DESIGN CULTURE(S)

Cumulus Conference Proceedings Roma 2021

Volume #2

ARTIFICIAL
LANGUAGES
LIFE
MAKING
NEW NORMAL
MULTIPLICITY
PROXIMITY
RESILIENCE
REVOLUTION
THINKING

Cumulus Association

Cumulus Conference
Proceedings Series
07/2021 Rome

Design Culture(s)
Cumulus Conference
Proceedings Roma 2021
Volume #2

Editors
Loredana Di Lucchio
Lorenzo Imbesi
Angela Giambattista
Viktor Malakuczi

Layout and Graphic Design
Viktor Malakuczi
Concept for Cumulus
Conference Proceedings
Series was developed in
2018 by Jani Pulkka

Cumulus conference
Design Culture(s)
hosted by
Sapienza University of Rome, Italy
on June 8-11, 2021.
Conference website:
www.cumulusroma2020.org

Published by Cumulus
Cumulus the Global Association of
Art and Design Education and
Research. Aalto University, School
of Arts, Design and Architecture
PO BOX 31000, FI-00076 Aalto
www.cumulusassociation.org

ISBN 978-952-64-9004-5 (PDF)
ISSN 2490-046X
Cumulus Conference Proceedings
Series, N°7

Cumulus Conference
Proceedings Series

Editor-in-Chief
Cumulus President
Mariana Amatullo

Publications in the Series
01/17 Kolding, REDO
02/17 Bengaluru, Letters to the Future
03/18 Paris, To get there: designing together
04/18 Wuxi, Diffused Transition & Design Opportunities
05/19 Rovaniemi, Around the Campfire – Resilience and Intelligence
06/19 Bogotá, The Design After
07/21 Rome, Design Culture(s) Volume #1, Volume #2

DESIGN CULTURE(S)

Cumulus Conference Proceedings Roma 2021

Volume #2

Cumulus Conference
Proceedings Series

Cumulus the Global Association
of Art and Design Education and Research

Rome 2021

DE
SIGN
CULT
URE(S)

ROMA 2021

JUNE 08.09.10.11
CUMULUS CONFERENCE

OVERVIEW

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

DESIGN CULTURE(S) | CUMULUS ROMA 2021
JUNE 08.09.10.11, SAPIENZA UNIVERSITY OF ROME

Green infrastructures and satellite images: the case study of Munich.

Giovanni Borga[a], Filippo Iodice*[b], Federica D'Acunto[c]

[a]IUAV University of Venice
[b]Vitrociset Belgium and IUAV University of Venice
[c]UptoEarth GmbH
*f.iodice@stud.iuav.it

Abstract | Although being the main driver of economic growth, cities have simultaneously contributed to the most serious increase of environmental degradation, being simultaneously targeted by Climate Change effects. In this scenario, decision makers are called to identify the best actions for mitigation and adaptation of urban spaces, exploiting innovative Information and Communication Technologies (ICT) resources and approaches. Based on the City Sensing approach, the aim of this paper is to present a case study that demonstrates how the application of integrated ICT frameworks - including free Copernicus satellites data, big data sources and cognitive techniques – to urban regeneration practices such as green infrastructures can support decision makers and citizens in order to create a knowledge community which is aware about air pollutants and carbon emissions of its neighbourhood. Making risk visible and shared will contribute to the modelling of a resilient, inclusive and sustainable city.

KEYWORDS | CLIMATE CHANGE, POLLUTION, SATELLITE, MOSS MAT

1. Introduction

Rapid urbanization and economic growth unveil how cities are the centre of economies, attracting an increased number of people which is expected to reach the 70% of the world's population by 2050 (UNDESA, 2013). Nevertheless, because of their crucial role in driving world economies, cities are mainly responsible for environmental degradation since 1990s (World Bank and Institute for Health Metrics and Evaluation, 2016), with energy and transportation sectors being the most anthropogenic activities responsible for Greenhouse Gas (GHG) emissions and air pollution (FAO, 2016). As a result, the high population density and the proliferation of economic activities have exposed cities to great aggregate risks, with negative impacts in terms of quality of life, environmental security and economic loss (ITU, 2015). This framework unveils a wide spectrum of Climate Change effects, ranging from natural disaster and environmental degradation to diseases, whose uncertainty in terms of climate impacts determines also uncertainty of response.

Urban centres, in fact, are characterized by a distinct capacity and legitimacy to define policies and allocate resources, which is crucial in order to trigger effective interventions (Hunt&Watkiss, 2011). Nevertheless, when speaking of climate change, decision-making process lacks of a full picture of the nature and magnitude of risks as well as of the potential impacts and trends. In order to give legitimacy and authority back to policy-makers, it is necessary to make climate-change risks "visible" (Global Commission on Adaptation, 2019).

2. Research methodology

2.1 Research objectives

The aim of this research is presenting an innovative approach of city planning based on City Sensing which can simultaneously free cities from the burden of air pollution and climate change effects and trigger urban and social regenerative intervention.
The application of integrated technologies, in fact, can contribute to the definition of new approaches to support urban planners in:

- understanding the co-existence of several variables of Climate Change;
- inclusively engaging and connecting researchers, policy-makers, citizens into the decision-making process;
- creating a knowledge and practice community of resiliency (ITU, 2015).

Due to the capacity of regulating urban microclimate of green infrastructures – in particular green roofs made with moss mat covering abandoned public building – the application of innovative technology can develop a reliable measuring system to detect atmospheric pollution which is scalable and allows urban and economic regeneration of abandoned areas

of the city. The United Nation Report on Extreme Poverty and Human Rights shed lights on the possible scenario of a 'climate apartheid' "where the wealthy pay to escape overheating, hunger, and conflict while the rest of the world is left to suffer" (United Nations Human Rights, Office of the High Commissioner, 2019).
Starting from this terrible forecast, the study will propose a sustainable financially and environmentally alternative which empowers the adaptive capacity especially of vulnerable areas and groups.

2.2 Research methodology

City Sensing is a widespread and pervasive approach of city knowledge aimed at supporting urban planning and monitoring and share such a knowledge with key stakeholders in order to trigger a participative city modelling process. Such an interactive, streamlined but comprehensive decision-making is facilitated by the integration of ICT which, on the one hand, improves city resilience and its adaptive capacity thanks to the creation of an informed network of people. On the other, it enables territorial governance through the systematic dissemination and communication between all relevant stakeholders (ITU, 2015; Condotta&Borga, 2012; Borga, 2011).

In particular, heterogeneous quantitative data that have been gathered during this research derive from two different sources: all Open-Source satellites of the Copernicus Mission and on-site surveys and official EUMETSAT[1] databases providing information about pollution levels.

As far as satellites, even if Earth Observation is not systematically used at local level for monitoring atmospheric pollution yet, its accurate resolution guarantees analysis consolidation potential on a continental scale. In particular, the 5P satellite can be widely applied in order to monitor urban air pollution and estimate green areas' sequestration capacity, through the TROPOMI[2] sensor which measure tropospheric pollution.

With the aim of creating a city map, we first developed Sentinel-5P level 2 products to maintain a single grid per orbit (level 3 –L3). The conversion was carried out in a second phase, combining the different data in a single call. They were then merged with the Copernicus atmosphere monitoring service (CAMS) data. Finally, a map of samples was created on a normal spatial lat / lon grid with related product variables. All data have been geometrically corrected and compared with the near real-time data of the ECMWF[3] Integrated Forecasting System (IFS) which assimilate the IASI[4] and MOPITT[5] observations of carbon monoxide (CO) (Inness et al., 2015), provided by the CAMS.

[1] European Organisation for the Exploitation of Meteorological Satellites.
[2] TROPOspheric Monitoring Instrument.
[3] European Centre for Medium-Range Weather Forecasts ECVs Essential Climate Variables.
[4] Infrared Atmospheric Sounding Interferometer.
[5] Measurement of Pollution in the Troposphere.

Data analysis has been carried out on ozone (O^3), carbon monoxide (CO), nitrogen dioxide (NO^2), sulphur dioxide (SO^2) and methane (CH^4). Here we only present data related to CO. The interpolation of CAMS data with the time and position of the single TROPOMI measurement allowed to analyse the average density of the air column, taking into account the sensitivity to the vertical recovery of the TROPOMI sensor.

All the processing tools are Open-source. SNAP[6] libraries have been used for the processing of satellite images. Instead, the control and validation of data is carried out within the Python libraries (TensorFlow, Scikit-Learn, Numpy, Keras etc.) in order to guarantee low-cost services and wider accessibility.

However, the orbit model has some variations. Every day the satellite's orbit moves slightly further east, so even two images of the same position for consecutive days have slightly different ground cover. After 16 days, the satellite passes back to exactly the same geographical point on the ground, restarting the orbit sequence. To solve this problem, we resampled the data on a normal spatial pixel grid. Data fusion was performed using multiple linear regression and its residual spatial interpolation (residual kriging). The results were verified by cross-validation (i.e. the interpolation calculated repeatedly, each time leaving out a sequence of satellite data).

3. A Service Design approach for the city of Munich

In the study case of Munich, the underlying theme is the pollution of urban areas. This project tackles the problem of pollution and urban decay in a holistic way, that is, treating a specific part of the city as an "ecosystem" that includes buildings and people, with the possibility of identifying possible advantageous variables of urban requalification with benefits in terms of environmental well-being by inserting, when possible, economic facilitating devices. The technological solution here developed provides a suite of services for different stakeholders; this solution, if properly connected, selects an integrated and synergistic use of technological, methodological, economic and social resources.

The taken approach is that of Service Design whose concept is linked to the economic financial discipline and indicates an activity of integration and organization of different types of resources, including communication artifacts and materials pertaining to a specific service, aimed at improving the relationship between supplier and end user. In other words, Service Design can be seen as an interdisciplinary approach to the design of a service in which User-centered Design assumes a central importance in giving the service greater usability, desirability, accessibility and attractiveness and is recently described by some research (Prestes Joly, et al, 2019) as a key factor in service innovation.

[6] Stanford Network Analysis Platform.

One of the substantial elements of the approach is for example the use of satellite data. Salinas, et al (2014) show that they use digital tools and georeferenced data, combined with a co-design approach, interactively connecting between citizens, stakeholders and decision makers in the approach to urban problems as it provides a common and shared information base and efficient methods of communication and exchange of information between the various subjects. Salinas, et al, (2014) underline among the main vulnerabilities, the frequent and well-known difficulty of making the most technical aspects of the processes and the very different actors understandable.

The approach to Service Design is applicable on many aspects, however a rather well-known aspect but less applied on a large scale, is certainly linked to the reliability and quality of the information that feed the digital strategies; in this regard, the idea that the blockchain can make a substantial contribution is very widespread and shared, however the examples of application of this technology are still rare. In the future prospects of evolution of this research, the blockchain has a central function in Service Design as it plans to automate the process that guarantees the origin of the information generated from data processing provided by satellite platforms, whose reliability and quality is consolidated.
When satellite data are attributed an economic value, the need for a transfer register is evident, generating related costs and impacts on the service economy; alternatively, a self-certified blockchain-based tracking system that is practically cost-free can be used. The same technological platform, in addition to the structured register, must also perform the important function of a meeting place between sellers and buyers of carbon credits by developing a market in which financial resources of the real market are introduced.

The foregoing lays the foundations for the development of a process in which a subject owning a property to be redeveloped is convenient to carry out a "green intervention" thanks to the guarantees of return on short investment times, as well as bringing an environmental benefit to ensure community.

3.1 Data driven sustainability model for city resilience

The City Sensing approach is specifically oriented towards detailed knowledge of phenomena characterized by high temporal resolution and a medium-large spatial context; for this reason, it is also particularly suitable for this project where the topic of urban sustainability is central. As well known, the concept of sustainability is often characterized by different aspects interconnected with each other, in fact, sustainability understood almost always from an environmental point of view is highly dependent on the economic one and / or related to the social dimension.

In this research, it is developed a cognitive and interpretative model of urban complexity supported by a system of digital data and information whose main objective is to provide a certain and reliable quantification of phenomena and dynamics usually considered unnecessary or not useful. It is possible therefore to speak of a "Data-Driven Sustainability Model" referring to a technological system of monitoring and evaluation of phenomena on an urban scale that allows to develop real economies aimed at reducing negative impacts and improving the environmental quality and urban space.

4. A project for the city of Munich

4.1 Application of moss mats on abandoned buildings' rooftops

Urban regeneration, known as the installation of different forms of vegetation within the city, including street trees, hanging gardens, green roofs, green walls, etc. represents a strategic approach if supported by enabling technologies. Green infrastructures, in fact, can greatly reduce the level of concentration of particulates and CO^2 through the sequestration capacity of the soil and plants related to photosynthesis and the regulation of the urban microclimate, contrasting the increase in temperature with the evapotranspiration of the leaves (Rete degli orti botanici della Lombardia, 2009; Rete Rurale Nazionale, 2012). Since '90s, green infrastructures and their different applications (green roofs, green walls, vertical gardens) became very popular elements to counter-balance urban pollution's effects and regenerate given areas (Bassan, 2014) through the implantation of some species into the city. A crucial role in sequestrating CO^2 and particulate matter is played in particular by moss which is usually applied to cover roofs and walls of buildings through the creation of a "mat" (Directive 2000/60/CE).

Our case study refers to the city of Munich (Germany) taking as a reference period from February 2019 to August 2019 with the processing of satellite images classified on a monthly average. Munich is Germany's third largest city with the highest population density and the capital of Bavaria, one of the most competitive industrial regions in Europe. Within the project, we processed information from the sentinel 5P satellite, the first mission dedicated to monitoring our atmosphere. Operating in synchronous orbit with the sun, the satellite maps a multitude of air pollutants around the world. The latter, in combination with the auxiliary input data, allowed to elaborate the concentration of each atmospheric gas and to model it on the basis of its absorption characteristics at specific wavelengths of light.
The data we have analysed refer to the air column and not to specific points of the city, this allows us to analyse the problem of air pollution with a different view from the normal ground-based control units[7]. In this study we do not take into account the winds and possible variables that could interfere with our results.

Therefore, the preliminary phase of the study was to identify the surfaces and buildings suitable for hosting garden roofs, green areas. We understood that all buildings cannot accommodate garden roofs or walkable green areas. In particular, the city of Munich has a building architecture mainly characterized by pitched roofs or roofs that are not suitable for

[7] Of course, it must be emphasized that atmospheric central units have much more precise data than satellite data.

extra weights. To solve this problem, we identified our solution in absorbent moss panels. These panels solve numerous problems, first of all the moss does not grow like a classic vertical plant but remains flat and can be installed both on pitched roofs and on all roofs that already house solar panels or external bodies.
Moss is an inexpensive material for insulating homes. It is characterized by environmental compatibility, antiseptic properties, resistance to deformation. Furthermore, moss is characterized by being adaptable to almost all temperatures, in fact it needs little water due to its capacity of capturing it from the air humidity and natural precipitations. For this reason, it is able to remain dry for long periods by changing its color and then greening up as soon as it absorbs water. This guarantees a wider scalability of the solution as the moss mat can be used both in southern and northern Europe.

. Figure 1. Moss installations in Stockholm, Sweden. 2017. Source: © Anselmo Lepore.

Due to the low maintenance needs of the musk carpet, we have studied the effects of its installation on public and abandoned buildings and industrial areas. We have chosen this type of buildings because, on the one hand their large size guarantees a greater surface available to plant the moss. On the other hand, being public buildings, the interlocutor is in most cases a public administration, so it should be simpler finding agreements addressing community benefits. Furthermore, public and industrial buildings are homogeneously located throughout the city.
Authors of many studies from North America and Europe have made strong economic arguments in favour of adaptive reuse of old public buildings, claiming that rehabilitation projects cost around 30 % less than comparable new construction, with possibility to access to tax credits and incentives to offset the high cost of rehabilitation (Rypkema, 1994).
Abandoned buildings are often cataloged as a problem, but with the installation of mosses and green areas they play a double function. The first one is purely aesthetic, the second one is tied to the environment: abandoned buildings may turn into "sponge" buildings, literally buildings with the qualities of absorption of polluting substances.

4.2 Study results

To better define and locate the areas with the highest pollution, Monaco has been divided into 5 areas used as a classification tool for statistical surveys. The 5 areas are very different from each other. For example, area 3 is the historic center, area 1 is mainly industrial, area 4 and 5 are residential and industrial, finally area 2 is a residential area with a strong presence of greenery.

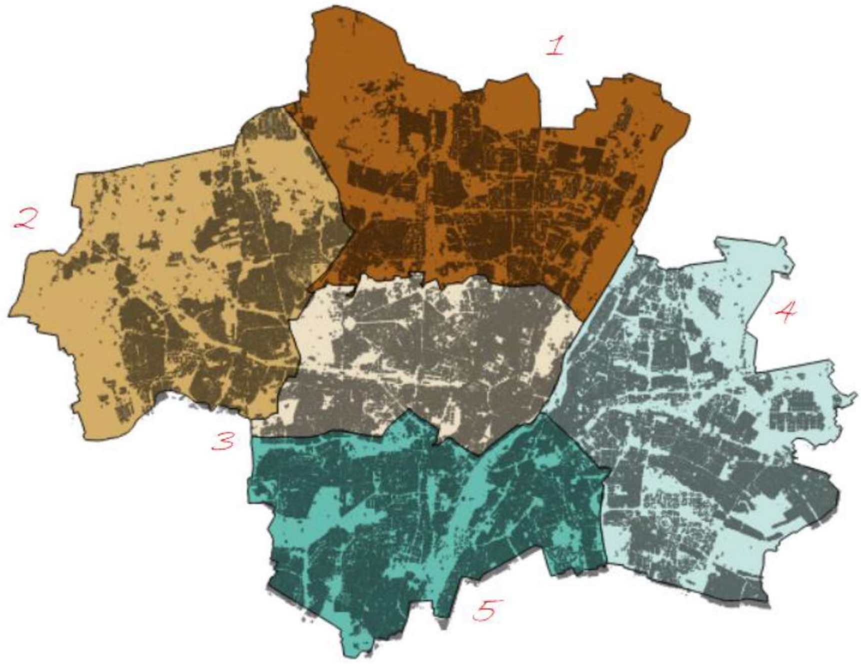


Figure 2. Portioning of Munich in five study areas.

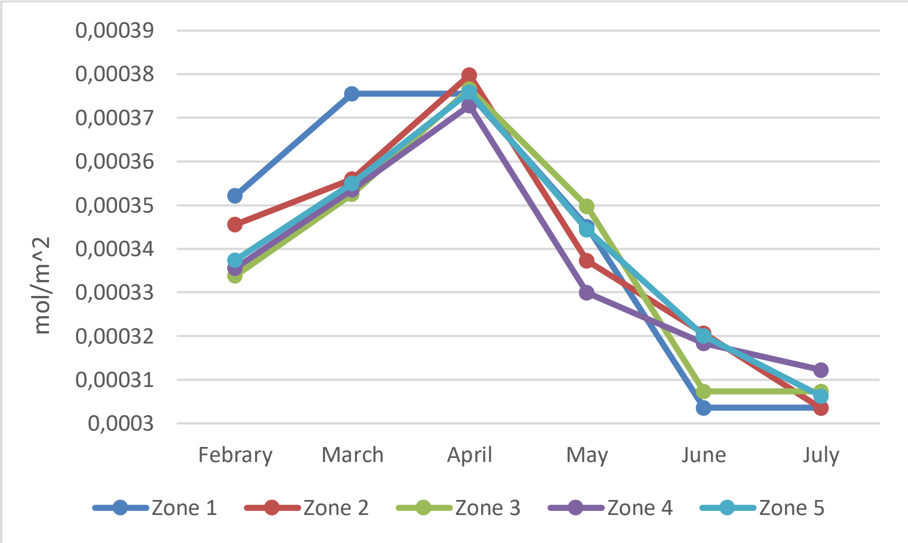
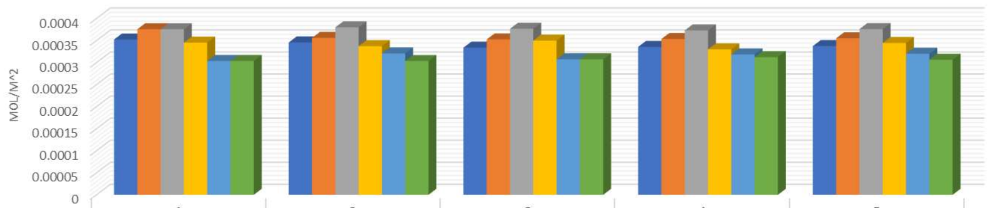


Figure 3. Distribution of Carbon Monoxide within the 5 study areas in Munich expressed in mol/m² (at variable temperature and pressure) – Monthly Average

The reference data used in this document derive from the monthly average of 2/3 images per day.



	1	2	3	4	5
Febrary	0.035222314	0.03455661	0.033378471	0.033555491	0.033732511
March	0.0375561238	0.0356000816	0.0352516741	0.0353476042	0.0355006869
April	0.0375561238	0.0379806592	0.0376653137	0.0372852848	0.0375902414
May	0.0345133831	0.0337207270	0.0349783028	0.0329945953	0.0344368009
June	0.0303587835	0.0320696740	0.0307343296	0.0318326571	0.0319992890
July	0.0303587835	0.0303479003	0.0307343296	0.0312243217	0.0306260238

Figure 4. Distribution of Methane within the 5 study areas in Munich expressed in mol/m²– Monthly Average

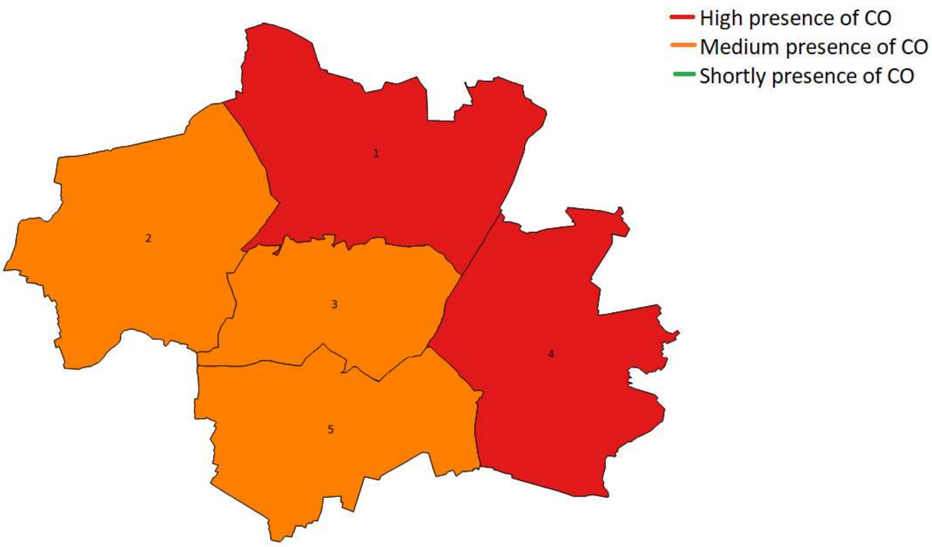


Figure 5. Distribution of Carbon Monoxide within the 5 study areas in Munich expressed in mol/m^2– Monthly Average

The figures showed the density values of the vertically integrated CO column. The major polluted areas are 1 and 4. In Figure 3, the influence of weather and climatic conditions on the concentration of pollutants in the atmosphere is noted with precision. In particular, we note that in June and July on average weather was rainier than in March and April, contributing to "cleaning up" the atmosphere. Figure 4, on the other hand, highlights the values of the monthly averages, which show the highest values and therefore a higher concentration of CO in these two areas compared to others. After carefully calculating the aerial columns of the whole city for a period of 6 months, for the purpose of our work we had to detect with certainty the available buildings and their shape. Carbon monoxide (CO) data are calculated using the measurement of the terrestrial radiance of the clear sky and the cloudy sky in the spectral range of 2.3 µm of the short-wave infrared part (SWIR) of the solar spectrum. TROPOMI's clear sky observations provide total CO columns with sensitivity to the tropospheric boundary layer. For cloudy atmospheres, the sensitivity of the column changes according to the path of the light.

Although Sentinel-2 data has a resolution of 10 m, we preferred to use it anyway to make a comparison with the available Open Street Map (OSM) DATA. Therefore, Sentinel-2 images have been classified into a Pixel segmentation and objects like clouds are removed. The validation led to the division of the territory (August 2019) with the assignment of the respective use (e.g. School, hospital etc.).

Sponge buildings were identified in zones 1 and 4: 65 public buildings with a total area of 175,156 m² were selected. The identification took place using the Google Maps geocoding tool, which allowed us to georefer on a map the addresses of all the public bodies of Monaco, only later through a classification of objects and OSM data we extrapolated the geometry of the building.

Figure 6. Selected "sponge" buildings located in area 1 and 4 of Munich

Finally, a georeferenced file was prepared for the city of Munich. The data on the concentration of air quality have been attributed to the respective geometry of the buildings on a semi-annual and seasonal scale. The data on the half-yearly average concentration were interpolated and then compared with the CAMS monitoring data. From the geometry we extrapolated the surface taking into account the frames and unsuitable areas for installing the moss. The 65 buildings with their extension could reduce the presence of CO by 15% per month in the two selected areas. The data were calculated taking into account the fact that moss has a storage capacity of 2,500 Ug / m^2 per hour of carbon monoxide and 2,000 Ug / m^2 of methane per hour (Forest Inventory and Analysis Database, 2018). Finally, in addition to the storage of pollutants, the same moss could capture 35 kg m^2 of carbon per year, which can be sold on the voluntary carbon market (Voluntary emission reductions - VER) through the blockchain. Below we show the advantages of the 65 buildings for the two polluted areas of Monaco: the proximity to these green infrastructures is a non-trivial condition to guarantee the highest level of removal of pollutants. With a 1 km buffer that uses Geographic Information System (GIS) tools, we made a projection of the potential benefits of these sponge buildings onto the city. The areas within the green line will benefit most from the presence of green roofs and walls in terms of the effect of mitigating air pollution.

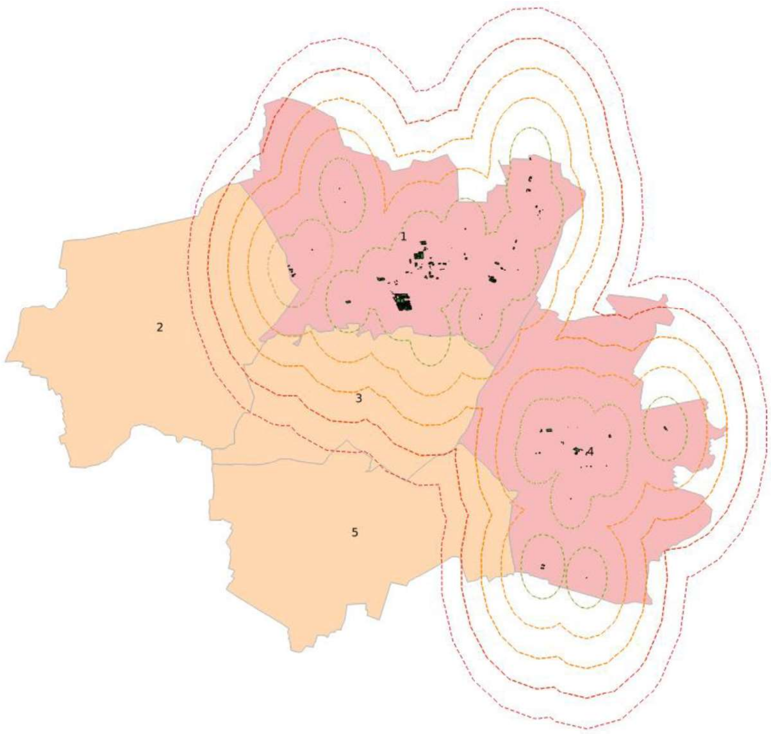


Figure 7. Mitigation effects of sponge buildings in the area 1 and 4 of Munich

5. Conclusions

Main results from the case study of Munich unveil that the extensive use ICT integrated with urban greening and applied in a small reference area can represent a key mitigation and adaptation strategy, expecting therefore higher benefits if applied to the whole city of Munich.

The great advantage of the presented integrated approach is that not only it mitigates climate change effect by monitoring and absorbing carbon emissions, but it also enhances adaptative actions related to the creation of green infrastructures and, in a future, a community-scale business model.

Besides from being the new city lungs, future perspectives are here introduced for green walls through the integration of another technology – blockchain – whose tokenization system can contribute to the transformation of moss mat as net carbon sinks that can generate carbon credits to be sold in the carbon credit market. In this way, we demonstrated here that there is still time to work to build urban resilience and reduce climate risks at all scales with a price which is much cheaper than recovery and rebuilding: building on resilience, we prospect a scalable project which even can take profit from its source of deterioration.

Moreover, the reintroduction of these green infrastructures not only contributes to inner city and suburban recovery, recognizing the importance of recycling old and underutilized buildings in terms of urban requalification, but this also discloses full social opportunities such as the re-acquisition of a sense of community intended as responsibility and obligations for one's place and its residents, which is usually lost when deteriorated vacant buildings appear (Stas, 2007) or gentrification practices are implemented.

Environmental degradation increases everyone's vulnerability to climate change recalling on choral effort in order to empower resilience capacity. Making effects of climate change visible, however, helps integrating this variable into urban planning decisions: the integration of several technologies can therefore trigger experiential learning and participatory planning within communities. Based on City Sensing approach, in fact, our solution gives back decision-making power, especially to most vulnerable groups, allowing the development of shared goals and coordinated actions (Global Commission on Adaptation, 2019).

References

Bassan, B. (2014). *Tetti e pareti verdi come possibile difesa dall'inquinamento urbano* [Green roofs and green walls as a possible defense against urban pollution]. Università degli Studi di Padova, Dipartimento Territorio e Sistemi Agro – Forestali, from http://tesi.cab.unipd.it/46943/1/Bassan,_Barbara.pdf

Borga G. (2011), "Geomatic City Sensing, città, reti, sensori e tempo reale. Tecnologie e approcci innovativi per conoscere e governare il territorio" per incrementare l'efficacia e l'usabilità delle risorse digitali", in GEOmedia, 5, pp. 10-13.

Condotta M., Borga G. (2012), ""Sensing" il "city model" per incrementare l'efficacia e l'usabilità delle risorse digitali", in Territorio Italia. Governo del Territorio. Catasto. Mercato Immobiliare, n.02, pp. 83-92.

European Parliament and Council, (2000). *Directive 2000/60/CE*, from https://eur-lex.europa.eu/legal-content/IT/ALL/?uri=CELEX%3A32000L0060

FAO (2016). *Greenhouse Gas Emissions from Agriculture, Forestry and other Land Use*, from http://www.fao.org/resources/infographics/infographics-details/en/c/218650/

Forest Inventory and Analysis Database, (2018). *Database description and User Guide for Phase 2*, from https://www.fia.fs.fed.us/library/database-documentation/current/ver80/FIADB%20User%20Guide%20P2_8-0.pdf

Global Commission on Adaptation (2019). *Adapt Now: A Global Call For Leadership On Climate Resilience*, from https://cdn.gca.org/assets/2019-09/GlobalCommission_Report_FINAL.pdf

Hunt, A., & Watkiss, P. (2011). Climate change impacts and adaptation in cities: A review of the literature, *Climate Change*, 104(1), 13-49.

Inness, A., Blechschmidt, A., Bouarar, I., Chabrillat, S., Crepulja, M., & Engelen, R. et al. (2015). Data assimilation of satellite-retrieved ozone, carbon monoxide and nitrogen dioxide with ECMWF's Composition-IFS. *Atmospheric Chemistry And Physics*, 15(9), 5275-5303.

Iodice F. & D'Acunto F. (2019). Sustainable cities and communities through Observation of pollution and climate feedback from space. *Proceedings of the 3rd edition of the UphD Green Conference "SDG - Sustainable Development Goal n.11. L'impegno dei dottorati nella costruzione di città e comunità sostenibili».* Rome-Milan: Planum Publisher.

ITU (2015). *Information and communication technologies for climate change adaptation in cities*, from https://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/website/web-fg-ssc-0107-r7-ICTs-for-climate-change-adaptation.docx

Prestes Joly, M., Teixeira, J., Patrício, L., & Sangiorgi, D. (2019). Leveraging service design as a multidisciplinary approach to service innovation. *Journal Of Service Management*, 30(6), 681-715.

Rete degli orti botanici della Lombardia, (2009). *Piante e cambiamenti ambientali* [Plants and environmental changes], from https://www.labnet.re.it/files/materials/Esperienza%202/Piante%20e%20ambiente.pdf

Rete Rurale Nazionale, (2012). *Low Carbon Economy: Il Settore agro-alimentare di fronte all'opportunità di coniugare la valorizzazione del Made in Italy e la difesa dell'ambiente* [Low Carbon Economy: The agro-food sector faced with the opportunity to combine the enhancement of Made in Italy and the defense of the environment], from https://www.reterurale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/a%252F6%252Fc%252FD.14309679eec74b3148fb/P/BLOB%3AID%3D7184/E/pdf

Rypkema, D. (1994). *The economics of historic preservation* (1st ed.). Washington, D.C.:National Trust for Historic Preservation.

Salinas, L., Weise, S., & Pollastri, S. (2014). Transforming the planning process - challenges for the service designer. *Proceedings of ServDes.2014. Fourth Service Design and Innovation conference*. Lancaster: Lancaster University, Retrieved January 2, 2020 from http://www.ep.liu.se/ecp/099/036/ecp14099036.pdf

Stas, N. (2007). *The Economics of Adaptive Reuse of Old Buildings A Financial Feasibility Study & Analysis* (Master). University of Waterloo, from https://pdfs.semanticscholar.org/aa18/d97931c050f30728ebd383c6af96b6042c87.pdf

UNDESA (2013). *World Urbanization Prospects: The 2009 Revision*, from http://esa.un.org/unpd/wup/Documents/WUP2009_Highlights_Final.pdf

United Nations Human Rights, Office of the High Commissioner (2019). *UN Expert Condemns Failure to Address Impact of Climate Change on Poverty*, from https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=24735&LangID=E.

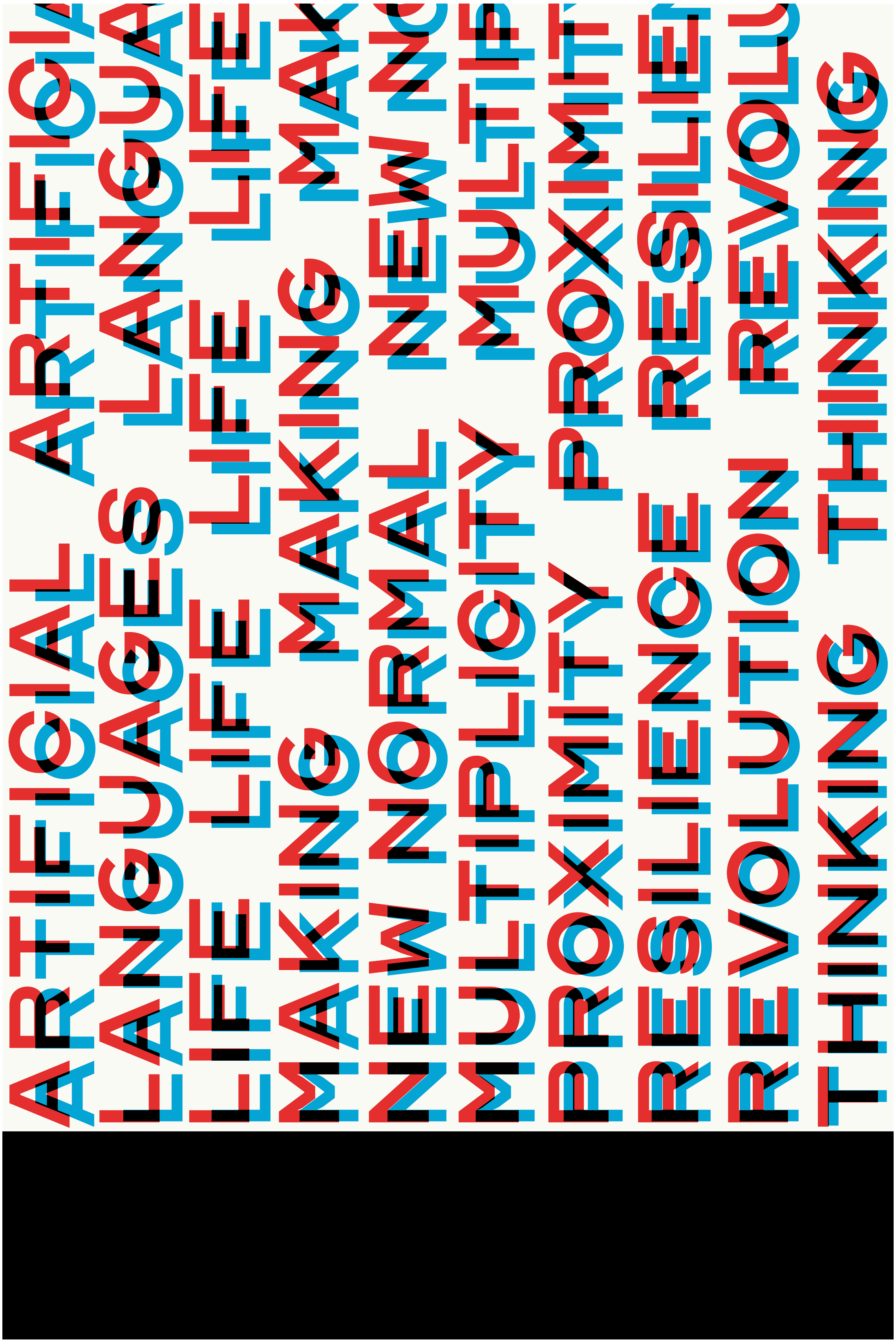
World Bank and Institute for Health Metrics and Evaluation (2016). *The Cost of Air Pollution: Strengthening the Economic Case for Action*, from https://openknowledge.worldbank.org/handle/10986/25013

About the Authors:

Giovanni Borga is Adjunct professor of Web Design and Geographical Information System at IUAV University of Venezia. His research focuses on the application of digital technologies and data visualization techniques in the field of product and communication design.

Filippo Iodice is attending an industrial PhD at the Vitrociset Belgium and IUAV University of Venice. In particular, his PhD thesis focuses on deep neural networks (deep learning) for remote sensing image analysis and Earth Observation.

Federica D'Acunto is Founder and Project Manager at UptoEarth GmbH. She has a Master in International Relations from the Ca' Foscari University of Venice.


ARTIFICIAL ARTIFICIAL
LANGUAGES LANGUAGES
LIFE LIFE LIFE LIFE
MAKING MAKING
NEW NORMAL NEW
MULTIPLICITY MULTIPLICITY
PROXIMITY PROXIMITY
RESILIENCE RESILIENCE
REVOLUTION REVOLUTION
THINKING THINKING