PROCEEDINGS
of the
INTERNATIONAL CONFERENCE
on
CHANGING CITIES V
Spatial, Design, Landscape, Heritage & Socio-economic Dimensions

CHANGING CITIES

Changing Cities V, Corfu, 20-25 June 2022

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PROCEEDINGS
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***Corfu Island, Greece,* June 20-25, 2022**

Organised by
Department of Planning and Regional Development, University of Thessaly
Laboraty of Urban Morphology and Design

in collaboration with
Department of History, Ionian University, Greece

Under the aegis of

Green Fund
The Greek Ministry of Environment and Energy

and

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University of Thessaly, Volos, Greece

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University of Thessaly, Department of Planning and Regional Development,

Laboratory of Urban Morphology & Design,

Volos, Greece

Tel. UMLAB: +3024210.74457-74422● e-mail: umlab@uth.gr

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FORWARD

The series of international conferences on *CHANGING CITIES* aspires to bring together urban planners and designers, architects, landscape designers, urban geographers and historians, urban economists, urban sociologists, and urban policy makers, and investigate new challenges concerning cities and their future. The conference aims at becoming an international forum of transaction of ideas on cities' transitions. We have so far organized five conferences, with peer-reviewed Proceedings, taken place always in June, in venues with unique urban and natural landscape.

- *CHANGING CITIES I: Spatial, Morphological, formal and socioeconomic dimensions, 18-21 June 2013, Skiathos Island, Greece.*
- *CHANGING CITIES II: Spatial, Design, Landscape and socioeconomic dimensions, 22-26 June 2015, Porto Heli, Peloponnese, Greece.*
- *CHANGING CITIES III: Spatial, Design, Landscape and socioeconomic dimensions, 26-30 June 2017, Syros Island, Greece.*
- *CHANGING CITIES IV: Spatial, Design, Landscape and socioeconomic dimensions, 23-28 June 2019, Chania, Crete Island, Greece*.
- *CHANGING CITIES V: Spatial, Design, Landscape, Heritage and socioeconomic dimensions, 20-25 June 2022, Corfu Island, Greece*.

All Changing Cities conferences have been welcomed by the academic communityworldwide, usually attracting over 300 presenters from more than 50 countries - Greece and Europe, USA and Canada, Latin America, Middle East and North Africa, Asia, Far East, and Oceania.
On this basis, we believe thatdespite the difficult conditions of the pandemic crisis, the energy crisis, and the war in Ukraine, the 5th Changing Citiesconference will also be a successful academic event. This year, 400 abstracts from Greece and other 32 countries around the world have been submitted, while13 special sessions have been pre-organised by distinguished academics. Besides, the relatively high percentage (about 40%) of contributions by scholars from abroad indicates the international character of the conference. The 5th Changing Cities conference puts an emphasis on transformations of cities caused by COVID '19 pandemic; the main theme is *'Making our cities resilient in times of pandemics'.* It also highlights issues of *heritage management in cities* validating the co-organisation of the conference with History Department, Ionian University. The strong interest in the 5th CC conference by academic communities, yet under difficult global conditions, allows us to have thoughts about organising the 6th Changing Cities conference on another Greek island in two years' time.
I would like first to thank the Organising Committee, the keynote speakers, and the members of the international scientific board who supported enthusiastically the academic organization of this conference. I would especially like to thank those colleagues of the Scientific Committee who have also pre-organized special sessions in this conference. I would like to thank all the academic and state organisations which supported this conference in many ways: University of Thessaly; The Ionian University in which the conference has been hosted; The Greek Ministry of Environment and Energy - The Green Fund; The Greek Ministry of Maritime Affairs and Insular Policy for offerring their aegis and financial support.

Aspa Gospodini, PhD
Professor of Urban Planning & Design,
University of Thessaly,
Department of Planning & Regional Development
Chair of the Organising Committee &the international scientific board
of the series of Changing Cities Conferences

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OPENING CEREMONY

CHANGING CITIES

Changing Cities V, Corfu, 20-25 June 2022

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7. **Christos Voskopoulos,** Architect, Mayor of the Municipality of Kaisariani, Athens – Greece

KEYNOTES SPEECHES

CHANGING CITIES

Changing Cities V, Corfu, 20-25 June 2022

Changing Cities for Resilience against Climate Changes: Architectural, Engineering and Human Health Implications – The H2020 Project HARMONIA

J.N. Tzortzi[1], G. Barbotti[1], C.A. Castiglioni [1], A. Voza[2]
[1]Department of Architecture, Built Environment and Construction Engineering (DABC), Politecnico di Milano, Milan, Italy
[2]Humanitas Research Hospital, Milan, Italy

**Corresponding author: E-mail julia.georgi@polimi.it, Tel +39 02 23995622*

Abstract
Climate changes are inducing consistent variations in the "actions" that are normally considered in design of buildings and more in general in Risk Analysis for urban environments. Extreme winds gusts, Heat Islands and Waves, instant flash floodings and thunderstorms are representing a natural phenomenon that become more and more frequent across Europe, causing large economic damages as well as human lives losses.
The Architects & Engineering Community response, to try to improve the Cities' resilience toward such "Extreme Actions" is inducing a global "re-thinking" of Urban Environments, introducing several innovative solutions to increase the inhabitants' well-being and capability to cope with these threats.
One of these strategies is the introduction of Green Vertical Walls as façades of buildings, a technology that, most probably, will in the next future at least partially replace the technology of the curtain-wall façades made by steel and glass.
However, a massive introduction of this very promising technology is, currently, partially prevented by several uncertainties related to some issues of different types: technological (e.g., interaction of the green wall with the building existing façade and the risk of mould growth), structural and mechanical resistance (e.g., drag force due to tangential action affecting the green features such as branches and leaves) and Health Safety (e.g., increment of PMs during the blooming season).
This paper (based on experimental results of some pilot study carried out at Politecnico di Milano) tries to summarize the main advantages and disadvantages of this technology, while introducing the H2020 European Research Project HARMONIA, which is dealing with Climate Changes and, in accordance with the approach of Vulnerability Assessment and Risk Management, aims at providing hazard indicators that can help policy makers and increase the citizens awareness.

Keywords: human health; risk assessment; COVID-19 pandemic; built environment; urban adaptation

1. INTRODUCTION

In recent decades, as already highlighted by United Nations predictions and scientific community (Guida C. et al., 2021; Tapia et al., 2017), globally large urban settlements are becoming more aware as well as vulnerable about the risks that severe threats such as atmospheric ones can pose to human and built environment safety. Atmospheric Particulate Matter (PM) has several negative effects on human health (Holder A., et al., 2020), rising temperatures (combined with Urban Heat Island effect and Heat Waves) are also threatening urban population, and especially the most fragile categories such as the elderly. Furthermore, new diseases such as COVID-19 and the consequent pandemic has been proving this issue with no doubt (Mouratidis K., 2022; Hamidi S et al., 2018), recalling the discussion about urban health even more urgently also for urban planners (Geneletti D., et al., 2019). Within the framework of Horizon 2020 and restricting the geographic focus on

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Europe, HARMONIA project is including these items previously mentioned as key topic as an essential priority in the development of an Integrated Resilience Assessment Platform (IRAP) which is meant to be a support for decision-makers in the strategic planning and adaptation programs.
The HARMONIA Decision Support System will be a tool for a better assessment of the correlation between the probability of occurrence of chronic diseases in the population of urban areas and certain thresholds (European Commission Law with the Directive 2008/50/EC imposes limit values) of air pollution in conjunction with different Climate Change scenarios that leads to an increase in air temperature, moisture level compared to seasonal reference values (Rädler A. T. et al., 2019). In accordance with the approach of Vulnerability Assessment and Risk Management, HARMONIA will provide hazard indicators that can help policy makers and increase citizens awareness. Moreover, based on the different data sources collected by IRAP and thanks to machine learning techniques, it will be possible to improve on a continuous basis, the accuracy and consistency of forecasts, opening the opportunity for future research that considers new variables for the determination of risk factors. The city of Milan, located in northern Italy, is one of the four pilot cities of the project and the one where we are applying experimental procedures to test preliminary the inclusion of urban health parameters in the overall resilience assessment tool (LWT).

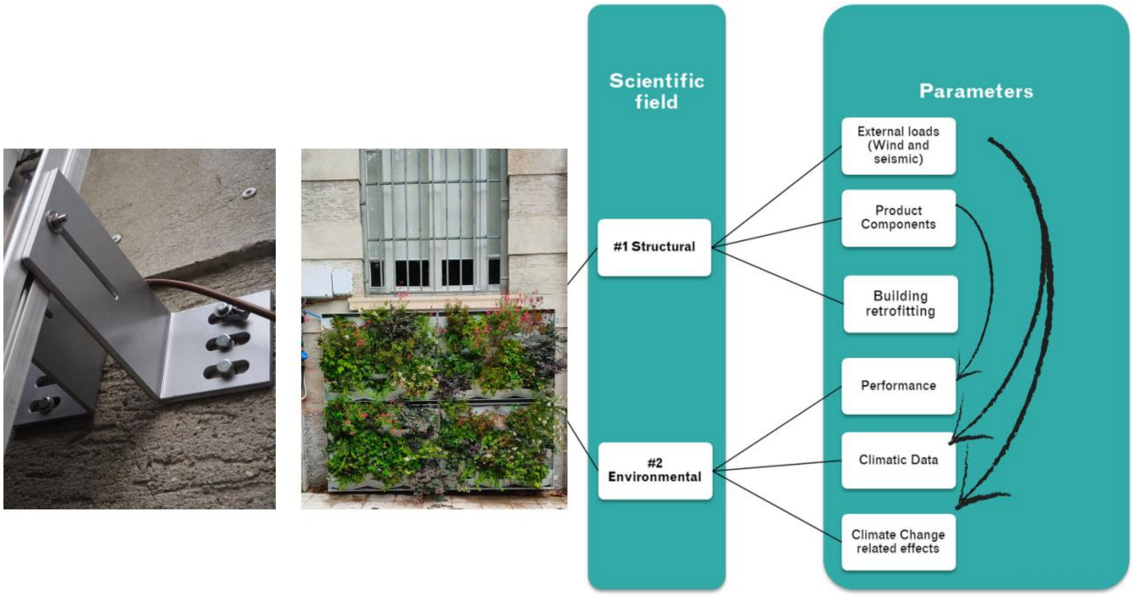

Figure 18 Edited by the authors. Scheme proposing the parameters to consider for green building products.

To this demanding issue, it can be additionally mentioned the fact that the urban sprawl must be controlled and might be the reintroduction of Nature in cities (Susca T., et al., 2011) a response to the implications of those rapid changes listed before, reversing the waterproofness and high built-up density of constructions (Massetti, L. et al., 2019). An under-development topic, which lies among heterogeneous fields: ranging from environmental and urban forestry engineering architectural design and urban landscape. Indeed, living walls technology (LWT) aimed to renaturing the cities must deal as well as horizontal solution (Coma J., et al., 2017) with the state of art of buildings (SoA): from the structural point of view not complying with safe regulations and mechanical resistance and as a result being unsuccessful. For instance, in 2016 in Milano the DECUMANUS project aimed to develop a set of sustainable services, linked to geo-spatial products and their

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strategies accounting Climate Change. It mapped all the potential green roof areas available in Milano, pragmatically most of the construction sites were built before the introduction of the current guidelines, and in terms of seismic verifications they are oftenly not in compliance.

2. MATERIALS AND METHODS

2.1 Prototype set-up

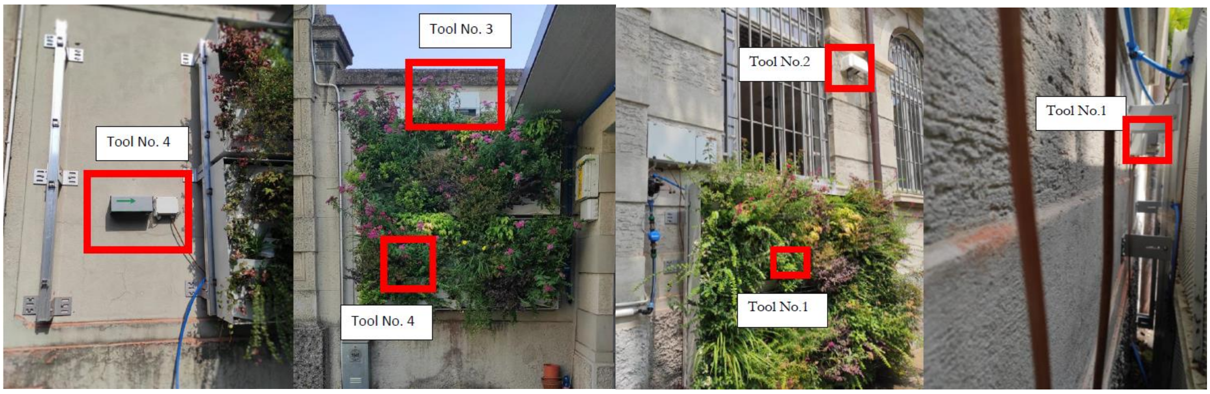

Figure 19 Take by the authors. Placement of sensors to collect environmental data. On the left side Building 10 on the right Building 9.

The method hereby proposed account a pilot case of vertical green panels since summer 2020, date of the placement in situ in Leonardo Campus, in a geographic area subjected to humid temperate climate, with a considerable annual temperature variation (hot summer and cold winter), named as Cfa according to the Köppen climate classification., where the Politecnico di Milano technical university has settled since 1863 the head office and historical faculties, closer with Statale University. They are both facing South, for a total of 4 panels, equivalent of 5.4 m^2, presenting a cavity of 17 cm in between building outer layer and the internal layer of the expanded metal mesh. The authors recall the attention to this sun exposure orientation (Susorova I. et al., 2014) which of course allow the analysis to consider a consistent amount of incoming radiation. The environmental data here below presented and discussed are the findings of this pilot project, (air pollutants, thermoigrometric properties) and the structural open debate, after conducting an analysis of the State of the Art (SoA).

2.2 Environmental behaviour

Milano city has suffered for years the dramatic consequences of consistent pollution levels and experienced other phenomena related with an extremely anthropized environment and resulted to be one of the most vulnerable to phenomena such as COVID-19, if then is combined the occurrence of phenomena such as Urban heat Island (UHI) and Heat waves (HW) (Manoli G. et al., 2019; Zhao L. et al., 2014). Here becomes essential to involve the concept of “envelope” (D. Aelenei et al., 2016).

2.3 Structural SoA.

Nowadays, living walls and green façade are more and more substituting steel-glass facades for new buildings and/or refurbishment/renovation of existing ones. This relatively new construction technology has similarities as well as great differences with its twin steel-glass façade. If vegetation is going to become a common feature of urban spaces a proper question to be posed is: will be designers and researchers to handle the organic nature of it (vegetation) including structural verification and mechanical resistance of the subsystem? In Europe the design of façades against wind actions currently follows the Eurocode 1 (EN1991-1-1:2002. Eurocode 1: Actions on

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structures – General actions) but extreme loading configurations, including natural hazard events, are only marginally considered.
Nevertheless, some past extreme weather events highlighted the insufficiency of such regulation in terms of maximum design values for wind.

Figure 20 Edited by the authors: European standards criteria.

However, nowadays is available no guidelines supporting designers addressing the structural response under wind actions. A better and more accurate prediction and estimation of tangential stresses affecting the vertical walls becomes essential at least as baseline guide for designers. From the preliminary live loads calculation up to the definition of the façades components verifications, considering the product approvals data, the designer is supported with a series of steps to follow and verify. It is widely recognised how much importance has the building field linked with the standards and guidelines.

2.3.1 Drag coefficient, literature review

The so called drag coefficient. It is mathematically a dimensionless number used to express and to rank the resistance of an item/object into a fluid environment, such as the water or commonly the air (atmospheric air can be considered as an uncompressible gas). A commonly used form is the following:

Greenery species *(Both shrubs and individual trees)*	*Reference parameter*	*Values calculated/simulated*	*Author*
Glazed panel *(safely assumed different by zero)*	z_0	0.0015	CNR Guidelines
(*Not usable due to inconsistent output for the error estimation*)	C_{Dd}	0.16	(Fischenich & Dudley, 2000)
	C_{Df}	0.07	
	C_{Dw}	0.06	
Crop: Tomato (*Solanum Lycopersicum*)		0.26	(Molina-Aiz et al., 2006)
		0.21	
		0.22	
		0.22	
		0.32	(Haxaire, 1999)
Uniform canopies		0.25	(Brunet et al.,1994)
		0.25	(Raupach et al., 1996)
		0.25	(Finnigan & Belcher, 2004)
		$0.1 \leq C_D \leq 0.3$	(Raupach & Thom, 1981) (Katul & Albertson,1998)
	C_D	0.25	(Amiro,1990)
		0.3	(Halldin & Lindroth, 1986)
Oak-hickory		0.15	(Lee et al. 1994)
Deciduous forest		0.15	(Shaw et al., 1988)
Maize (*Zea Mays*)		0.20	(Wilson & Shaw, 1997)
Wheat canopy (Triticum spp.)		0.47	(Patton al. 1998)

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Malayan Banyan (*Ficus macrocarpa*)		0.93	(Senlin Zheng, et al., 2020)
Mango *(Mangifera indica)*		0.88	
Michelia Alba		0.523	
Hong Kong orchid tree (*Bauhinia blakeana*)		0.815	
Sweet pepper (*Capsicum annuum*)		0.23	(Molina-Aiz et al., 2006)
Aubergine (*Solanum melongena*)		0.23	
Beans (*Phaseolus vulgaris*)		0.22	

Table 1 Literature review summary for drag coefficient values, edited by the authors.

2.3.2 K-means Clustering

Clustering method is an iterative approach, widely diffused as attempt to evaluate and investigate the distributions of dataset (the drag coefficient in the case which will be presented). Calculating a series of centroids (mean values) and assigning to each of them the values, the plotted results generally display a set of clusters. Aim of the author is to observe how much our values of C_D will get closer to the centroids estimated. The k-means approach will evaluate each value with each centroid and then it will be located numerically only if there is a certain reliability. This will be validated accordingly with the silhouette index. It is not meant to set clusters equal to the total numbers of the sample C_D listed from the literature. Moreover, the value equal to "1" make no sense. This methodology cannot consider 57 groups or just 1, so it has been carried out through MATLAB a series of calculations from 2 (number of clusters) up to 56. Specifically, is expressed such as: "k means (X k)"in which it attempts the k-means clustering partitioning the evaluations of the" n-by-p data" matrix X (so the column of C_D) into k clusters and returns an n-by-1 vector (id*x*) containing cluster indices of each evaluation. Rows of X correspond to points and columns correspond to variables. The following analysis considers a one variable dataset and 57 points.

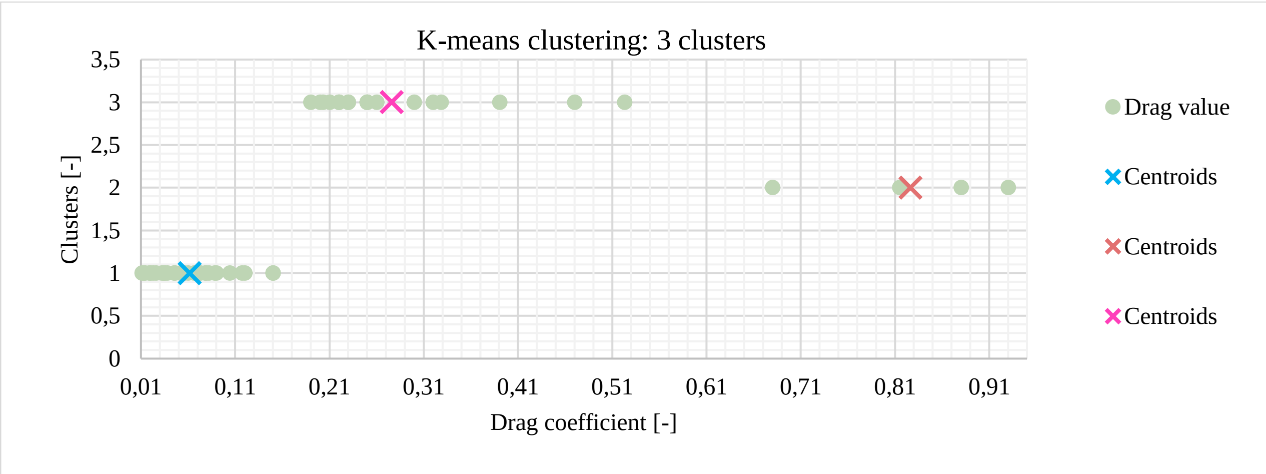

Chart 1 Display of the cluster's outcome, edited with Matlab and then Microsoft Excel.

About the method, it is highlighted that it runs iterating some peculiar aspects to keep in mind:

- k value is a setpoint choice made by the user.
- centroids are selected by a first "shuffling" of the whole dataset, and then with a random selection of k.
- iterating process is active up to the moment in which the centroids change. By the way, the classification of each value from the dataset to the cluster does not vary.

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Furthermore, some more aspects to describe the method:

- Among the dataset points and the centroids is computed the sum of squared distances
- To each cluster is assigned the closest point from the variable list dataset.

About the silhouette index, it can be seen the "how to" evaluating the reliability of the clustering quality itself since it is a points cloud subgroup classification. Assigning to each value of the column of values a mark (estimating how much appreciable was the assignation of the value itself to the cluster) it will be then calculated the mean and then the choice for the most reliable and usable output will be made among all the 57 clustering attempts.

3 RESULTS AND DISCUSSION

3.1 Drag estimation

The chapter has opened looking at the wind loading on plants, facing what can be now clearly recognised as a complex and not-so-easily item to predict. However, the focus on drags coefficient and force developed through the series of research and works which have been carried out by many and especially on different species of vegetation support well enough to make a further effort: computing the values has led to the first attempt (reported in chart.1) trying to identify range and rank of the drag coefficient.

A second attempt has been developed due to the inconsistency of evaluation of error and mean value for the drag: the non-gaussian distribution has required attention and so a different method introduction has been made as choice: the k-means clustering. Thanks to this additional attempt more reliability and consistency has been given to the final list of ranks, here below summarized.

1st category	$0 \leq C_D \leq 0.10$	Dimensionless
2nd category	$0.10 \leq C_D \leq 0.35$	
3rd category	$0.35 \leq C_D \leq 0.70$	
4th category	$0.7 \leq C_D \leq 0.93$	

Table 2 Categories listed after the clustering analysis.

3.2 Environmental parameters

Regarding the observations done about the PM2.5 and PM10 concentration, it is noticed that they are affected by the season variation and activities during the week (working days and off), so it is reported the daily average values for the measurements obtained with the stationary tool AIRCARE. The horizontal axis displays the hourly steps, while the vertical represents the pollutants fluctuation during the average day. Two types of lines and colours have been used to highlight the distribution assumed by the data set.

In the plotted charts March, April, and May 2021. Overall, the PM2.5 concentration have remained between 2.98 $\mu g/m^3$ and 15.45 $\mu g/m^3$ and the maximum values are achieved by the internal AirCare (fig.2). In March, the maximum concentration was achieved at 9hours with a value of 15.45 µg/m3, in April, at 6 hours with a value of 11.49 µg/m3 and in May, at 9 hours with a value of 5.92 µg/m3. The pollutants concentration recorded in the cavity (between sub-system and the vertical green internal layer) was 46% greater than the outdoor. These results are suggesting that the presence of the vegetation and vertical panels did not control nor directly influence the PM10 pollutants in springtime. This situation is explained by the increase of temperature (air and soil) producing the flourishing of the plants installed.

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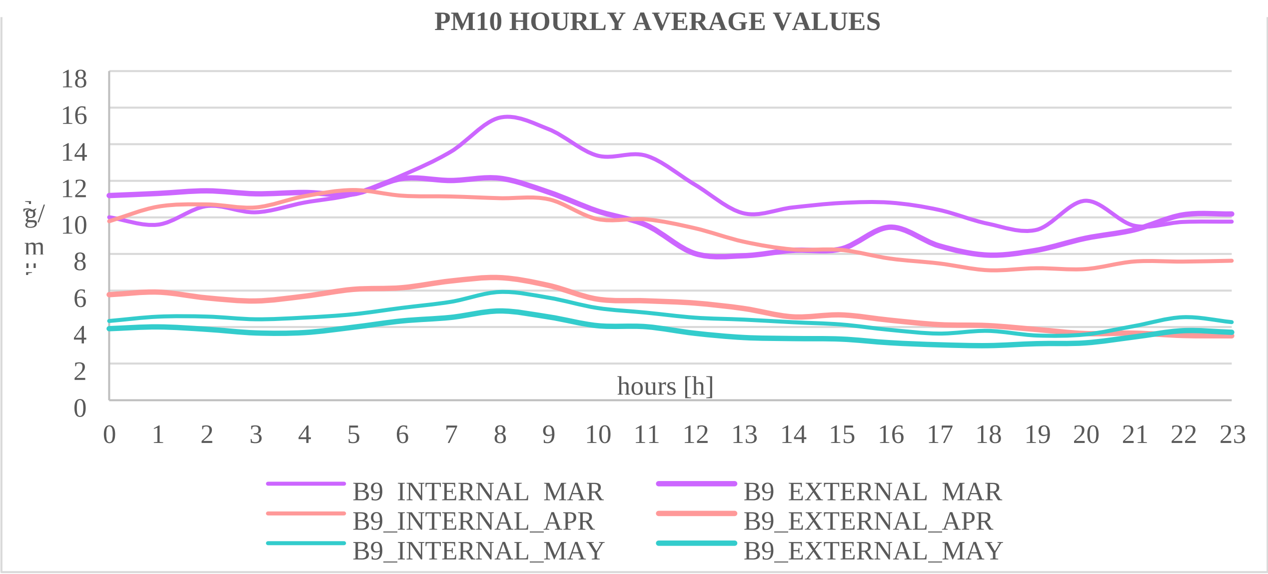

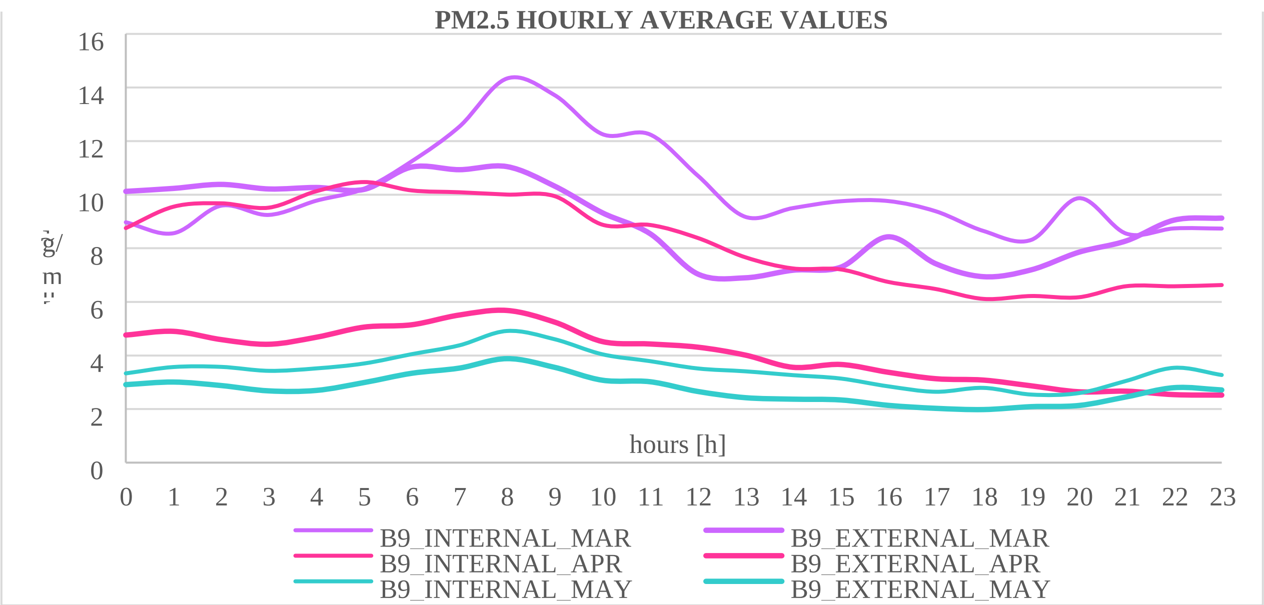

Chart 2 and 3 (up and down-side). PM10 and PM2.5 data recorded in Building 10, Leonardo Campus. Season: Spring (March, April, and May)

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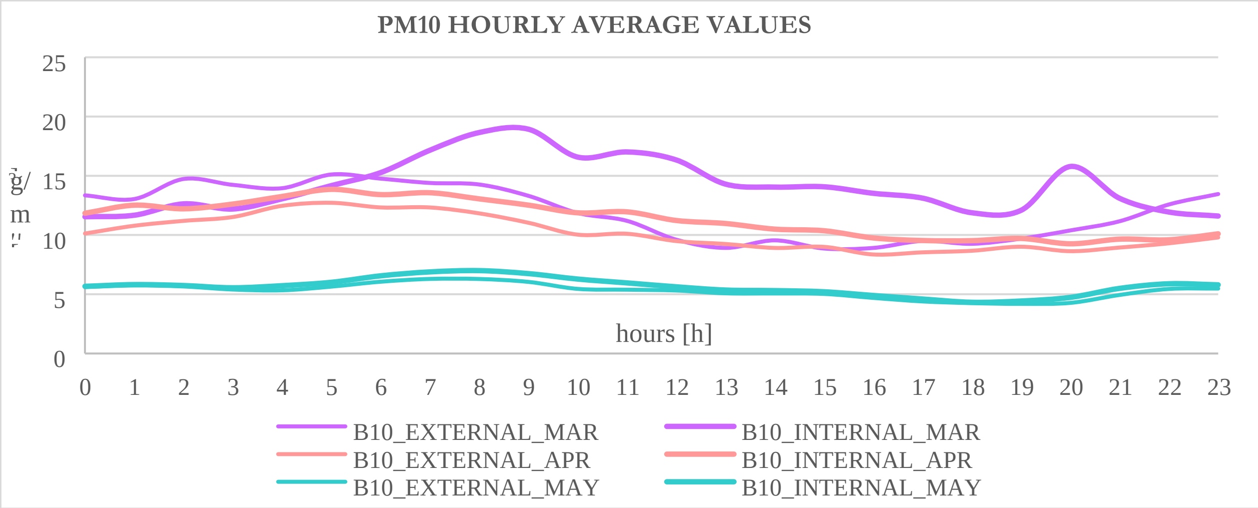

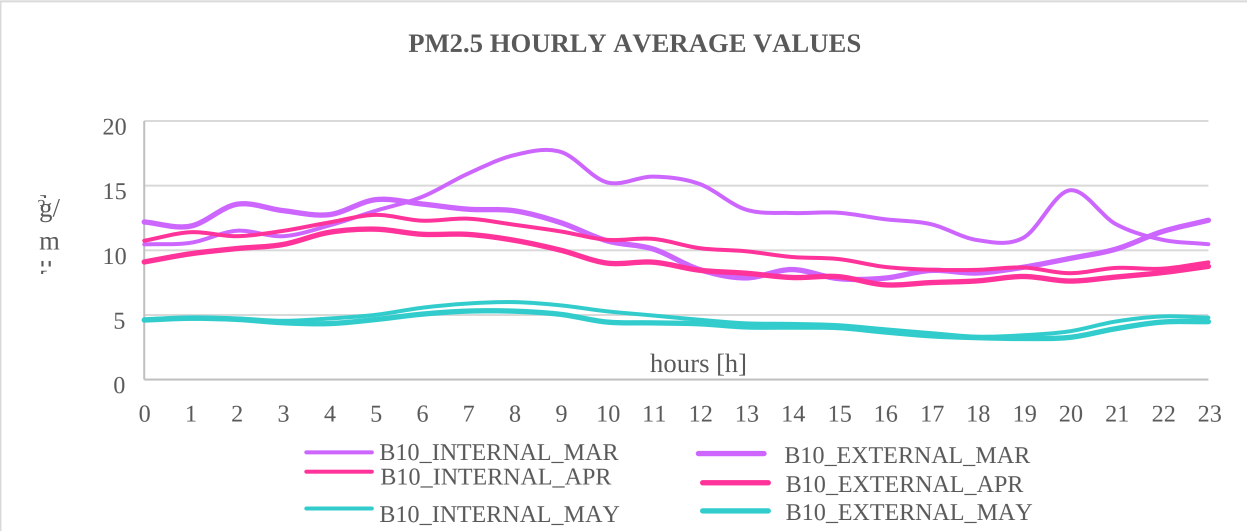

Chart 4 and 5 (up and down-side). PM10 and PM2.5 data recorded in Building 10, Leonardo Campus, Season: Spring (March, April, and May).

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4 CONCLUSION

The paper is aimed to recall the risks and implications due to Climate Change, and so the need of ensuring a urban enhancement practice (Alexandri E. et al., 2008). Is truly encouraged to apply NBS solutions, like the installation of a sub-system able to tackle the challenging issues posed in the introduction.

From an environmental point of view, there is still need of collecting values especially accounting the activities which take place in the proximity of the installations: for the health of the occupants, it should be considered the risk of not allowing a sufficient ventilated environment, since pollutions could be attracted and trapped by the vertical green systems.

However, mechanical, and structural aspects are crucial and must not be underestimated as well, since are not understood if this building technology solution is implemented. This is the case of flying debris if extreme wind gusts (Solari G. 2014) or peaks are observed (Tadrist L. et al., 2018; Niklas, K.J. 1992; Grayson J.M. et al., 2013). An interesting and recommended readings is represented by the work done by Gardiner B., Berry P., Moulia B., 2016.

A better understanding of the LWT can represent a successful solution to introduce in such context where buildings feature 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 L., et al., 2014).

At the conclusion the strong statement is the prediction of a future more and more wide implementation of greenery on buildings, despite the type of construction, that will require the followings aspects to be taken carefully into account.

Firstly, it will be led to the need of an implementation inside the standards and guidelines to make them a reference and a safe approach available for all the professionals figures involved in the building field and especially for the façade engineering world. Moreover, the results show the effect induced by the wind motion: it appears relevant to have a complete and deep understanding of the phenomenon especially supporting future analysis with a wind tunnel test. It is a warm recommendation and proposal the one from the author to develop a sample of masonry and green panel equipped with anchors or sub systems anchoring profile which can be conducted to the case of fastenings in the masonry. This is not excluding the technology which implements steel/aluminium profiles but is declassifying them as less severe stressed scenario. At high altitude profiles and especially on tall buildings in any case is recommended to account for wind actions the risk of having under strong kinetic wind peak pressure the partial or total failure of elements, and flying debris effect, exposing the users and other building components to life risk scenarios and building economical losses.

Clearly from the analysis of the surface and botanical aspects of the vegetative species in literature it has been understood they led to important different values. In function of the green, we can evaluate different values of C_D with more than one order of magnitude as difference, and this is not acceptable to work out with the output of drag to estimate a specific value.

At the end of the facts, some findings can be mentioned:

- Structural, due to the wide variety of drag values and the unsuccessful result of trying to understand if vegetation can be classified for each botanical properties, a logical and more pragmatic approach seems to be the one to assume certain safe and reliable threshold values, such as “ultimate” values.

Always based on structural observations the seismic is significantly less than the tangential action if high drag values are assumed: this would represent an unfavourable and severe scenario to check and verify during the dimensioning of anchoring sub-systems.

The proposal from the author is therefore, to evaluate the shear stress with real green panel carrying out wind tunnel tests and then validating into a finite element software (FEM) software the values

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estimated in the following analysis to quantify the actual stress imposed on the sub-system. Another important proposal is to develop according with the guidelines provided by CNR-DT 207 R1/2018 ROMA a computational wind engineering (CWE) model, to validate the numerical considerations so far achieved. However, the last confirmation and validation comes out from the wind gallery analysis thanks to the reliability of simulating an actual scenario of implementation of the green system on building features.

DATA AVAILABILITY

The data that were discussed and considered in the findings in this paper (PM2.5 and PM10) and the collection has been done implementing AIRCare sensors and downloaded from the related portal https://fits.harpaitalia.it/login?alias=aircare.

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