition de l'identité urbaine celles de la définition d'une intensité urbaine et des principes d'intensification perceptive.

Le premier d'entre eux, au niveau le plus général, est celui de la qualité architecturale des espaces densifiés. Dans cet esprit, deux logiques de "densification qualitative" sont souvent évoquées dans les recherches sur la densité comme chez les praticiens:

- celles qui consistent à privilégier le remplissage des dents creuses, la reconquête des friches ou la réhabilitation de logements (III.2.2.);
- celles qui concernent les espaces verts, qui culturellement sont massivement bien perçus; mais les calculs de densité d'espaces verts dans un quartier ou une ville [...] se heurtent aux mêmes insuffisances que les coefficients d'occupation bâtie; et c'est donc en d'autres termes qu'il faut aborder la question de la qualité végétale de la ville (II.3.2)." (Amphoux, 2003, pp. 27)

For our purpose it is very interesting here to observe how Amphoux also addresses the question of method, theorizing a project that deals with the intensification of perception also through a minimalist approach. In systematizing the criteria of the densification process, he consistently passes to the formulation of effective "principles of intensification", such as the tensioning of the elements of the urban composition, "the minimum means for the maximum effect", the reinterpretation of the context, the detector of human presence. Intensity is therefore defined as a sensitive dimension, such as the degree of activity or energy of a sensitive phenomenon (sound, light, gesture), poignancy or liveliness of feeling, gaze or relationship. In this sense, rather than densifying, we are talking about intensifying the city and its relationships, offering a better perceptibility, reinforcing the feeling of urbanity or the identity of the territory. For these reasons, according to the author, designers should not so much deal with the definition of urban identity, but rather with the definition and design of urban intensity, according to principles of perceptive intensification, which make it possible to pass from a normative statute with quantitative prescription to that of qualitative performance through the project procedure. What we observe today is that this is precisely the task of architec-

**Table 1:** Principle of controlled densification of identification

| **Principle of controlled densification** | **Negotiation document** | **Negotiation rules** |
|---|---|---|
| **Identification** | **Atlas of Perceptions** | **Observation system** |
| Directory of the qualities of the place *(principle of perception)* | Type-morphological analysis<br>Socio-anthropological survey | Architectural typology<br>Commented itineraries and routes |
| Reintroduction of the sensitive<br>*elements of perennial*<br>*evolution of availabilities*<br>*transformation typologies* | Sensitive approach | Photographic survey |

*Source: Excerpt and translated by P. Amphoux, p. 31*

tural technology, with the study of the methods of qualification through the project, where the process of intensification takes on an extremely important and connotative role.
The shift from the idea of density to that of intensity is also supported in Kormoss' contribution (2003), criticizing the approach expressed by Winy Maas when he proposed systematizing density as a technique for maximizing differences (Maas, 1998). Rather than conceiving density only as a tactic of compacting physical data, Kormoss proposes an internal strategy of intensification, as "hyper-ipo intensity" of form-matter, based on notions such as immanence and repetition of difference. The support offered by the set of such reflections in the direction of a critical reading still substantiates the idea of extending the concept of density, and therefore of intensity, to the systems structuring the urban environment with the aim of enhancing its characteristics of functionality, performativity and sustainability.

## 2. Intensity/Infrastructure

Density considerations in the settled territory can be reflected in a scalar way on its constituent parts; thus, similarly to a dense urban structure that contains them, the connection infrastructures can in their turn be considered among the main dense, or rather intense, and complex, sustainable components when they amplify functionality and attractiveness. Density, or rather intensity, is the characteristic that can multiply the uses of infrastructure, the reasons for its transformation and the benefits it brings. It therefore determines a sort of oxymoron for which a negative, empty space becomes dense, intense, thanks to the sustainable environmental project that amplifies its meaning and contents.
This scalar, even fractal, interpretation of the concept of density allows to increase the benefits through projects of what since 2004 in the in-depth PhD thesis work presented by Mariachiara Catani were defined "eco-technological corridors". They are the results of projects that apply tools for the eco-compatible requalification of the road space, through four fundamental criteria: the network design, the temporal management of the project, the use of vegetation as an element of environmental rebalancing, the hybridization of functions and contexts. Main features have been identified in the multidisciplinarity, for the quantity of technical and cultural aspects to be considered, as well as in the inter-scalarity, downwards in the detailed solutions and upwards in the interconnection to large scale networks (Catani & Valente, 2008-2010).
These results came in parallel with the contemporary debate on the topic: if already in the 1980s the international literature of reference considered greenways as multi-purpose green arteries and no longer only for naturalistic purposes, since 1995 a careful observer like Jorgo Simeoforidis suggested to think about new spaces and uses for infrastructures in transformation. In 2006 Elizabeth Mossop defined infrastructure as the most important generative public landscape (Mossop, 2006), while Pierre Belanger, a profound scholar of infrastructure of landscape and landscape as infrastructure, illustrated the concept of transcalarity with the brilliant definition of "telescopic design", through scales, strategies, disciplines, underlining its contrast with fixed infrastructures, loose ecological systems with micro and macro level effects (Belanger, 2006).The discussion on the subject evolved in 2013, when Kristina Hill invited to treat the edge zones as dynamic edges, including lateral areas (clearly inspired by Gordon Matta-Clark and his Fake Odd Lots) (Cozzolino, Nardi, Valente, 2014). At the same time Karl Kullmann defined four generations of greenways where the last one, in the period from the mid-90s to the present, shows them as integrated into the infrastructure, so that the complete networks rival the grey ones of the incumbent urban fabric, including roads, abandoned spaces and interstitial spaces (Kullmann, 2013). In seeking appropriate environmental design criteria for the sustainable recovery of infrastructure, Kullmann refers to a sophisticated concept cited by Massumi (1998), which proposed tunnelling, i.e. taking perceptions originating from afar and influencing them in the composition of the space of a place to enrich it with references, as for a karst emersion. In this way the infrastructures become vectors of memes, units that carry cultural concepts along the network they form.
In profound harmony with the development of this concept, we have been investigating since long time the operational codes of an environmental and technological project that expresses its criteria and characterizations, reasoning on classifications of places, systems, components and cultural impact on the structure of the urban environment. The result of the reported reflections confirms in fact the value of an interdisciplinary consideration in the project of urban infrastructure redevelopment, which integrates technical performance and significance of the values of the crossed places

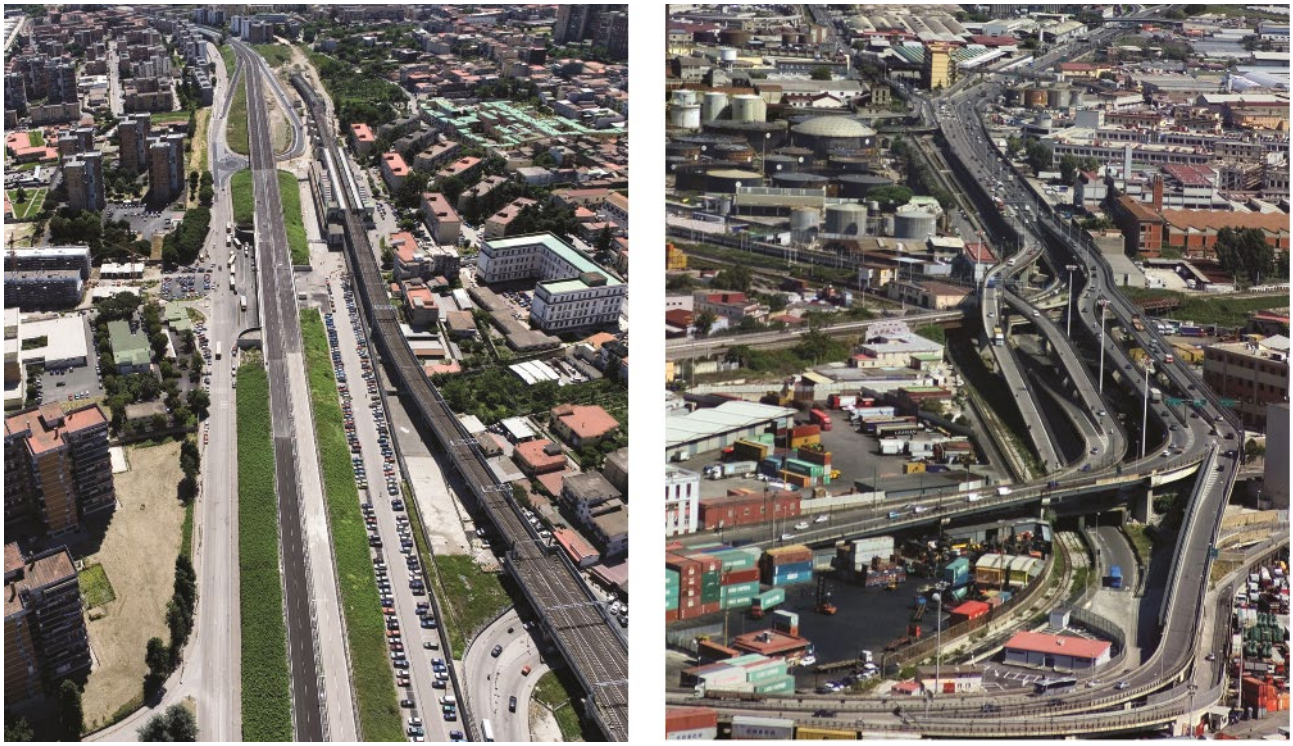

**Figure 1:** Naples, primary urban roads in peripheral areas. *Source: photos by Paolo De Stefano.*

## 3. Intensity of performance

At the scale of the urban environmental project, based on the definition of "nature based solutions" characteristic of green streets, the spaces can offer uses with multiple benefits beyond rainwater management, such as improving the quality of run-off water and air, increasing infiltration into the soil, reducing the urban heat island, the availability of green pedestrian connections.
In the dedicated scientific literature and in the examples of technical manuals disseminated by local administrations at the forefront on the subject the solutions are now canonized (Valente, 2017) but it is necessary to study and experiment operational processes to apply these strategies in the Mediterranean area. The chance is to take the opportunity of the existing delay to implement the required qualities aiming at a virtuous polarity between reduction of construction components and implementation of the obtained effects. Moreover, coherently with the illustrated theories, it is considered necessary to work on the research of further meanings for the devices present in the infrastructures, in order to preserve and make them functional even in moments of aridity or in contexts characterized by a lack of environmental awareness by the citizens.
These are the targets of the research in progress at the operational unit of the University of Campania Luigi Vanvitelli within the PRIN 2015 Project "Adaptive Design and Technological Innovations for the Resilient Regeneration of Urban Districts under Climate Change Regime" (The local unit coordinator is R. Valente. The team includes S. Cozzolino, C. De Falco, A. Di Nardo, M. Di Natale, C. Donadio, F. La Rocca, M. Pernetti, D. Ruberti, S. Strumia, M. Vigliotti, P. Ferrara, E. Cappelli, R.Bosco, G. Moccia. The National P.I. is M. R. Losasso).
On this occasion, research through design is experimented along the stretch of road 7 bis between Aversa (CE) and Melito (NA), an area subject to flooding distant in time, but ferocious in the results, looking for an adaptive project that reduces risks and enhances direct and induced benefits. The objective is a green street, which through devices for the sustainable management of rainwater, also counteracts the phenomenon of urban heat island and high temperature regimes, improving the quality of air, wastewater, urban and suburban environment, recharging the aquifers.
The stretch of road, 5.5 km long, is affected by rainwater from a 2.18 sq km drainage area shared by the municipalities of Aversa, S. Antimo, Giugliano and Melito. The research focuses on public connection spaces on a total of about 480,000 square meters, to locate best management practice (BMP) devices that collect, retain, filter, purify, infiltrate

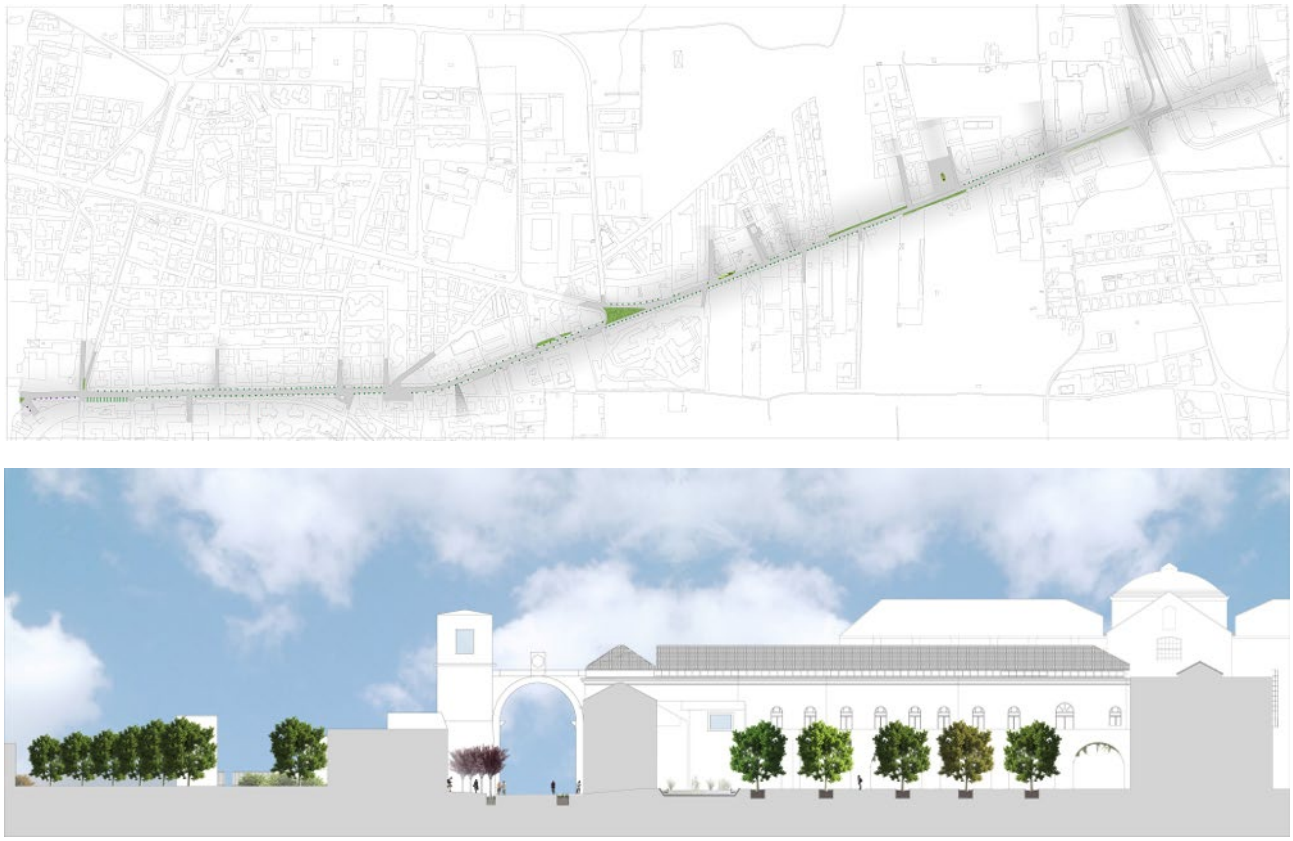

**Figure 2:** Aversa-Melito SS7bis Green Street: plan and cross section on Pilot Area 1. *Source: PRIN 2015, Unicampania, resp. R. Valente.*

and/or convey about 8500 cubic meters of rainwater, for a precipitation of thirty minutes with a return time of twenty years, adding multiple induced services (Kurtz, 2009; Valente, 2017).
The environmental project in progress integrates quantitative, social and historical data, testing tools to support a strongly interdisciplinary work. Starting from the consultation of high scale maps on the waterproofing of surfaces, on land use, on the presence of street trees from Copernicus satellite data, the model of areas subject to flooding has been developed, in relation to the different degrees of centrality with respect to historical centers, highlighting remarkable places and monumental assets. The crossroads between the main axis and the ancient watercourse routes have indicated critical places where special attention should be paid in the project. The definition of the drainage sub-areas indicated areas suitable for the positioning of the devices according to the necessary quantities, as well as in relation to the available free surfaces and the H/W ratio of the roads. Through a GIS model of LIDAR and hydrological data, the historical analysis of the environment, the study of the pre-existing buildings, the complete map of vegetation, the destinations of use on the ground floor with time periods of activity, traffic flows, construction materials, street furniture and territorial information have been integrated.
The presence of tall vegetation has also been investigated with the software I- Tree street, calculating the benefits in terms of reduced CO2, stored CO2, concentration of pollutants, reduction of water runoff and landscape value of the places.
The operational research presents a typology of devices spread throughout the territory for a total area of 16,300 square meters. The equipment, designed according to the areas in which they fall driving forward the research on site specific nature based solutions, implement the permeable areas of the connection spaces and are recorded in a database with dimensions, volumes, materials, costs, vegetation, to facilitate planning and management. This typology includes green spaces for collection, bio-retention, purification and shading (Valente, 2017), which reconfigure a network of special places along the drainage area.
With the aim of contrasting the frequent flooding phenomena, the ongoing research also investigates the microclimate and environmental com-

fort conditions of the places under examination, in order to enhance the advantages induced by the green street construction criteria. To this end, the areas under examination have been subjected to virtual modelling using the ENVI-MET fluid-dynamic software, which simulates surface-vegetation-air interactions in urban environments. Analyzing the data related to the potential and radiant temperature values, as well as the predicted mean vote (PMV), focus points were identified where it is appropriate to improve the existing conditions by integrating the redevelopment project with more suitable materials for walkscapes and tall trees. Special attention must be paid to the recording of the discontinuous regime of temperatures and mainly of the area's meteoric precipitation, with short and intense peaks twice in the year and prolonged periods of aridity. This certainly involves attention to the botanical aspects in the project phase for the choice of xerophilous species but which must be nevertheless suitable for the purification of rainwater for which the devices are intended. However, the discontinuity of the rain regimes, in addition to the profound difference in the characteristics of the localization sites, starting from various conditions of urban centrality and circulation flows, leads to the hypothesis of innovative devices. These can be transformed according to the season and the phases of usability, when they can be managed by caregivers encouraged by appropriate policies and the interest in attending safe and welcoming places.

The objectives described in this way are correlated and implementable when we also refer to the definition of performance intensity spaces, given to those open public spaces whose environmental design processes have been studied, identifying four main characteristics (Bosco et al., 2012):

1. the greatest possible integration of the new equipment needed in existing spaces and surfaces: the reconfiguration of the urban landscape according to an adaptive viewpoint that adds to the expected environmental benefits also the opportunity to rationalize the existing volumes and the language according to which they are conformed;
2. physical transformability of the equipment itself and control of the configurations, for transitional periods of variable durations: the consideration of the meteo-climatic regimes of rain, temperature, humidity and relative well-being parameters;
3. energy supply from renewable source for the dynamism of space configurations and high performance: the implementation of off grid configurations to alleviate general loads;
4. performativity, i.e. the predisposition both to provide a direct performance and to produce a new participatory relationship between users and places, attributing relational value to the outcomes of the interventions, through which to become aware of social and/or environmental dynamics: this public space-time is understood as performative, in the sense that the inhabitant of the open space is seen as a participant in it, living the place and not only staying in it (*ivi*).

This value of social activation, awareness and civic citizenship, can lead to extraordinary phenomena, as happened with the conviction to preserve the route of an old elevated railway and make it become one of the most famous promenades in the world in less than a decade, starting from the action of a group of inhabitants of the areas adjacent to the artery, which were previously neighborhoods with a very low market value.

## 4. Conclusive considerations

The possibility of attributing a multiplicity of functions, solicitations and missions to the flow space of urban infrastructures refers to what in the opening we reported as a definition of density, that is the capacity of an infinite articulation, a congenial sphere for the environmental project, where its creators must also be the political drivers of multi-faceted approaches. In this sense we are still guided by the words of a master of the technological discipline of architecture, remembering that it is necessary ...

"Una ricerca di materiali fluttuanti per «edificare», luoghi destinati alle attività umane [...]. Una tradizione diversa che pone in discussione proprio la reverenza verso quelle tipologie chiuse, immobili nello spazio e nel tempo, che contrastano qualsiasi relazione dinamica e cioè mutevole, tra spazio fisico naturale e spazio costruito. Un paesaggio di cose concrete non perenni [...]. Un progetto-percorso per fare spazio, un intervento in qualche modo provocatorio per modificare le strutture esistenti della città [...] cercando di sostituire alle strade e alle piazze [...] un insieme di luoghi aperti al disporsi non perenne delle cose. [...] fare spazio, privilegiando l'effimero, il caduco, l'impalpabile, contro il solido, il perenne, il consistente, significa privilegiare l'organizzazione delle cose viventi [...] sull'organizzazione delle cose inanimate [...] Se si vuole cogliere quell'evanescente dimensione che è data dall'iconosfera urbana, unico bene che può essere captato e fruito da tutti." (Vittoria, 1982, p. 10).

## Acknowledgements

We thank Paolo De Stefano for the courtesy of the photos in Fig. 1. Figg. 2 and 3 are by Eduardo Cappelli. We thank editors and reviewers for the useful advice to improve the paper quality.

## References

Amphoux, P. (2003). Polarité, Mixité, Intensité: Trois dimensions conjointes de la densité urbaine. In *Inside Density, International Colloquium on Architecture and Cities,* Bruxelles, Belgique, Mar 2003.

Belanger, P. (2006). Synthetic Surfaces. In C. Waldheim (Ed.), *The Landscape Urbanism Reader* (pp. 239-266). New York, US: Princeton Architectural Press.

Bosco, A., Rinaldi, S., & Valente, R. (2012). *Strumenti per il progetto di microlandscape urbano. Design Tools in Urban Microlandscape*. Firenze, IT: Alinea editrice.

Catani, M., & Valente, R. (2010). New models for the recovery of urban main road system in mediterranean environment. *III International Conference on Architecture and Building Technologies - Regional Architecture In Euro-Mediterranean Area*. Firenze, IT: Alinea editrice.

Catani, M., & Valente, R. (Eds.). (2008). *Around Urban Highways Connections and Studies for Environmental Reclaim*, Firenze, IT: Alinea.

Cozzolino, S., Nardi, L., & Valente, R. (2014). *Teorie di progetto ambientale attraverso l'Europa*. Napoli, IT: CLEAN.

Kormoss, B. (2003). Intensity vs. Density. In *Inside Density, International Colloquium on Architecture and Cities*, Bruxelles, Belgique, Mar 2003.

Kullmann, K. (2013). Green-Networks: Integrating Alternative Circulation Systems into Post-industrial Cities. *Journal of Urban Design*, 18(1), 36-58. doi: 10.1080/13574809.2012.739545

Kurtz, T., (2009). Managing street runoff with green streets. In N. She & M. Char (Eds.), *International Low Impact Development Conference Low Impact Development for Urban Ecosystem and Habitat Protection 2008*. Seattle, United States, November 16-19, 2008. Reston, US: ASCE library.

Maas, W. (1998). Datascape: The final extravaganza. *Daidalos 69/70*, 48-54.

Massumi, B. (1998). Sensing the Virtual, Building the Insensible. *Architectural Design, 68*, 16-25.

Mossop, E. (2006). Landscapes of Infrastructure. In C. Waldheim (Ed.), *The Landscape Urbanism Reader* (pp. 163-178). New York, US: Princeton Architectural Press.

Rapoport, A. (1975). Toward a redefinition of density. *Environment and Behavior, 7*(2), 133-158.

Simeoforidis Y. (1995). El proyecto urbano entre el lugar y el no lugar. In *Construir la ciudad sobre la ciudad*, EUROPAN Catalogue, Paris.

Solla, G. (2014, May 15). Elogio della densità. In *Doppiozero*. https://www.doppiozero.com/materiali/contemporanea/elogio-della-densita.

Valente, R. (2017). Water Sensitive Urban Open Spaces: Comparing North American Best Management Practices. *UPLanD – Journal of Urban Planning, Landscape & environmental Design, 2*(3), 285-297. doi: 10.6092/2531-9906/5421

Vittoria, E. (1982). Fare spazio per un progetto-percorso. In A. Capasso, A. Niego & Vittoria E. (Eds.), *Lo spazio pedonale e la città*, (pp. 7-12). Napoli, IT: Società editrice Napoletana.