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Il verde pensile per rigenerare le città

Conference Proceedings

New forms of Nature

Green roof for regenerating cities

a cura di/edited by
Adriana Ghersi
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Studi e ricerche sul paesaggio

2

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Il presente volume raccoglie i principali contributi del convegno internazionale 'Nuove Forme di Natura - Il verde pensile per rigenerare le città', tenutosi presso il Dipartimento di Architettura e Design dell'Università degli Studi di Genova il 6 e il 7 aprile.

I testi sono stati selezionati e revisionati dai Membri del Comitato scientifico.
This publication collects the main contributions to the international conference 'New Forms of Nature - Green roof for regenerating cities', held at the Department of Architecture and Design of the University of Genoa on 6 and 7 April 2022.

The texts were selected and reviewed by the Members of the Scientific Committee.
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La collana si propone di valorizzare e diffondere il ruolo, i contenuti specifici e la cultura dell'Architettura del Paesaggio per dialogare e accogliere le molteplici competenze e discipline che studiano il Paesaggio, con l'obiettivo di comprendere e valorizzare sul piano ecologico, sociale e culturale i diversi elementi che caratterizzano i paesaggi, per affrontare le sfide della contemporaneità, attraverso strumenti innovativi.

La complessità del Paesaggio richiede l'individuazione delle conoscenze necessarie alla sua comprensione e interpretazione attraverso la lettura degli elementi strutturanti e delle relazioni che ne determinano la morfologia e il funzionamento ecologico, dei diversi significati a esso attribuiti, delle stratificazioni e delle tracce degli elementi scomparsi in relazione ai mutamenti economici e sociali e, quindi, l'elaborazione di proposte nelle quali conservazione e rinnovamento siano fortemente integrati.

La collana accoglie contributi e studi che affrontano i temi più rilevanti del dibattito contemporaneo, in una visione transdisciplinare e a diverse scale spazio-temporali, per costruire occasioni di confronto rispetto agli aspetti teorico metodologici e all'analisi critica di opere e progetti di trasformazione e gestione del Paesaggio.

Studi monografici, testi di più autori, atti di convegni e saggi saranno sottoposti a peer review.

The series wants to enhance and spread the role, the specific contents and the culture of Landscape Architecture to dialogue with and welcome the multiple skills and disciplines that study the Landscape, with the aim of understanding and enhancing at the ecological, social and cultural level, the different elements that characterize the landscapes, to face the challenges of the contemporary age, through innovative tools.

The complexity of the Landscape requires the identification of the necessary knowledge for its understanding and interpretation through the reading of the structuring elements and the relationships that determine its morphology and ecological functioning, the different meanings attributed to it, the stratifications and the traces of the disappeared elements in relation to economic and social changes and, therefore, the elaboration of proposals in which conservation and renewal are strongly integrated.

The series includes contributions and studies that face the most relevant topics of the contemporary debate, in a transdisciplinary vision and at different space-time scales, to build opportunities for comparison with the methodological theoretical aspects and critical analysis of works and projects for the transformation and management of Landscape.

Monographic studies, texts by several authors, conference proceedings and essays will be subjected to peer review.

Indice

Evaluations on green vertical walls to enhance design quality: the experience of zero gravity eden in Leonardo Campus, Milano

Julia Nerantzia Tzortzi, Giovanni Barbotti
Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano

Introduction

Since the last few decades, and in accord with United Nations projections, Climate Change hazardous events increase of severity is a matter of global awareness which has grabbed the attention from citizenship up to the countries' government politician leaders and urban planners research orientation (Geneletti *et al.*, 2019). As a matter of further concern, most of the mankind is localised in urban areas, which can be not easily named 'cities', due to the metropolitan area that could be quantitively much wider and somewhere much higher inhabited, although the percentage of land occupied by them is incredibly small if compared to the overall on Earth. Moreover, accordingly with the projection released by the scientific community (Guida *et al.*, 2021), it is a raised concern the risks of living in those areas: increased exposure to illnesses, new disease such as COVID-19 pandemic that has been proving this issue with no doubt (Mouratidis, 2022; Hamidi *et al.*, 2018). To this demanding issue, it can be further asserted that avoiding urban sprawl and pulsing for wise strategy of built environment planning practice perhaps can contribute to health and well-being. Additionally, the simultaneous phenomena of Urban Heat Island effect (UHI) and Heat waves (HW) (Manoli G. *et al.*, 2019; Zhao. *et al.*, 2014) combined are leading to a challenging scenario to deal with. A proposed strategy to approach this severe trouble is to reintroduce the greeneries in the urban environment (Susca *et al.*, 2011) balancing the waterproofness and aggressive buildings density of built environment (Massetti *et al.*, 2019). An emergent topic which lies among several professional fields: environmental engineering, architecture and urban landscape, botanical and naturalistic. As a matter of relevance, the design of green aimed to renaturing the cities must face an issue of not immediate solving: integration of the green solutions (Coma *et al.*, 2017) both horizontally and vertically is generally ending up facing the state of art of buildings: structurally not adequate to safely integrate the retrofitting proposal.

If the history of architecture has taught something of evident is the industrial revolution has brought a breakage with Nature: the borders of cities became crossed by infrastructural arteries and consequently the forests sealed within cramped perimeters and often no longer accessible for the citizen. Ambitiously, it is nowadays an issue that Milano is bravely facing, encompassing the experience of EXPO 2015. As stated by the official dissemination page of the municipality, 'Milano 2030' is the goal to look forward to accounting. Linked with sustainability and resilience (a discussed and perhaps abused word) there are two main paths. One is the wish to work in the direction of a greener, sustainable and resilient place to live. The new plan envisages a 4% reduction in soil consumption compared to the current plan, to be achieved by limiting agricultural use of over 3 million square metres of land, expanding the South Park by about 1.5 million square metres, creating a large Metropolitan Park by means of an ecological link between the North Park and the South Park, creating at least 20 new parks, including the 7 planned inside the railway yards, and a forestation plan under study that envisages a significant increase in the number of trees in the metropolitan area.

Regarding the built environment, the required standards are expected to be raised by improving energy performance, creating new permeable areas, including through 'green roofs', and certifying CO_2 reduction, of course listed as a threat together with several other pollutants present (Holder *et al.*, 2020). The second point is aimed at the 'self-regeneration' of buildings, thus upgrading existing ones so as not to consume further public land. The Plan identifies several 'Urban Regeneration Areas', areas on the fringes of the territory that will be enhanced

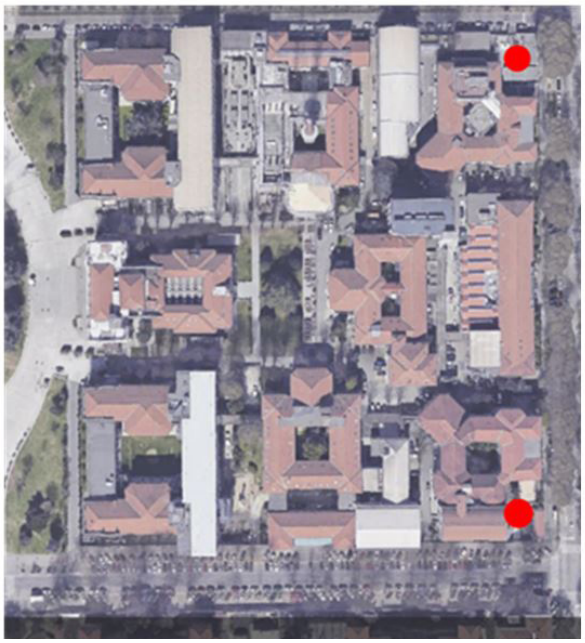


Fig. 1 Google Earth Pro view of POLIMI Campus. The red circles are respectively Building 10 installation (upside) and Building 9 (downside).

by interventions aimed at recovering the degraded building stock. It also includes the recovery of 3,000 public housing units, the construction of some social housing units in the framework of the Programme Agreement on railway yards, the experimentation in 10 public areas of social housing and housing services in mixed social contexts. Finally, strict measures are envisaged on the abandoned buildings front, with the loss of existing volumetric rights and the allocation of the building index only for those who leave buildings in a state of disrepair.

In a district of the city, thanks to the strong and strategic proposal of 'ViviPolimi' (https://www.vivipolimi.polimi.it/) that has materialised and for which the campus is intended, the Politecnico di Milano University has once again demonstrated its ability to redevelop and grow, mending the link with the city context and improving its liveability. Regarding the well-being of all those who actively live in the campus spaces, vegetation is not just an element to be installed but a way of anticipating the future of the city: Milan ambitiously looks to a horizon that will have to deal with climate change, reinterpreting itself. The improvements to the campus spaces are reflecting and sharing all the benefits with the neighbourhood: the right exchange with a space that hosts and participates in the life of the Politecnico.

Materials and methods

Site description

The research activity here presented has been carried out since July 2020, date of the successful installation of the panels in Milano Leonardo Campus, 45°N subjected to a humid temperate climate, with a considerable annual temperature variation (hot summer and cold winter), Cfa according to the Köppen climate classification, where the Politecnico di Milano technical university has its main head office and historical faculties, together with Statale University. Nevertheless, the district is called 'Città Studi'.

The research is focusing on two installations that will be described in the further sections of the paper. The site of interest as displayed in the key-map below.

Prototype set-up

The previously mentioned installations (Building 9 and 10) are both facing South and are composed respectively by 4 panels getting a surface cover of 5.4 m^2. The distance in between the wall and the internal layer of the aluminium mesh is 17 cm. One of the choices to place and study this high sun exposure orientation (Susorova *et al.*, 2014) is to investigate the irradiation effects on the vegetation and the thermoigrometric differences with the external environment.

Instruments

For the purpose of the research and to collect data about environmental parameters (relative humidity, dry bulb temperature, pollutants) sensors have been placed in proximity of the panels, precisely at the back and closer to the masonry wall. For the sake of the article here are discussed the values coming from the one placed at the back in B10 (Figg. 3 and 5), inside the cavity which is matter of interest due to the microclimatic new boundary conditions.

As presented briefly (Fig. 4) the botanicals selection and planting has been one of the most crucial phases for several scientifical reason. The purpose of selecting specific vegetation samples is due to technical and structural issues: firstly, the presence of shrubs allows

Figg. 2 and 4 (left side) and 3 and 5 (right-side). Respectively, Building 9 and 10 (B9-B10) and different configuration. The modules can be hanging with no limits in height, allowing the designer to adopt it to the building envelope.

Fig. 6 Seasonal adaption response was documented since installation period (currently under investigation). Pictures taken by the authors.

Figg. 7 (left side) and 8 (right-side). Technical details of the stainless-steel brackets.

to observe how much compatible are the *Spaghum sp.* tanks in allowing the greeneries to grew up, especially with summer exposure that in summer 2020 and 2021 has showed high temperature profiles, affecting the aluminium surface of the panels. A matter of concern was the high insulation and therefore overheating which could have led to a thermal stress induced on the essences. In January 2022, the tridimensionality hanging garden grow up to almost 1 mt of length out-plane in respect to the original planting tank (more a slot, since the main void measures 30x8 cm and at the edges is 7x15 respectively length and width).

Fig. 9 (From upside left to right): 1. *Spirea bumalda* 2. *Lonicera pielata* 3. *Hemerocallis stella de oro* 4. *Nandina power* 5. *Lonicera pileata* 6. *Loropetalum chinense* 7. *Potentilla fruticosa* 8. *Salvia da fiore* 9. *Pitosforo nano.*

As illustrated in Fig. 6, after several months and seasons the health of botanical is stable, except for the which has not well tackled the coldest months.

Design quality assessment

Mentioning the quality into a design process means to involve a proper knowledge and consistent set of skills enough well wide oriented to embrace the heterogenous diversity which NBS and hanging gardens can require to designers (Manso & Castro-Gomes, 2015) and corresponding firms. The assessment of this aspect, which is an essential milestone to ensure and validate requires a proper *ad hoc* analysis.

In this paper, mainly the goal is to highlight the crucial role of a proper technological assessment of the green building product (both horizontal and vertical). Especially when the object falls into the category of 'hanging garden' such as the case of the Zero Gravity Eden prototype, the satisfaction of the six points based on the scheme in Fig. 11 becomes essential.

Functionalities

One of the reasons of appreciation in the last months has been seeing people living as an aggregation place the otherwise empty space, induced by the presence of the hanging garden. The students in the Campus, as well as the residential citizens (since it is possible to walk and get in contact with both installation in B9 and B10) have the possibility to physically 'experience' the effect of placing in front a common and more likely high diffused masonry grey tone building.

Results

Here below are then briefly presented some results and outcome, aimed to support the evidence of the technological issue of investigating more and more this relatively new assessment of hanging gardens, including all the implications if it were applied also in other building positions or orientation. Especially, some output of the sensor installed behind the green panels are displayed and compared with the data recordings collected and validated by ARPA Lombardia in Milano Brera (urban district in the municipality) and the TMY data elaborated thanks to the sensors in Linate airport (rural area). Concerning the environmental parameters, in between the hanging gardens and the outer masonry wall it seems operating a sort of reduction in terms of numerical range for the physical parameters accounted. The maximum and minimum values are reduced, and this is due to a noticeable delay of the thermal wavelength crossing the internal thermal zone of the building and the external space. Furthermore, the tests conducted so far highlight that:

- the absence of fertilizers into the irrigation system (Nektarios, 2018) as in Fig. 11 is not affecting the health of botanicals so far. The possibility of not adding chemical additives to the H_2O to feed the plants could avoid expos-

ing the sub-system or panels themselves to a more aggressive pH (investigation in progress);
- technically, the irrigation is scheduled in order to avoid any waste due to exceedance of water. In the first weeks, it was calibrated, but no consistent loss or drainage malfunctioning were observed so far;
- the microclimate existing in the cavity here below showed in terms of water vapour and RH (Measured in %) recorded do not show critical values which could interfere with the masonry of the existing building, neither during winter or spring, when the highest values of relative humidity were recorded. After 18 months, no failure or pathology has been observed.

Discussion and Conclusion

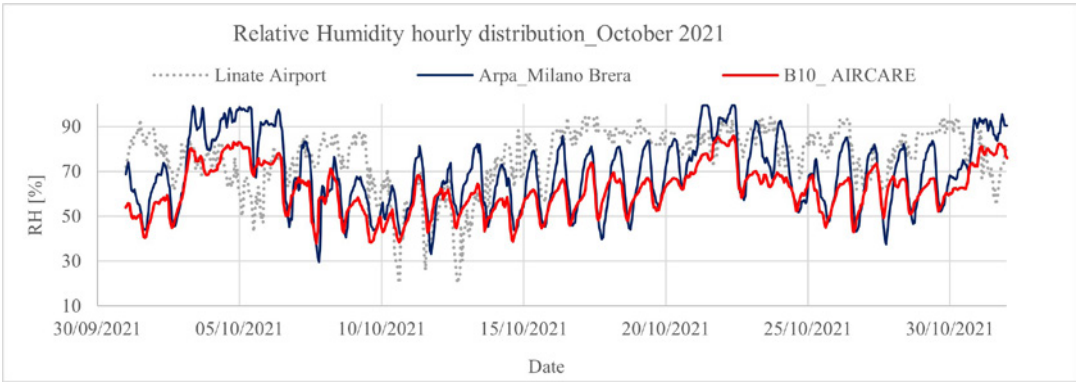
The method is aimed to the enhancement of the built environment (Alexandri *et al.*, 2008) and it shows an approach to amplify spaces with NBS solutions, equipping them with recent designed building product: the installation of a sub-system able to address and to cope the issues posed by urban landscape, synthetically explored previously.

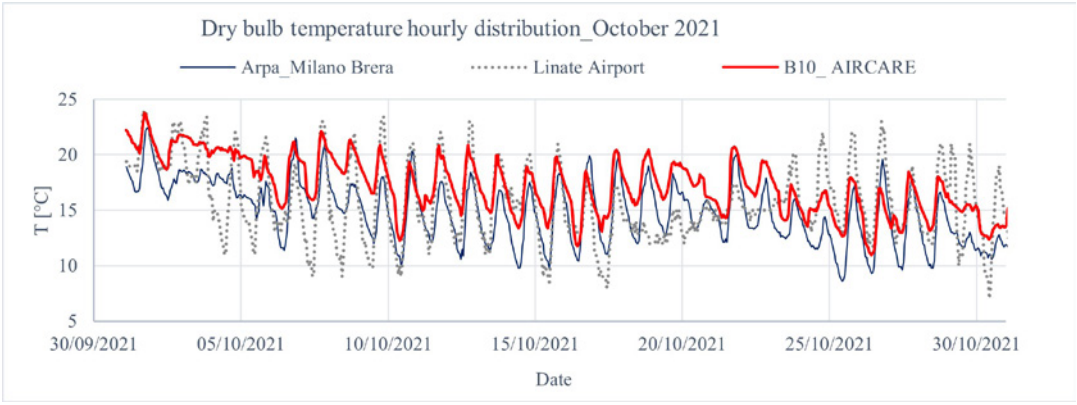
However, a noticeable aspect that is not so deeply and well investigated if this solution is considered, is the risk due to flying debris if wind phenomenon takes place (Tadrist *et al.*, 2018; Niklas,1992) and affect it (Grayson *et al.*, 2013). A safe and wise practice should warmly take this into account. (Gardiner, Berry, Moulia, 2016)

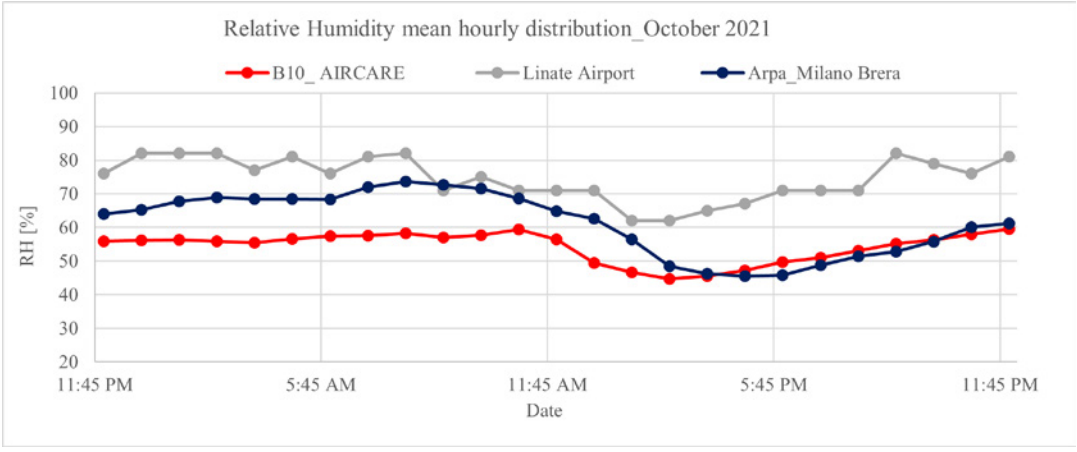
A further remarkable aspect which is source of great interest and simultaneously reason of such a challenging research subject is the wide spectrum topics that are embedded in this path. The application of botanicals to the built environment can represent a successful solution to introduce in such context where buildings feature (sloped roof, structurally not adequate slabs) could otherwise might block its dissemination. Overcoming the concept of horizontal and vertical is pursued by adopting a sub-structure that allows flexible and *ad hoc* application, enforcing the mitigation to UHI (Zhao *et*

Fig. 10 (left side) shows (red hatched focus) the position of the AirCare sensor and the main components of the irrigation system.

Fig. 11 Edited by the authors.







Charts 1, 2 and 3.

al., 2014). Another guarantee of the product quality must be seen in the reversibility of the building system: the only point of connection to the existing building is through the fastening anchors, which considerably limit the intervention in respect of the building (Figg. 2, 3 and 8). There are others application in the literature (Sternberg, Viles, Cathersides, 2011) that on a side show interesting microclimatic achievements but not a feasible substitution and still not ensuring the protection of sublayer.

The essay displays also other future challenging aspects which in future could be considered: the mullion and panel respectively made by stainless steel and aluminium (including the tanks devoted to host the vegetation planting) represent an open question if the system could be replaced by alter-

native more effective materials (wood, for instance) but at this point other technical checks will have to be accounted (growth of decay-fungi). Furthermore, specific analysis and studies must be carried out to evaluate the carbon footprint (Blanco *et al.*, 2021) presenting different materials for the structural support, such as Life cycle assessment (LCA).

At the conclusion of the paper, some interesting key points can be listed:

- Botanical selection must be firstly guided and strictly in accordance with the naturalistic and geographical site but it is no forced to limitations for their implementation in panels tanks. This is ensuring high quality design outcome for designers and agronomist.
- Application on existing buildings is demanded to enhance the architectural intrinsic value, so far is possible to adopt the modules to the need of the designer. Fig. 4 and Fig. 5 display two common situations in built environment: not always is possible to cover from the ground level with the NBS proposal technology; on the other side, the traditional buildings features, such as massive wall and windows, are requiring the adaption of the sub-system.
- Rooftop (Manso *et al.*, 2021) can potentially be equipped with this system, if implemented with vertical structural system to anchor the mullions;
- A proposal for future analysis is to place also aromatic essences, increasing the functionalities of the hanging gardens, and in contexts such as hotels, residential housing places could be seen as a horticultural implementation of more dedicated space. Furthermore, the Bryophyta group could represent a step forward to enhancing the ecological intrinsic value of the living walls (Perini *et al.*, 2020).

A final aspect to state is that enhancement of biodiversity does not require attention only to the vegetative items, but also to wildlife (fauna). A further development could be to implement botanicals accounting blossom periods, supporting life at much wider degrees.

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Collana ***Studi e ricerche sul paesaggio***

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Adriana Ghersi, Professore Associato di Architettura del Paesaggio presso il Dip. DAD dell' Università di Genova (Italia), si occupa del ruolo del paesaggio come luogo di relazione tra le diverse discipline, con riferimento a Pianificazione e Progettazione del Paesaggio nell'età contemporanea, Paesaggi Terapeutici, Giardini Storici, Paesaggi Rurali Terrazzati.

Stefano Melli, Architetto Paesaggista, è studente PhD presso il Dip. DAD dell'Università di Genova (Italia). L'ambito di ricerca è incentrato prevalentemente sullo studio multiscalare del verde pensile come nuova forma di natura in città.

Il volume raccoglie alcuni contributi dei relatori del seminario 'NUOVE FORME DI NATURA: il verde pensile per rigenerare le città' organizzato a Genova, il 6 e 7 aprile 2022, nell'ambito della Scuola di Dottorato in Architettura e Design e del Corso di Laurea Magistrale Interateneo in Progettazione delle Aree verdi e del Paesaggio.

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