

Envisioning Resilient Cities for a Post-Pandemic One Health Future

*Original*

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# ENVISIONING RESILIENT CITIES

for a

# POST-PANDEMIC ONE HEALTH FUTURE



REsilienceLAB

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# ENVISIONING RESILIENT CITIES FOR A POST-PANDEMIC ONE HEALTH FUTURE

ENVISIONING RESILIENT CITIES FOR A POST-PANDEMIC ONE HEALTH FUTURE

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The manuscripts in this publication exceeds the contributions to the initial conference. It highlights a variety of other inputs, opinions, points of views, and works of several citizens, international organizations, public institutions, NGOs, NPOs, associations, independent researchers, research centers, universities, and academic institutions from all over the world, who have all come together to envision resilient cities for a post-pandemic one health future.

The book includes Scientific paper and reframing contribution stimulating challenges, highlighting crosscutting phenomena and providing perspectives envisioning resilient and sustainable cities futures.

The Scientific paper were selected after a call launched during the Urban Resilience and One Health international conference and admitted to the publication after a double blinded peer review process guaranteed and coordinated by the Resilience LAB Editorial Committee and REsilienceLAB Scientific Committee.

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The reframing and envisioning contributions were reviewed by the Editorial Committee and the Scientific Committee of REsilienceLAB.

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*Pavia, 10 April 2023,*

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# Foreword

ANGELA COLUCCI ON BEHALF OF RESILIENCELAB

*REsilienceLAB is a network of people who approach and face the resilience concept and resilience capacities of our complex territorial and urban systems. It is a multidisciplinary network including researchers, students, and professionals from different disciplinary fields such as ecology, psychology/sociology, urban planning and design, and economics.*

*Resilience LAB founding members believe that advancements and innovation arise from cross-fertilization, synergies activation, collective experimentations, and practices diffusion and blooming. Since the beginning, REsilienceLAB has primarily focused on the action and practices domain to foster the implementation and enable tangible changes, improving our cities' resilience capabilities towards sustainability and the well-being of all living on the Planet. To reach tangible changes in our complex urban systems, REsilienceLAB supports the transition policies, processes, and practices with multiple initiatives providing dynamic toolboxes and engaging and promoting alliances among all the players and perspectives. The Resilience Practices Observatory project demonstrates the success of the proposed approach rooted in cross-fertilization and coproduction as crucial principles for urban transitions enabling the activation and stabilization of innovative processes providing multiple tangible benefits in our territories and urban context.*

*In 2020, thanks to the developed experiences in facing ecological and social challenges, REsilienceLAB launched the coproduction "[Dis]seminare Resilienza" project [Resilience (Dis)semination] path. It was launched during the pandemic and is still an open project, evolving its core issues according to emerging phenomena and urgencies. The Banca del Monte di Lombardia Foundation supported (and supports) the "Disseminare Resilienza" events and initiatives.*

*The need to accelerate the transition towards a model shift has become more urgent than ever, as confirmed in this challenging period. The shift must be rooted in the complex approach connecting and simultaneously facing the challenges imposed by climate change, social-economical phenomena, and the health emergencies and implications dramatically highlighted by the pandemic event on our territorial and social systems and behaviors. Strengthening resilience capacities must be approached as an opportunity to provide multiple responses to environmental, social, and health challenges.*

*The Resilience Dissemination project activated a series of coproduction activities exploring the Creative Diversity property applied to our territorial and urban systems. The "Urban Resilience and One Health" international conference was one of the activities promoted during the Resilience Dissemination path.*

*In coherence with our core distinguishing principles, organizing the "Urban Resilience and One Health" international conference the REsilienceLAB aimed to promote dialogue, comparison, and cross-fertilization between approaches and disciplinary fields to synergies activation, strategic envisioning, and operative toolboxes development. Being aware that the earth systems that regulate the stability and resilience of the Planet are under significant threat due to the phenomena characterizing the Anthropocene epoch, REsilienceLAB collected all the outcomes from the Urban Resilience and One Health conference contributions, suggestions, and debates and activated the editorial process enlarging and enriching the UROH conference perspectives to transfer innovations and advancements in urban systems' transformation processes, fostering a radical shift in the decision-making phase, design solutions and tools, and implementation processes. The book includes selected and reviewed scientific papers and reframing contributions emerging from post-conference and coproduction activities promoted.*

*A core aim of the book is to explore Urban Resilience and Planetary Health concepts to activate synergic dialogues among disciplinary research fields and action domains towards urban vision challenges rooted in resilience and adaptive experiences promoted by academia, experts, the third sector, and communities.*

*The Intergovernmental Panel on Climate Change (IPCC) warned that the Planet's natural and human systems will face severe challenges, and the climate change impact has already been demonstrated to endanger human health directly and indirectly through the alteration of the Planet's interrelated systems (Watts et al., 2015) [Planetary*

health & COVID-19; Health and climate change: policy responses to protect public health]. *Planetary Health* invite to achieve worldwide the highest standard of human health, well-being, and equity to guarantee the Earth's natural systems' health that permits humanity flourishing (The Foundation–Lancet Commission on Planetary Health).

For these reasons, the collective effort to foster the model shift is more urgent than ever. Academia, Institutions, and Civil society (as organization/institution and individual) must collaborate by hybridizing knowledge, and action procedures/processes must be rooted in innovative frames embracing the planetary health concept that implies understanding, designing, and acting on the existing connection between human health and the Planet's natural systems. Urban Resilience and Planetary Health concepts urgently invite considering human health as core principles for our territorial and urban system and incorporating the indissoluble interdependences with the Earth's natural systems.

Pavia, March 2023

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## References

REsilienceLAB web site <https://resiliencelab.eu/en/home-en/>

The Intergovernmental Panel on Climate Change (IPCC) web site <https://www.ipcc.ch/>

The Rockefeller Foundation–Lancet Commission on planetary health Web site <https://www.thelancet.com/commissions/planetary-health> [In particular, the report Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health: Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., Dias, B. F. de S., Ezeh, A., Frumkin, H., Gong, P., Head, P., Horton, R., Mace, G. M., Marten, R., Myers, S. S., Nishtar, S., Osofsky, S. A., Pattanayak, S. K., Pongsiri, M. J., Romanelli, C., ... Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: Report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, 386(10007), 1973–2028. [https://doi.org/10.1016/S0140-6736\(15\)60901-1](https://doi.org/10.1016/S0140-6736(15)60901-1)

★ quotes/excerpts from the contributions shared by the participants of the UROH international conference and the co-production activities promoted by REsilienceLAB

\*URBAN RESILIENCE  
IS AN OPPORTUNITY  
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IS NOT A NEW URBAN  
PLANNING TOOL BUT  
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FRAMEWORK TO  
MANAGE THE  
COMPLEXITY OF ALL  
ASPECTS OF THE  
URBAN SYSTEM TO  
ENSURE THE WELL-  
BEING OF CITIZENS.

# Introduction

YAHYA SHAKER, EDITORIAL MANAGER

*The sudden shock of the pandemic might has given some of us the time needed to reflect upon how we got ourselves to a 2-year state of lockdowns, curfews, and home confinement. Travel was restricted and we did not have access to any means of physical communication outside of our homes. This has been one consequence of our way of living over the past decades; more are on the horizon.*

*Uncertainty, decision-making, and radical reforms are tragedies of the commons that we have to deal with. We are in need for contemporary ideologies that fits our contemporary challenges, new alternatives to the ways we plan and govern our cities, the will to admit our mistakes, and taking the responsibility of the decisions we made and most importantly for the ones we did not make.*

*According to Slavoj Žižek's interview on Big Think titled: Don't Act. Just Think, published on the 28th August 2012:*

*[...] My advice would be—because I don't have simple answer—two things: (a) precisely to start thinking. Don't get caught into this pseudo-activist pressure. Do something. Let's do it, and so on. [...] "In the twentieth century, we maybe tried to change the world too quickly. The time is to interpret it again, to start thinking." Second thing, I'm not saying people are suffering, enduring horrible things, that we should just sit and think, but we should be very careful what we do. [...] universal health care is not some crazy, radically leftist notion. It's something that exists all around. [...]*

*Here, we are trying to offer another attempt, to critically re-view and re-think the most pressing issues we had experienced during the pandemic lockdowns. We tried to put together inter and multidisciplinary views with the aim of forming a wider perspective based on various experiences of citizens (scholars, civil society, governing bodies, and among others), evidence, testimonies, and critical scientific research.*

*Our ambition is to try to envision resilient cities for a post-pandemic one health future together and to offer a book of ideas, a report, a manifesto, a collection of manuscripts to our fellow citizens that have the burden of policy and decision-making.*

*This collective manuscript is a collection of scientific evidences, data and information that support the idea that in order to envision a post-pandemic future for our cities, first our cities need to be enough resilient and healthy with all what these terminologies hold. Each citizen's participation in public decision-making can assure a better policy-making process, can widen our collective perspective of perceiving our cities and our planet, and could foster building trust between us.*

*This book focuses on urban resilience and one health processes in particular, as part of a wider effort to become more inclusive and more open to citizen's collective knowledge. Assembling contributions from several scholars from all the continents, have without questioning enriched our understanding the social, health, economic, political, and geopolitical complexities in today's world.*

*In many ways, citizens' collective ideas have became essential to embed urban resilience and planetary health into public decision making since the pandemic hit. This could be our very first steps towards just and green transitions. We thought the book could be better organized in four parts that are core for the envisioning process:*

## **PART I: Urban Resilience (UR) and One Health (OH) Proximities**

*We dedicated the first part of the book to discuss what urban resilience means, what is One Health concept, through scientific argumentations on the proximities and the perception of urban resilience from a healthcare point of view and vice-versa. That has been through looking deeply at reframing One Health in post-pandemic cities, widening the perspectives between territorial planning and the healthcare sector, and envisioning post-pandemic transitions and their governance frameworks.*

## **Part II: "Resilience" between Territorial Planning and Healthcare**

*In the second part, we wanted to explore in depth how the term resilience is being perceived by different scholars from planning, policy, governance and architecture disciplines, and the healthcare sector. Our objective is trying to see how far are these perceptions aligned, and how could they both be integrated. We approached this question through viewing: urban resilience under pressure, what urban planning can do for cities after covid-19, environmental analysis and design anticipation for urban resilience and human health, designing healthy cities through adaptive urban planning, green spaces and children's resilience, lessons from the pandemic: mapping urban resiliency and robustness, assessing link of urban morphology and health, improving public health through integrated urban regeneration process, one-health: a transformational concept to drive urban planning and resilience for the post-pandemic future.*

### **Part III: Reality Check**

*After having viewed different case studies and ideas about the state of resilience of our contemporary cities and the different perceptions of our cities from planning and healthcare points of view, we needed to acquire testimonies, life stories, social evidences, and to double check the theories with what truly happened in practices. We requested the knowledge of the frontliners; the citizens who faced the emergency pandemic shock first, those who have voluntarily risked their lives to save the lives of others and those who have tested practically the definitions of resilience, preparedness, adaptation, mitigation, and recovery. The Italian Red Cross Volunteers have shared with us their experience and the impacts of the COVID-19 pandemic emergency on two Italian Red Cross Committees.*

*To better understand how territories could face climate change from an urban and healthcare point of view, how Spatio-temporal variation of air pollution could impact on our cities, climate change and health interlinkages with urban resilience, traditional and modern building materials and practices adapted to natural resources, horticultural therapy and mental health recovery in post covid outbreak, from scientific evidence-based data to the need for a professional approach to care with nature, and how to reconceptualize public park resilience and adaptability for the post-pandemic future: a perspective from a high-dense urban environment.*

### **Part IV: Key messages**

*Finally, we wanted to share the key messages and the citizens' experiences for a healthier future, the resilience practices and the COVID-19 crisis, the contribution of community and territorial resilience in facing new urban challenges, and last but not least, some urban envisioning perspectives.*

*We hope through this manuscript to have been able to offer some useful insights, to have stressed enough the importance of collective citizens' knowledge and evidence-based approaches towards more inclusive policies and decision-making processes.*

**\*TO ALL THE  
CITIZENS OF  
PLANET EARTH  
WHERE WE ALL  
BELONG.**

**FOR THOSE  
WHO HAVE BEEN  
WITNESSING THE  
ONGOING COVID-19  
PANDEMIC, GLOBAL  
CLIMATE CRISES,  
AND ENERGY AND  
FOOD CRISES OF  
2022**

**AND FOR WHOM  
OUR SURVIVAL ON  
THIS PLANET MAY  
CONCERN**

**WE DEDICATE  
THIS BOOK FOR  
YOU.**

\* Dedication by Yahya Shaker





Photo Credit: Angela Colucci

# PART I. Urban Resilience (UR) and One Health (OH) Proximities

# [RCh 1] Reframing One Health in Post-Pandemic Cities

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On October 26th 2022, the European Commission introduced more binding measurements against ambient air and water quality pollution through several directives (WHO, 2021). The Directorate General of Environment of the European Commission has focused its new regulations mainly on air and water providing incentives on the investments that benefits the public health, green energy, eco food production, environmental-friendly industries. The Commission has ensured through the fit for 55 plan to minimize the allowed levels of pollutants at least by 55% by 2030. In December 2022, the Council of the EU adopted several rules which assures a concrete contribution to climate neutrality by 2050. (Council of the European Union, 2022).

*"We believe that places where we live and work in every day represent a major determinant of our health—and that urban resilience should be regarded with the so-called 'One Health approach.' We exist only in the frame of our relationship with the environment, both the natural and artificial ones, including urban and indoor spaces where we spend the majority of our time". The design process of such spaces including their construction methods and materials, all affects the quality of our lives. That represents a crucial precautionary challenge that entails the commitment of all members of society. (IWBI, 2022)*

*In a period of rapid acceleration of our daily-lives' dynamics, Italy is the ranked among the first countries in Europe for deaths attributable to air pollution with about 80,000 premature deaths a year. This was underlined by the Italian Society of Environmental Medicine (SIMA), following the research disseminated by Legambiente on the 30th January 2023 discussing the smog emergency in Italy, according to which 29 cities exceed the limits of fine particles in 2022. (Legambiente, 2023). Pathologies of the cardiovascular system represent the first cause of death in Italy, followed by pathologies of the respiratory system. The indirect effects of pollution lead to a +14% increase in the incidence of all cancers in polluted sites.*

*It is thus, essential and can no longer be postponed to act quickly to drastically reduce the main emission sources of air pollution. It is crucial to intervene on the mitigation of air pollution with concrete, immediately implementable, sustainable, and socially acceptable actions. These cannot be aimed exclusively at the right energy transition towards renewable energies or in dreaming of greener cities, considering that we do not have enough trees to carry out adequate urban reforestation.*

*The World Health Organization considers one third of premature deaths due to heart attacks or strokes, asthma, and lung cancers to be directly attributable to air pollutants, with very different impacts depending on the country. For Italy, unfortunately, the good news contained in the new "Air Quality Report" of the European Environment Agency (EEA) does not apply, which confirms the trend of constant reduction of the average annual concentrations of fine particles and the consequent premature deaths, but PM 2.5 levels remain above the health limits set by WHO in the 2021 Guidelines for Air Quality and Italy remains at the top of the rankings.*

*In fact, if the estimates of premature deaths from PM2.5 have increased for Germany from 58,600 in 2016 to only 28,900 in 2020, for Italy, however, they have gone from 58,600 to 52,300 premature deaths. The same EEA report clearly explains that the highest concentrations of PM10 are observed in the Po Valley in northern Italy, attributing the phenomenon to the density of population and industrial activities in an orographic and meteorological context that favors the accumulation of fine particles.*

*The novelty of this latest report on Air Quality is also a focus on the mortality data reported annually by the European Agency. In fact, an estimate of the years of life loss due to chronic obstructive pulmonary disease (the so-called COPD) from exposure to fine particles and diabetes in relation to nitrogen dioxides is provided (quantified overall in 350,000, with Italy among the leading countries), as well as an assessment of the number of hospitalizations for lung diseases in the elderly resulting from ozone levels above the health safety threshold (about 12,000 cases a year, with Italy in first place with 3,000 hospitalizations avoidable).*

*These data certify that Italy is among the European countries that must start the progress for the implementation of the European "Zero Pollution Strategy", which underpins the revision of the Guidelines for Air Quality presented by the European Commission last October to align with the more stringent*

WHO directives, making the best use of the National Recovery and Resilience Plan (NRRP) funds to quickly reverse course with a careful resource allocation strategy and ongoing verification of the results produced by specific actions capable of impacting on Health, Environment issues and Climate Change. If we look at the data published by the Italian National Institute of Health (Istituto Superiore di Sanita') concerning deaths from Covid-19 in Italy, we realize that the approximately 75,000 deaths in 2020 and 60,000 in 2021 (when the vaccination campaign was implemented) are in fact comparable to the numbers of deaths attributed each year by European authorities to air pollution in Italy.

However, the problem of the impact of air pollutants on human health goes far beyond the characteristics of the pandemic, as it represents a long-term structural problem with enormous consequences, we are unaware of, due to the absence of specific diagnostic tests.

Unlike the coronavirus, air pollution is erroneously perceived as a non-specific collective risk and far from each of us despite the fact that it affects thousands of liters of air that enter our lungs every day and from there into our entire body together with all the contaminants carried by fine and ultrafine dust, capable of triggering vascular inflammation, influencing cardiac activity, affecting the immune system, depositing themselves in the brain with millions of nano particles per cm<sup>3</sup> and even damaging cellular DNA in an epigenetic key. It is therefore necessary to intervene and do it with evidence-based actions that are economically and socially sustainable, non-energy-intensive and rapidly implementable.

The energy transition towards renewable energies, awaiting clean nuclear energy, is going in the right direction but the times will obviously be extended, the selective urban reforestations, which we talk about so much, hide a vulnerability, namely that in Italian and European nurseries we do not have a sufficient number of trees to make them.

So, what to do now? SIMA has suggested to the Government to start a Mitigation Action, to be supported by Europe, aimed at providing fiscal incentives for private individuals and carrying out coating interventions for the public on the external wall surfaces and windows of urban buildings with an innovative transparent photocatalytic coating of ethanol-based titanium dioxide, locally produced in Italy, which has been shown in scientific studies to be activated by natural light to carry out an action of decomposition and reduction of atmospheric pollutants.

The application of such photocatalytic nanotechnology is low-cost because it does not require a consumable material, does not require regeneration, and is not energy intensive, it has no contraindications on the health of humans and animals (following the "Do No Significant Harm principle (DNSH)" indispensable for implementing projects funded by the National Recovery and Resilience Plan (NRRP)) and the results of air pollution mitigation are scientifically measurable.

In addition to this "active" action, the ethanol-based titanium dioxide photocatalytic coating actually represents a permanent barrier against atmospheric pollutants, which in its absence are deposited on the facades (the so-called black crusts).

# [RCh 2] Widening the Perspectives between Territorial Planning and the Healthcare Sectors

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## Introduction

*Environmental health problems have been usually successfully addressed by controlling a single source of pollutants or exposure. However, today's issues are usually more complex. Challenges such as climate change, resource depletion with their enormous implications for human health and wellbeing, the obesity epidemic, and persistent worsening of social inequalities in health have been identified as planetary health and ecological public health issues.*

*All such issues must be considered with a consistent health infrastructure and organization, planning and implementation.*

*Complexity: how to face it?*

*Scientists in public health (Mc Michel 2000, Koopman 1996, Pearce 1996) have emphasized the importance of identification and study of population risk factors in their social, cultural, and historical context as a critical development for the future of public health science and policy.*

*In the more traditional view of science, populations and subsequent health outcomes are often treated as the sums of individuals' health, not as a system of interacting individuals, groups, and society. This reductionist approach to population health sciences often neglects social, political, economic, cultural, and historical contexts as population risk factors.*

*Determinants of population characteristics may not be direct causes of illness or mortality; however, they are central factors that affect the distribution of direct risk factors such as alcohol drinking or tobacco smoking. (Marmot 2006)*

*Several key societal factors, such as economic, political, and social, are the fundamental drivers of population health. These factors are the determinants of the distribution of "intermediary" and more "proximal" risk factors.*

*Our understanding of the world has changed quite fast in recent years. The globalization of economic systems has enormous impacts on populations and the ecosystems on which human survival depends. (Steffen 2015) The complexities of such transitions and the multiple links amongst the systems, these being economic, social, environmental, and climate change, will affect any economic models that attempt to measure the costs of environmental health interventions.*

*Such complexity makes necessary an integrated and holistic approach to environmental health in a broader spatial, socioeconomic, and cultural context beyond individual toxic or infectious threats. (Lauriola 2019)*

*"Planetary health" (Whitmee, 2015) and the related concept of "ecological public health" (Rayner, 2012) may be the ultimate 'wicked problems' of our time. (Behbod, 2016)*

## The role of the Health Sector

*COVID-19 has highlighted that, despite the unavoidable discrepancy between and within the policy and scientific communities, the decisions in response to the emergency must make sense and, more importantly, facilitate the interrelation and mutual support between health and social, environmental, and politico-economic domains.*

*COVID-19 pandemic and the origin of SARS CoV-2 have revealed the precariousness of the systems upon*

which trade, food, energy, transportation, and social safety nets depend.

The reported origin of the current pandemic emphasizes the special relationship between environment, animal, and human health (One-Health approach- Amausi, 2020). It has been estimated that about one billion cases of illness and millions of deaths occur yearly from zoonosis, which comprises about 60% of all emerging infectious diseases globally. Over 30 new human pathogens have been detected in the last three decades, 75% of which have originated in animals. (UNEP, 2020).

Ecosystem health, wildlife health and human health are interconnected. There is a need to develop a coordinated plan to focus on the impact of Climate change (CC) on zoonotic and parasitic infections, (Huefer 2013) which is also not the last in the case of COVID-19. (Herrero 2020),

According to the Italian National Recovery and Resilience Plan (the acronym of which in Italian is PNRR) Mission 6 "Health Care", during COVI-19 pandemic "critical issues emerged which can be summarized as follows:

- an excessive gap between health levels provided by the Italian regions, especially in terms of prevention and territorial assistance and - within these Regions -, the inequality between urban areas and internal areas;
- a poor capacity in integrating hospital services, local health services and social services;
- a delay in the implementation of local health care services and prevention services, also with significant disparities among regions, especially concerning hospital territory integration;
- a poor synergy in the definition of prevention and response strategies of the health service with respect to environmental and climate risks, according to the so-called "One-Health" approach." (Governo Italiano, 2021)

Poor coordination between primary and long-term care is a long-standing issue in long-term care. In 2019, between 36% and 88% of the primary care providers in 11 OECD countries reported not coordinating care frequently with social care or other community care services. COVID-19 has magnified the impact of poor care integration when attempting to protect care recipients. (Doty 2020)

As such the final goal should be a "people-centered care": an approach to care that consciously adopts the perspectives of individuals, careers, families, and communities as participants in and beneficiaries of trusted health systems that are organized around the comprehensive needs of people rather than individual diseases, and that respect social preferences. People-centered care is broader than patient and person-centered care, encompassing clinical encounters and including attention to the health of people in their communities and their crucial role in shaping health policy and health services. (WHO, 2018)

## The role of Primary health care (PHC)

PHC was famously set as a global priority in the 1978 Alma-Ata Declaration. The 2018 Astana Declaration on PHC made a similar call for universal coverage of primary health care across the life cycle and essential public health functions, community engagement, and a multisectoral approach to health. In many places across the globe, PHC does not meet the needs of the people - including both users and providers - who should be at its center.

COVID-19 pandemic has emphasized the relevant role of the primary healthcare (PHC) systems in the first diagnosis (screening) and the assignment of degrees of urgency to wounds or illnesses to decide the order of treatment (triage) and monitoring of the physical and psychological conditions of patients. With all that in mind, it also emerged the need they work in coordination with other health care organizations (Xi Li 2020) and those addressing public health at the community level. (Lauriola, 2021)

Many examples worldwide figured out the benefits of involving Family Doctors (FDs) and primary health care services in the public health responses to COVID-19 at the local and global levels. (Mayaka, 2022) Success depends on collaboration between FDs and local and national public health organizations,

*allowing primary care services to contribute to the public health response, especially in case identification and contact tracing at the community level. Some important examples illustrating this come from China. (Harlan, 2020)*

*Some encouraging proposals have been arranged and promoted in Italy (Lauriola, 2018, 2019) also in view of possible implementation in LMICs. (Lauriola, 2018, 2021). According to Hanson (2022), "Putting people at the centre of these arrangements entails allocating resources for PHC based on population needs, rather than allocating resources to facilities, inputs, or vertical programmes. To achieve equity in this allocation process means prioritizing the needs of people with the lowest socioeconomic status and least-served geographic areas." (Hanson 2022).*

### **Conclusions and Recommendations**

*Nowadays, the complexity in which economies and societies point out the multiple connections between the environment and health sectors. It also emphasizes the need for no-further postponed environmental public health policies with an intersectoral and global perspective. The crucial challenge is to move towards a system that must be economically viable, ecologically sustainable, and socially fair (Lambert, 2020).*

*The awareness and knowledge about environmental public health issues, either in terms of understanding or actions both at the individual and collective level, could be introduced through an educational curriculum that fits a diversity of specialties and levels of training. Universities should collaborate with municipal and regional institutions for community health. The integration of academic and practical experience is crucial to the success of training in the environmental aspects of clinical medicine and environmental public health at the community level.*

*Along this line, it is essential to point out the role of PHC. It was based on the relationship between doctor and patient in the past. Today the influence of the environment and the need to act at this level are increasingly evident.*

*Therefore, physicians can play a crucial role in environmental public health if they pay proper attention to community health care and the traditional focus on the individual. On the other hand, Public Health agencies should encourage and promote the involvement of PHC within the frame of community health.*

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# [RCh 3] Envisioning Post-Pandemic Transitions and their Governance Frameworks

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*Instituting the necessary transitions, governance mechanisms and decision-making processes that are capable of significantly morphing the way collective problems are being perceived is without questioning a tragedy of the commons especially in contemporary democratic spheres (Dente, 2014).*

*The pandemic emergency has arguably demonstrated how challenging it is to make wise and effective real-time decisions, as well as being prepared both at the multi-institutional levels and most importantly at the citizen level. At the onset of the pandemic, some might have imagined that our contemporary cities are well-prepared and are just capable enough to deal with global crises without the need to coordinate with all other subnational and transnational levels; yet, the pandemic put such beliefs to question. These simultaneous disasters represent a natural counterweight accelerated by the impact of our “disorganized complexities” (Jacobs, 1961), and thus, we’d better learn to live with the complexity of today’s uncertainty, just as we’re ought to learn to live with Covid-19 and the future catastrophes (UNDP, 2022).*

*Now, we are left with not much of choices but to reinvent the way we envision our cities. Despite the fact that innovation in climate, environmental, health and territorial policies is accelerating, yet we are held back by the orthodoxy of our planning systems and our traditional governance mechanisms.*

*The lack of agreements between policy actors at the global level, the fragmentation between the competences of the institutional levels in and between the same national confine, added to the complexity of integration at the transnational level are all antagonisms to the possible achievement of a realistic planetary health plan of our post-pandemic cities.*

*This should be considered within the global crises that citizens and their cities are facing incessantly, since the financial crises of 2007-2008, followed by the global migration and refugee crises of 2015, then the ongoing Covid-19 pandemic and the environmental disasters since 2019, and recently the global energy crisis that started from 2021 with a subsequent food crisis from the beginning of 2022 (European Commission, 2022).*

*To deal with such emergency situations, all citizens – including governmental representatives, politicians, and decision-makers – need dynamic information focused on our collective knowledge (Citizens’ science) and based on scientific evidence. This aims at formulating wise, efficient, and effective socio-political decisions that aim to create inclusive public policies for our habitat (more resilient, healthier, more progressive cities).*

*The essential role of citizens is to shape and influence existing institutions, both formal and informal, government structures and civil society. On the other hand, institutions have a role in facilitating the transitions and transformations of cities, which implies an interdisciplinary contribution from different experts. The institutionalization of post-pandemic cities’ visions is all about incorporating the just and green transitions that occurs when multi-level agreements become sufficiently regular and pivots on socio-spatial justice. This green future we aim at, could be sustained if formal institutions truly include citizens’ collective knowledge, dynamic data, and evidence-based information, optimizing the organization of alternative strategies to make these transitions operational and space-based.*

*The alternatives we desire and green future we dream of cannot simply be achieved using existing governing and planning models. New Multi-level Governance models will be necessary to prepare and face upcoming global and local challenges (Newton, 2021).*

*Every planning decision made to govern our contemporary cities has a direct impact on our habitat, lifestyles, health, economy, and our evolution as humanity. In any decision-making process whether it is based on a strategic plan, an urban vision, a public policy, a local action, the health of citizens and cities is never a paramount concern. It is significant that health experts are rarely involved in the development of urban plans and public policies (URBACT, 2021).*

*According to Friedrich Hegel “the only thing we learn from history is that we learn nothing from history”. We could say that the pandemic has shattered the foundations of our ways of living/surviving. It’s unrealistic*

*to look at our cities and lives the way we used to; above all we'd better not replicate the same models and modes of living that led us to such unfortunate global cataclysmic events, and we'd better be very critical on not perceiving the pandemic as an unfortunate accident that is over, just to get rid of the responsibility of our past and on-going decisions (Žižek, 2020).*

*Every decision implies an act of will and the existence of alternatives. Understanding the functioning of collective policies means including each actor in the decision-making processes: a policy is an agreement; all policy actors and decision-makers are first and foremost citizens. The difference between an inclusive policy or an exclusive one lies in the mechanisms through which we citizens decide to decide together, to decide not to decide together, and/or not to decide at all (Dente, 2014). Any decision or policy implies potential transformations/transitions of the status quo, as well as the responsibility that every citizen will have to assume in these transitions.*

*"Responsibility" is the key point, a concept which implies the duty of every citizen to be active and to commit their selves to the prosperity of the society in which they live in. According to Plato, every citizen "knows how to govern and be governed justly" (Laws, 644a), a definition comparable to Aristotle's statement (Politics, 1277a25–26) according to which "the ability to govern and to be governed is in any case praised, and knowing how to do both well is considered the virtue of a citizen" (Cohen De Lara, 2017). We have a fundamental need to understand that our habitats (our cities) are living organisms; they are born, they grow, they die, they can be healthy or sick, expand or shrink, prosper, or decay. Cities are our creations. We created them in our image after our likeness.*

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Photo Credit: Angela Colucci

# PART II. Resilience between Territorial Planning and Healthcare

# [RCh 4] Cities under pressures: Urban Resilience challenges.

MILANO INNOVATION IN REBALANCING ECOLOGICAL FUNCTIONALITIES SUPPORTING COMMUNITIES AND ECOSYSTEMS HEALTH

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## **Crisis as an opportunity for change**

*In the last decades, the territorial and urban systems have been called to face increasing and diversified pressure phenomena. The increase is not only in the number and rapid succession of “emergencies” to be addressed but also concerns the complexity and the interdependence between the pressure phenomena and the different nature of the risks: extreme climatic phenomena, earthquakes, fires, pandemics, chemical accidents and disasters, terrorism, financial crises, cyber-attacks, and conflicts. On the one hand, the ever-increasing interdependence generates unexpected trajectories and a strong climate of uncertainty. Conversely, in the face of worsening pressure phenomena, the urban-territorial systems are (and confirm) to be particularly vulnerable and fragile. The COVID-19 pandemic revealed the several fragilities of our cities, making them tangible and understandable in everyone’s daily life. The COVID-19 pandemic, more than the climate crisis, produced impacts acting from global to the individual.*

*The pressures on the environment and living system are deeply correlated, demonstrating how human and planet health must be approached as inseparable.*

## **The resilience concept**

*In recent years, there has been a remarkable expansion in the use of the resilience concept, which is utilized as a guiding concept inspiring the policies, models, and approaches for urban action and intervention at the international and the European level. The recognition of ecological resilience as a key concept orienting the sustainable territorial systems development was officially introduced into the international and European policies debate in 2005 when the document Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations was presented (Background paper to WSSD is a technical-scientific paper in support of the Swedish Government’s Environmental and Scientific Advisory Council during the World Summit on Sustainable Development).*

*Resilience has become an often-overused umbrella concept, especially in media and policy discourses, emphasizing the positive envisioning potential of the concept itself (Colucci, 2012). Resilience, used more frequently in the debate on the innovation of urban regeneration models, is a concept of considerable richness enabling cultural innovation of urban and territorial design and management processes (Lerch, 2017; Nüchter et al., 2021). The success of resilience as a recurrent narrative metaphor is rooted in the capabilities to deal with the multiple dimensions of recovery, transition, and adaptation time frames, with the multiple vulnerabilities of urban socio-ecological systems, often involving social equity and environmental sustainability questions (Carpenter et al., 2001; Colucci & Pesaro, 2022; Galderisi & Colucci, 2018). Nevertheless, the same widespread over-use of the term (often not needed) has led to generalizing the more profoundly innovative content of the resilience concept.*

*Different disciplines have used and use the term resilience by developing definitions related and functional to the research focus of each disciplinary field. In ecology and psychology, the approach to resilience solicits coping and learning to live with uncertainty: changes and crises are part of the evolutionary processes of complex systems (Colucci, 2022). One of the key strategies to maintain and increase resilience mechanisms is perceiving dynamic conditions and grasping changes with adaptive responses oriented towards opportunities for growth and evolution.*

*In psychology, resilience defines the ability to cope with stressful or traumatic events and positively reorganize one’s life in the face of difficulties. Therefore, aspects and properties of the resilience of the individual are the ability to find “strength” to react (ability to react) in a positive way and the ability to learn from experiences, even traumatic (positive learning).*

*Multiple properties contribute to the resilience of an ecosystem: creative diversity and redundancy, emergent properties, flexibility and modularity, functional mechanisms and renewal cycles, feedback*

*cycles, and memory (some examples without the intention of a complete and comprehensive discussion and listing) (Colucci, 2022).*

*The research and literature debate often emphasizes the differences and gaps between approaches to resilience facing climate, social and economic stresses, and risk (Brand & Jax, 2007; Burayidi et al., 2020; Davoudi et al., 2012), unpredictable shocking events (such as the pandemic crisis due to COVID-19). The tensions between recovery, adaptation, and evolutionary, between disciplines and models related to risk and climate change, and between psychological and social resilience are the subject of a broad literature (Fletcher & Sarkar, 2013; Nüchter et al., 2021).*

*Grasping and integrating the different disciplinary contributions concerning resilience allows us to incorporate multiple temporalities and approaches to the evolutionary change of our urban systems (Davoudi et al., 2013). Concerning the Resilience concept in the territorial and urban action sphere, it is possible to provide a highlight:*

- Persistence, when transition initiatives and urban interventions/actions aim to cope with local urgencies related to social, economic, and environmental/climate impacts in the short term, not providing innovation (disruptive modification) in urban complex systems mechanisms;*
- Adaptability, when transition initiatives and urban interventions/actions initiatives aim for incremental adjustments of territorial/urban systems to cope and deal with emerging phenomena (adaptation);*
- Transformability (or evolutionary) when transition initiatives and urban interventions/actions are experimenting and implementing transformations in a long-term perspective able to promote modifications and innovations (perturbations) at the local level, influencing and activating societal transition of the whole territorial/urban system.*

*Holling has introduced adaptation dynamics, emphasizing that resilience assumes a dynamic and evolutionary vision of possible response mechanisms of complex territorial systems (Gunderson & Holling, 2002; Holling, 1973).*

*Strengthening the resilience properties of complex systems (such as territorial ones) enables the systems to activate responses of recovery, adaptation, and evolution when facing exogenous or endogenous disturbances and crises. In approaching the territorial/urban challenges facing Climate and health issues, our complex systems must shift the approach acting in an incremental approach reconfiguring our cities towards new equilibrium conditions and learning from adversity faced to produce new capacities to face the future.*

*The idea of the incremental and adaptive processes, to better face and be prepared facing crises and shocks, the innovative principle provided by the resilience concept:*

- It implies a strategic and positive dimension. Communities and territories foster their capabilities to overcome stress phenomena and get, at the same time, new equilibriums and capabilities to take advantage of different scenarios.*
- It includes multiple “uses” and declinations concerning contemporary phenomena and can be applied at different territorial levels and sectors. Starting from the issue of territorial risks, both in terms of catastrophic events and in long-term perspectives related to the health and well-being of populations, the concept finds more and more success in the local initiatives of communities. It is an effective approach and toolbox to deal with crisis phenomena related to economic, social, and governance changes.*
- It involves a process approach and allows for the building of changing paths over time and in a strategic and long-term perspective. The incremental and dynamic approach enables the development of learning paths and the production of resources, skills, and expertise to anticipate future events.*

### **Urban Resilience and planet health: Renaturing Strategies**

*In the most innovative research and best practices aimed at the mitigation of territorial risks, the concept of resilience has assumed a central role in the construction of strategies that include within the objectives of reducing risks and hazards a plurality of goals aimed at territorial quality. The concept of resilience in territorial risk management has existed in scientific debate for at least 20 years. Since the topic of resilience has long been debated, there are also significant theoretical focal points in terms of interpretation, such as*



the relationship between resilience and vulnerability. As underlined, Pelling the idea of resiliency suggests a proactive stance towards risks. It has been discussed within the ecological theory, system analysis, and disaster studies (Pelling, 2003).

Resilience fosters process innovation rooted in crosscutting and holistic approaches overcoming the siloed and sectorial approach of urban policies, planning, and management. Meanwhile, the urban resilience approach fosters a compressive strategic vision connecting mitigation/adaptation Climate policies and urgencies from social and economic dynamics, connecting communities' well-being and ecological/natural components improvement supporting the complex urban systems.

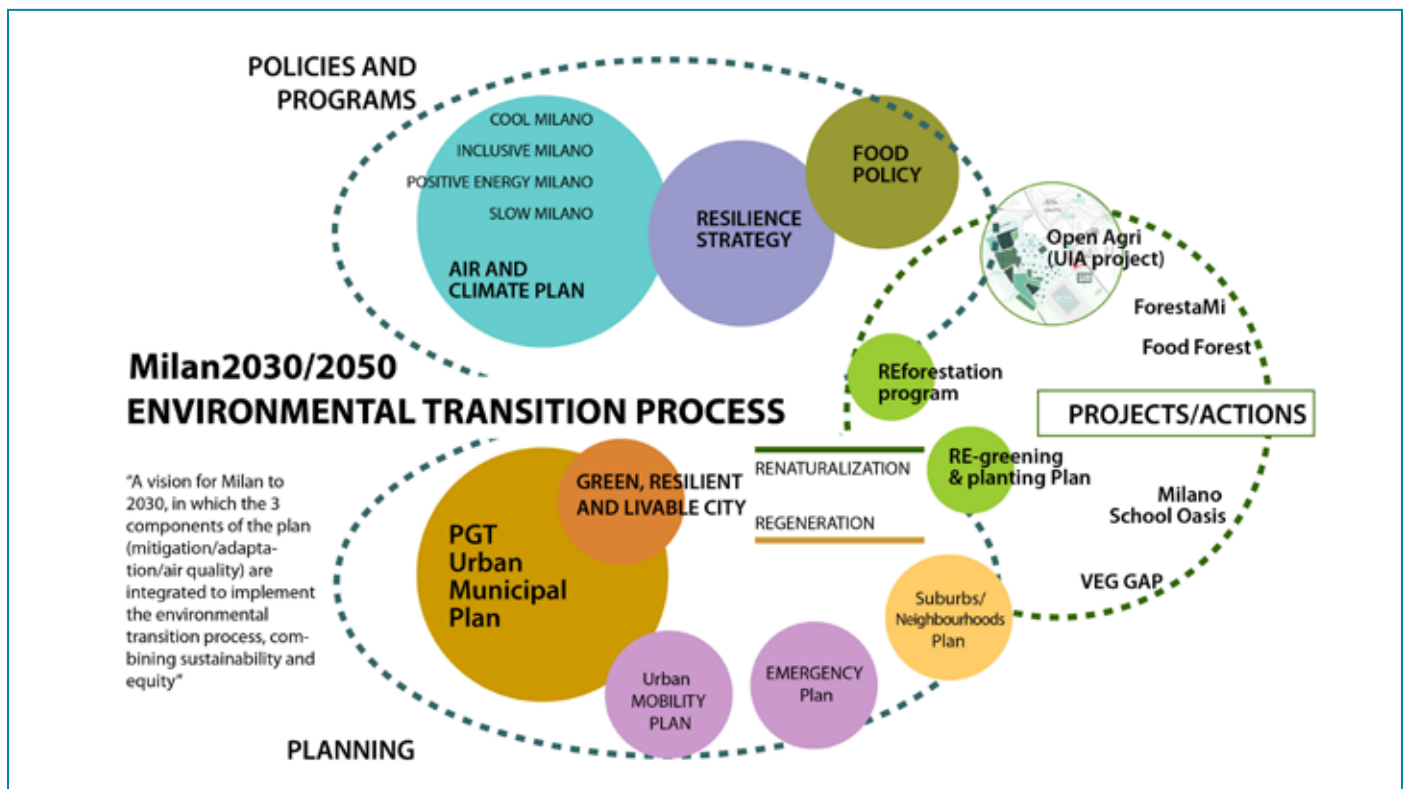
The strategies for improving the ecological and ecosystem values at territorial, urban, and local levels are fostered from international and European levels as crucial strategies to face multiple issues and benefit complex urban systems. Nature-Based Solutions (NbS), regreening, and blue/green multifunctional infrastructures become solutions often providing human and ecosystem health and local well-being.

The Milan Municipality has recently developed numerous policies to increase resilience, promote ecosystemic, social, and economic sustainability, and boost urban resilience. This complex and heterogeneous set of policies has been implemented through different tools (plans and regulations, intangible policies, urban regeneration projects) framed into a common vision.

The need for a better harmonization and synergies' activation represents a crosscutting challenge that addresses a heterogeneous landscape of plans and programs (e.g., Resilience Strategies, Climate Plans, environmental and urban regeneration plans, etc.).

The municipality of Milan represents a paradigmatic example in this line since it recently launched a relevant institutional initiative to integrate different tools addressing climate issues, sustainable and accessible food systems, and urban resilience fostering the role and values of ecological urban and metropolitan components.

[RCh4] Figure 1. From a siloed approach to the development of integrated visions and actions: the Milan Municipality approach. Source: Angela Colucci



*In detail, to enhance the resilience capacities, promote climate mitigation and adaptation and citizens' well-being, the Municipality of Milan launched different policies, programs, plans, and projects, which identify NbS and social innovation as reference concepts for actions: urban food policy, air and climate plan, reforestation plan, widespread interventions of greening in the city center and improvement of green areas in urban suburbs, restoration of natural and rural corridors (figure 1). The different launched initiatives share two cross-cutting and common aspects: the long-term vision for a more resilient, green, healthy, and comfortable city and NbS as a core strategic tool for achieving such a vision. In particular, the activation of synergies among different sectoral competencies, tools, and management procedures at the Municipal scale may support implementing a wide range of actions addressed to the natural ecosystems' restoration and improvement, sustainable water management, and climate cooling through urban greening.*

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# [RCh 5] What Urban Planning can do for Cities after COVID-19

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## 1 Rediscovering the origins of the discipline

With the advent of industrialization came the era of urban growth and the conflicts brought about by the effects of social and economic transformations that, in the 19th century, led to the demand for urban renewal and expansion plans and the formation of the discipline of town planning. In the 19th century, in fact, cities became the subject of specialized studies and planning projects, the most significant interpretations of which are described below, along with experiences that generally highlighted the overcrowding of historical centers, often in conjunction with epidemics, and the new needs for healthy living conditions. During the 19th century, also known as the century of networks, the discipline of sanitary engineering also took shape. The first network infrastructures were built, from those for mobility to energy and sanitation, and the first reports on the sanitary conditions of some London neighborhoods and the first censuses on unhealthy housing conditions, such as in the areas of the city of Paris affected by the rage, were drawn up.

The term Urbanism was coined by Ildefonso de Cerdà, considered the father of the discipline of town planning and author of the Barcelona expansion plan, carried out in 1850 on behalf of the prefecture with a project that broke with the concentric expansion model proposed by the Order of Architects. Cerdà, an architect and engineer, introduced into his project a hierarchy of urban roads with 60- and 30-meter elevations, distinguishing between roads intended for crossing the city and those for the neighborhood, and a system of settlement "squares" distinguishing the main fronts from those of a more strictly residential nature, with a ratio between the height and distance between buildings that would ensure that the ground floors would be sunny even during the winter solstice. The result is an extension project proposing the integration of formal aesthetic aspects in the city's construction with the elements of safety and health. In his general theory of urbanization of 1959, Cerdà considers the city as the result of the work, persevering, and continuous of different generations who, over the centuries, have adapted the city to the needs that, over time, may become obstacles and must be removed in order to build a city suited to the changing needs of life. For Cerdà, urbanization uses narrative, economics, and statistics. It must respond to a highly humanitarian end of satisfying human needs such as individual freedom and the need to socialize and interact with the outside world.

However, the 19th century is a very dense century of studies and projects on the city. In addition to Cerdà (1815-1876), we should remember Camillo Sitte (1843-1903), the Viennese theorist who, with his "Art of building the city", dealt with urbanism according to its artistic and perceptive foundations and was at the centre of the international debate on the expansion and urban planning of cities between the 19th and 20th centuries; Ebenezer Howard (1850-1928) the theorist of English town planning and garden cities, influenced by the utopian Robert Owen (1771-1858) and juxtaposed with the urban architect Raymond Unwin (1863-1949); Patrick Geddes (1854-1932), Scottish biologist, sociologist and urban planner, a pioneer of ecology who introduced the concepts of bioregionalism, conurbation, landscape architecture and green belts, i.e. those open spaces between urban settlements and cities that can contribute to the vital balance of cities, as Lewis Mumford pointed out in his History of Cities; Arturo Soria y Mata (1844-1920), urban planner from Madrid and theorist of the linear city (1882). Furthermore last but not least, Baron Georges Eugène Haussmann (1809-1891), a French politician, town planner, and civil servant, was appointed prefect of the Seine department by Napoleon III: the man who revolutionized the layout of Paris, freeing the city from cholera and tuberculosis by building sewers and a water network and restoring the city's role and value as a capital city of the Second Empire with the redevelopment and opening of the grand boulevards: an ante litteram model of urban regeneration even if the increase in real estate value of the areas concerned will induce a process of replacement of the local population.

Today, a consequence is increasingly evident in large metropolitan cities affected by urban regeneration and redevelopment programs by zones with the progressive spreading and removal of settlement decay and social marginality areas. In the same years, sanitary conditions also affected several Italian cities: for example, the city of Rome, which thought to make use of Haussmann, but to no avail, and the city of Catania with Filadelfo Fichera (1850-1909), an engineer-architect who worked on the plan for the hygienic redevelopment of cholera-stricken Catania in 1866, and who dealt with the consequences of settlement density with his miasmatic theory. Finally, in the 20th century, the rationalist movement deepened and disseminated criteria on the sizing and orientation of different settlement functions. The Greater London Plan, coordinated in 1943 by Patrick Abercrombie and recognized as the manifesto of 20th-century spatial and urban planning.

## 2 Returning to the care of the specificity of places

The growth of cities, which began according to the predominantly concentric model of Western cities, then spread throughout the world at different times and with different intensities up to Los Angeles, the last city in the West, fueling a process of urbanization that at the beginning of the 21st century brought the theme of the urbanization of the world to the attention of the public: this is the acceleration of the growth of the world's population, the concentration of more than 50% of its total in the world's large urbanized areas and the abandonment of many areas and territories that were once inhabited and cultivated.

These phenomena have been accompanied by a simultaneous increase in the environmental and health problems of entire regions and cities due to high levels of air pollution (one of the leading causes of mortality in the world, together with the scarcity of drinking water), the acceleration of climate change and the breakdown of all balance between man and other species of living beings, which is undoubtedly one of the causes of the most recent epidemic.

With the end of the Second World War, the Western world, despite tensions and low-intensity wars, was characterized by a period of growth in prosperity that affected many parts of the world and broad social strata, with seemingly limitless economic and technological development, which was then abruptly interrupted. With the emergence of new powers, such as China, on the world scene and the breakdown of the balance between the major economies of the century, the lack of any certainty for one's future has for some time been fueling a large flow of migration from many countries, not only from the South, in search of greater security and better living conditions. The outcome is, on the one hand, the growth of inequalities between the emerging classes holding large amounts of capital and the growing mass of marginalized people and, on the other hand, the contraction of the middle classes in the developed countries themselves and the growth of contradictions and tensions caused by uncertainty about the future.

This situation is accentuating a divide even in the choices of government and management of the cities with, on the one hand, a real estate market oriented by private financial investments towards interventions of the redevelopment of the cities for individual parts and, on the other hand, the widespread presence of movements that with difficulty support the protection of the environment, the defense of the soil and agricultural areas and, at the same time, even more, social interventions that guarantee better habitability for the populations of urbanized regions.

In the world, there is a lack, even if it is increasingly urgent, of wide-ranging environmental policies that must be supported by long-term economic and social planning and territorial planning scenarios that take into account regional cultural specificities and territorial fragilities. It is only under this frame that town planning can effectively re-propose the local government tools for land use and the attention that has long been paid to the diversification and safety of urban mobility routes, the orientation of buildings and natural ventilation for housing, avoiding inappropriate locations on the ground floor and in basements and intervening in many new cases of overcrowding and insalubrity in conditions of need. In this sense, the instrument of the general urban plan can regain certain effectiveness in guiding the interventions by

*parts promoted by the programmed agreements between the public and private sectors, such as the projects for a 15-minute city conceived and relaunched by the government of the large metropolitan cities to redevelop the areas and neighborhoods of the urban periphery (even if they too often focus into the boundaries of the capital cities).*

*On the other hand, it is only in the perspective of long-term objectives that town planning can once again play a role in restoring citizens' confidence in respecting the rules of settlement and in participating in the development choices of their own city: in the sense that a resilient community requires that accessibility to the various urban services be guaranteed, from those close to home (proximity facilities) to those of prevention and health services in safety and without improbable waiting times for the entire population "living and sleeping in the city."*

*Lastly, the integration of long-term scenarios and care for the specificity of urban places will also be able to re-emerge a design tension that prevails over any hypothesis of urban building growth as an end in itself and that, on the other hand, is capable of integrating large with smaller and more widespread urban regeneration projects.*

*As in "The Architect's Dream," the painting by Thomas Cole (1801-1848) that gives form to the dream of a man who, having emigrated from the old to the new continent, imagines in a moment of absolute stillness of sleep the juxtaposition in a perspective of buildings ordered according to canons ranging from Egyptian architecture to Greek rationality to the early Middle Ages and the Renaissance: a dream that can be interpreted as a metaphor for the timeless eternity of great architecture that every architect would like to realize and that we citizens would like to resort to in order to forget the frequent banality of ordinary buildings.*



Photo Credit: Angela Colucci

# KEYWORDS

URBAN RESILIENCE; GREEN  
INFRASTRUCTURES; URBAN  
ENVIRONMENT



[SCh 1] Figure 6. Existing Deciduous and Evergreen Trees. Source: Authors' Elaboration based on the Comune di Milano Database

# [SCh 1] Environmental Analysis and Design Anticipation for Urban Resilience and Human Health

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## 1. Premises

The built environment, conceived as the morpho-typology and the structure of cities, strongly influences the quality of life and the public health (Azzopardi-Muscat et al. 2020).

The worldwide climate change with the increasing of severe weather phenomena (IPCC 2013), such as heat waves and acute rainfalls as well as the concentrations of air pollutants represent relevant criticalities for the health and the psycho-physical well-being of people (Capolongo et al. 2018; Ministero della Salute 2015). Well-being, as defined by WHO, represents the essential element for fostering good livelihoods, building a productive workforce, creating resilient and vibrant communities, enabling mobility, promoting social interaction, and protecting vulnerable populations. Among the different factors of stress in the urban environment, those that have higher impacts on public health and psycho-physical well-being are the exposure to air and soil pollutants, to heat and noise and the loss of a sense of safety during acute rainy.

At the microscale of the neighborhood and the block, these factors of risk can be accentuated by the material composition of the surfaces (of the ground and buildings) as well as by the density of the building. In these terms, the climate and weather conditions directly affecting the human health can be conceived as barriers for the full accessibility and fruition of cities (Tartaglia et al. 2019). The European strategy for GIs (European Commission 2013) has highlighted how ecosystem services (MEA 2005) provided by nature-based solutions (NBS) and Green Infrastructures (GI) represent an effective solution for the reduction of both environmental stress and for the promotion of healthy life. (Mussinelli et al. 2018; Tucci et al. 2019).

## 2. Objectives

The essay aims to outline the potentialities during the decisional and design process related to the predictive evaluation of benefits deriving from the application of NBS and GI in environmental design projects at the urban local scale (neighborhood), with the identification of the impacts on the health and on the psychophysical well-being of the population. In particular, the proposal is focused on the environmental improvement of the public space. In order to assess the benefits deriving from NBS and GI, place-based and site-specific analyses of a selected test-site (Study Area) were necessary to estimate the level of environmental quality existing in the current state. This site-specific approach appears particularly

## ABSTRACT

*Relationship between human health and urban environment is nowadays well known. But, when we intervene locally, it is significant to have a site-specific approach in relation to the environmental and health local issues. In this scenario, it is very important to understand through predictive tools how the different design alternatives reflect on human health and well-being.*



relevant in order to identify priorities and suitable solutions for the improvement of health and safety of population contrasting specific environmental criticalities.

### 3. Methodology

In order to achieve the objective, the essay adopts a design-based approach consisting in: definition of a study area in the city of Milano; place-based and site-specific analysis of the site; development of project based on the adoption of NBS aimed at the improvement of the local environmental conditions; predictive evaluation of the benefits. More precisely, from a methodological point of view, the work was structured following these steps:

- Definition of the Study Area and context analysis;
- Definition of indicators and indices for the measurement and mitigation of environmental criticalities with impacts on health;
- Site analysis according to the selected indicators;
- Design proposal based on the adoption of NBS and GI to improve the environmental quality of public space and predictive quantification and assessment of the benefits generated;
- Evaluation of the results.

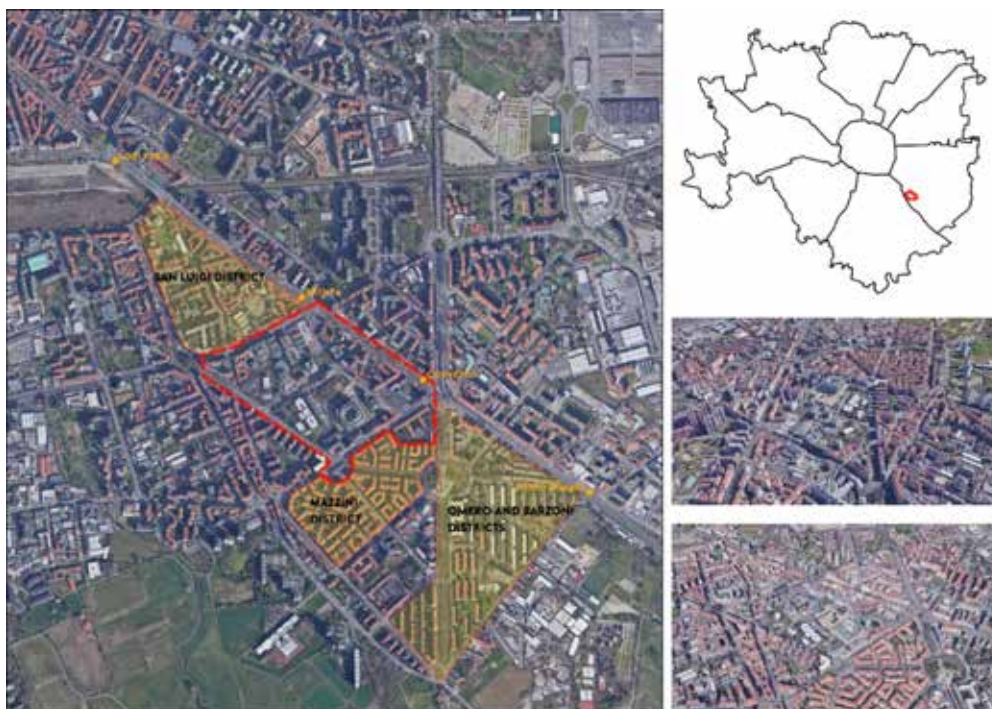
### 4. Definition of the Study Area and context analysis

For the definition of the Study Area, the Research Group has assumed the following criteria:

- Dimensional characteristics: coherency with the neighborhood scale;
- Morpho-typological characteristics: homogeneity of the urban fabric; presence of transformation areas;
- Functional characteristics: high prevalence of public functions (eg. services open to citizens, sport facilities, green areas, etc.); high accessibility to the area through public and private transport; presence of Systems of Public Spaces (SPS)[1].

Based on these general criteria and in coherence with other studies developed by the Research Group on the wider urban sector[2], the Study Area is identified in the context of Milan, more precisely in the South-East sector of the city (Figure 1). Furthermore, the Study Area is also a context where the Municipality of Milan intends to develop a series of interventions on public spaces[3]. The site is defined by four major streets (viale Brenta, corso Lodi, via Polesine and via Mincio) and within the Study Area there are five blocks.

With reference to the morpho-typological aspects, the identified site results clearly discernible from the neighboring districts. Thus, both from the San Luigi District localized on the North and the Mazzini District on the South. Similarly, Via Mincio on the West and Corso Lodi on the East represent borders between the identified area and other neighborhoods with different morpho-typological and functional characteristics. Through the historical cartography of Milan and historical urban planning tools (Prg 1953 and Prg 1980), it is visible that the development of the Study Area started during the second post-war period. With an initial mixed settlement (productive, commercial, and residential) and a further progressive replacement of the production destination with buildings for public services and for tertiary activities since the Sixties (Figure 3).



[Sch 1] Figure 1. Land Albedo and Permeability classification – Current State. Source: Authors' Elaboration.

[Sch 1] Figure 2. Localization of Public Buildings. Source: Authors' Elaboration



[Sch 1] Figure 3. Main building destinations. Source: Authors' Elaboration on Comune di Milano Database



In the current configuration, a significant concentration of public services characterizes the area with the presence in contiguous blocks of schools, municipal offices, and sports facilities. In fact, in the area the following public services area localized: the headquarters of the Municipality 4, Headquarter of the Municipality of Milan, the Civic Theater "Della Quattordicesima", the Schools Marcello Candia, the Lombardini Middle School, the Regional School Office for Lombardy, the municipal swimming pool, the multifunctional structure Polo Ferrara are located (Figure 2). The forecasts for a new student housing of the Politecnico di Milano and the requalification of the municipal market (Mercato Piazza Ferrara) through the "Made in Corvetto" initiative (collaboration between Fondazione Cariplo, Comune di Milano, Fondazione Snam and other institutions) are also significant.

The Study Area covers a surface of about 23 ha (229.841 sqm). With respect to this surface, a taxonomy of the morpho-typological composition of the surfaces has been drawn up.

The applied taxonomy was derived from the Regional Territorial Database (DBTR, 2019) used for the classification of the territory of the Municipality of Milan. Since the database for the Municipality of Milan refers to the year 2012, changes have been made to the classification of the recently transformed/under transformation.

## 5. Definition of indicators and indices for the measurement and mitigation of environmental criticalities

### 5.1. Indicators and indices for the identification of environmental criticalities with impacts on Health

Among the several indicators for the measurement of the potential level of environmental stress of open spaces, this study has taken into consideration those that have directly referable to health and safety of local population (Table 1). In particular, the following indicators have been identified:

- definition of the albedo values of the ground surfaces and of the building envelopes (vertical and horizontal surfaces);
- qualification and quantification of the permeable and impermeable surfaces of open spaces;
- shading provided by buildings;
- air temperature and ground surfaces temperature;
- soil permeability index;

[1] The public space is recognized as a key-factor in urban regeneration processes (Battisti, Mussinelli & Rigillo, 2020). Starting from this assumption, the research focuses on the analysis and the design proposal regarding systems of public spaces (SPS). SPS refers to a taxonomy of public spaces based on spatial and material characteristics (urban axis - streets, elevated roads, etc.; green spaces - gardens, parks and agricultural fringe areas).

[2] In particular, research PRIN 2015 "Adaptive design e innovazioni tecnologiche per la rigenerazione resiliente dei distretti urbani in regime di cambiamento climatico / Adaptive Design and Technological Innovations for the Resilient Regeneration of Urban Districts in Climate Change Regime". The scientific work was conducted by the following Research Units: Università degli Studi di Napoli Federico II (Principal Investigator and local coordinator Mario Losasso), Politecnico di Milano (local coordinator Elena Mussinelli), Sapienza Università di Roma (local coordinator Fabrizio Tucci), Università degli Studi della Campania Luigi Vanvitelli (local coordinator Renata Valente), Università degli Studi di Firenze (local coordinator Roberto Bologna), Università degli Studi Mediterranea di Reggio Calabria (local coordinator Maria Teresa Lucarelli).

[3] The Municipality of Milan, in occasion of the construction of the new Municipal Office in via Sile, has launched a program of interventions for the improvement of urban quality of public spaces. For more information, see: <https://www.comune.milano.it/-/via-sile-aprono-i-nuovi-uffici-comunali-al-corvetto>

- f) vehicular flows per hour;
- g) pedestrian flows per hour;
- h) average concentration of pollutants;
- i) type and the age of tree species.

The measurement of indicators a), b), c) and d) is necessary for the definition of the indices related to the so-called “perceived temperature” during summer. The reduction of the values of these indices implies greater well-being for the population. In particular, the indicator c) is relevant to understand which portions of public space are shaded during the hottest hours in the summer. The measurement of the indicator e) is not particularly relevant for the Study Area, due to the fact that the South-East sector of Milan, where the Study Area is located, is usually not affected by flooding and other problems related to the management of rain water during acute wheatear phenomena. Indicators f) and g) evaluate potential negative mixtures between vehicular and pedestrian paths (Table 2). The measurement of the indicator h), together with the analysis of the data on air pollutants concentrations by the Regional Environment Agency, was necessary to assess the quality of the air at the local level (neighborhood, blocks, and streets). The measurement of the indicator i) allow verifying the potential emission of Volatile Organic Compounds (VOC) by the existing trees. This study did not take into consideration the plant species (grasses and small shrubs) existing in the meadows, potentially allergenic for the human and animal population. With reference to the measurement of the perceived temperature indices, since the operation required complex processing, they have been calculated, in the current and project state, only for a portion of the Study Area.

[SCh 1] Table 1. Indicators/Indexes and Health and Safety Impacts. Source: Authors' Elaboration

Analysis	Indicators	Index	Health and Safety Impacts
Materic Surface Quantification and Qualification, Building Heights	Albedo values quantification	PMV - UTCI- HUMIDEX INDEX	Health Diseases due to Exposure to Extreme Heat
	Measured facade Temperature		
	Shadow casted on public surfaces (streets, square, etc.)		
Data derived from Existing DB	Land Surface Temperature	Run-off index	safety during severe Stormwater
	Permeability Quantification and Qualification		
Vehicular flows, Streets dimensions	number of vehicles per hour	AIR QUALITY INDEX	Health Diseases due to Air Pollutants Exposure, Noise Pollutants Exposure
Pedestrian flows, Walksides dimensions and accessibility	number of pedestrians per hour		
Green Areas Quantification and Qualification	Trees VOC Emission	-	Health Diseases due to VOC Exposure
	Surface of Graminaceous plants and grasses	-	Diseases due to Graminaceous plants and grasses

[SCh 1] Table 2. Dangerous admixture between pedestrians and vehicular traffic in viale Brenta. Source: data collected by Authors through direct surveys on viale Brenta on the 29.04.2019

Time	Pedestrian		Vehicles	
7:30 AM to 9:30 AM	1697		2100	
	North side	South side	North side	South side
	85%	15%	50%	50%
5:30 PM to 7:30 PM	1845		2350	
	North side	South side	North side	South side
	80%	20%	60%	40%

NBS Typologies	Regulation ES provided	Wellbeing ES provided	Socio-Cultural ES provided	Health and Safety impacts
Green Areas (meadows)	Albedo reduction, runoff reduction, air pollutants reduction, Land Surface Temperature, PMV-UTCI HI reduction, AIR QUALITY improvement	physical outdoor activity, reduced depression and anxiety, recovery from stress, positive emotions, enhance of sense of safety		HEALTHY AND SAFETY ENVIRONMENTS
Number and Trees Classification				
Biobasin and Bioswales				
<b>Seminatural Solutions</b>				
High-reflective Pavements	Albedo reduction, runoff reduction, air pollutants reduction, Land Surface Temperature, PMV-UTCI HI reduction	community cohesion and increase of visitors	quality of path, connectivity and linkage with other modes, walking and cycling increase	
Permeable Pavements				

With regard to the design choices for green infrastructure of public space using NBS and semi natural elements (SNE), the considered indicators/indices, mainly related to the measurement of the regulation ecosystem services (ES) (Table 3), are:

- A. Increase of albedo values through the replacement of pavement materials;
- B. Increase of shaded surfaces through tree planting (tree crowns);
- C. Increase in the permeability index;
- D. Reduction in absolute value of air pollutants.

## 6. Site analysis according to the selected indicators

### 1.a Built environment

The building footprint on the ground is almost 31% of the Study Area overall surface, while the open space is under 69% of the overall surface (Figure 4).

### 1.b Open spaces – taxonomy and quantification

The open space was also classified according to public and private ownership. The surface of open spaces in the Study Area consists of 15 hectares, of which the 78% publicly owned. With reference to the public spaces, almost half (55%) is devoted to the road and pedestrian system, the 17% to green areas and the 21% to access systems and courtyard areas serving the existing public buildings. The remaining 9% of public spaces is represented by a free area, still without a definitive destination (Figure 5)

### 1.c Open space - Spatial and environmental analysis

Particular attention was paid to the accessibility and usability of the public green areas, which represent the outdoor places where commonly physical activity is mostly carried out.

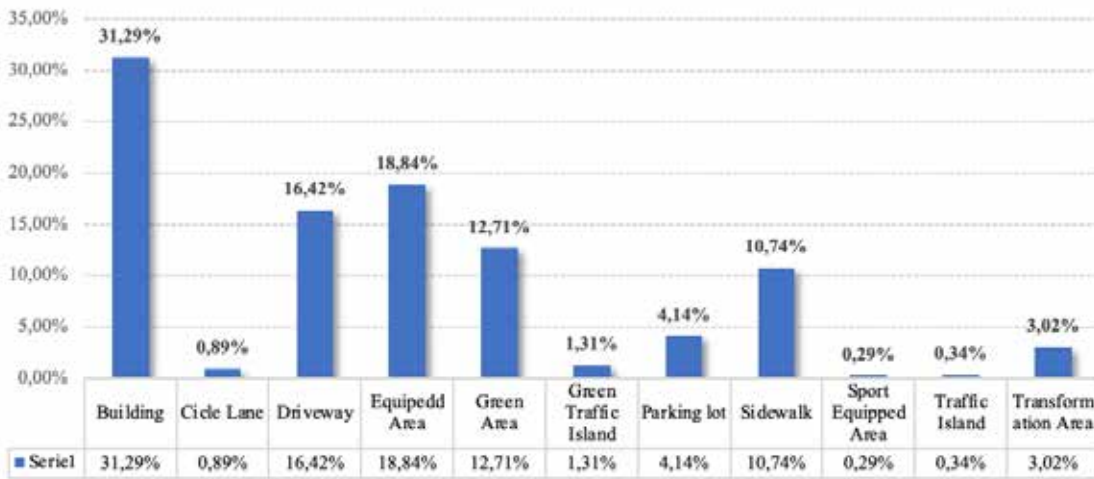
According to the conducted analysis, it emerged that all the gardens belonging to public buildings are fenced and not usable for outdoor activities. Furthermore, two thirds of these are pertinent to sensitive public functions (e.g., schools and elderly house). With reference to the additional public open spaces such as by the driveways and sidewalks, three types of analyzes were developed.

The first concerned the material consistency (albedo) and the permeability of the surfaces. The outcome of this analysis highlighted that the surfaces with albedo included in the value ranges between 0.04-0.12 represent the 68%, those between 0.13-0.25 the 27% and those between 0.26-0.55 the 4% of the total surface[4]. Moreover the 83% of the surfaces is not permeable[5].

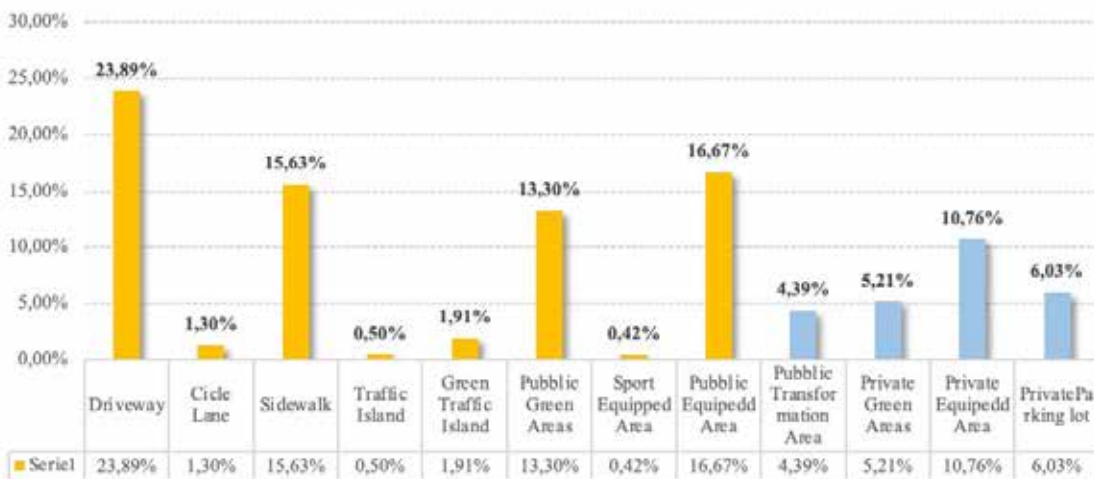
[4] The albedo analysis was conducted elaborating Comune di Milano Database with a classification of the ground surfaces according to three thresholds of albedo values related to the superficial materials.

[5] The permeability was conducted elaborating Comune di Milano Database with a classification of the ground surfaces according to the three levels: not permeable, semi-permeable, permeable.

[Sch 1] Figure 4. Land use Classification and Quantification. Source: Authors' Elaboration based on the Comune di Milano Database



[Sch 1] Figure 5. Quantification and Qualification of the Public and Private Surfaces. Source: Authors' Elaboration based on the Comune di Milano Database



[Sch 1] Figure 6. Existing Deciduous and Evergreen Trees. Source: Authors' Elaboration based on the Comune di Milano Database

The second analysis concerned the vehicular capacity of the roads[6]. The data by the PUMS were also corroborated by on-site surveys carried out in 2019 that for example in the street that defines the North limit of the area stressed the passage during the rush hours of approximately 2.100 vehicles and 1.700 pedestrians per hour. The pedestrian traffic flows to the public transport hubs in the Study Area were also analyzed. The third concerned the amount of shading on the surfaces of public open spaces during the summer period[7].

### **Environmental analysis - trees**

Trees were surveyed on all public open spaces (map of the green heritage of the Municipality of Milan, 2019). In Study Area, about 43% of the trees are localized along two major streets that define the East and South sides of the area. The remaining trees (including the 19 evergreen species) are planted in green areas located near public buildings (Figure 6 and Table 4). The conducted analyzes on the public open spaces enhanced the construction of the cognitive framework of the potential critical issues regarding the urban microclimate, air quality and rainwater management.

### **7. Design Proposal based on the adoption of NBSs and GIs to improve the environmental quality of public space and predictive assessment of the benefits generated**

The proposed green infrastructure of the Study Area, in coherence with the first hypothesis pointed out by the municipality, involved most of the streets and the large municipal area, located in the central block, through the planting of new trees.

Two internal streets have been redesigned for mainly pedestrian functionality. Two parking lots guarantee the possibility of parking cars: one private for public use (a market parking at the North East of the area, the other public, located at the South East. The new trees are planted between the driveways and the walkways. Moreover, the new trees along the roads are protected at the base with cast iron closures (tree pits). In the street on the North side (viale Brenta), in addition to the planting of trees, a hedge system is planned to protect the cycle lane located between the roadways. As regards the vacant area, a high-density tree plant system is forecasted, in line with planting practices already present in other parks in the city of Milan.

In total, the pilot project envisaged the planting of about 370 new trees, of which about 270 on public roads and about 100 for the construction of the park.

The projects doubles the arboreal heritage of the Study Area.

In addition to tree planting, bio-basins for infiltration and retention of rainwater coming from walkways and driveways (feature areas) were planned. The planting of shrubs able to withstand both long periods of drought and submersion during acute rainy phenomena has also made it possible to improve the interception of air pollutants at road level, to increase the flora and fauna biodiversity, to increase the quantity of CO<sub>2</sub> absorbed and sequestered as well as to improve the aesthetic quality of the streets.

Furthermore, other technological solutions were used to improve the environmental quality of the Study Area. With references to the paved surfaces of public streets, materials with high reflectance and permeability index (pervious concrete) have been designed. In addition, in the buffer area between the new headquarters of the Comune di Milano, a water blade has been provided with the function of a misting fountain capable of mitigate temperatures during the hottest hours of the summer.

The measurements of the benefits deriving from the use of NBS and GI were developed with respect to the main regulation ES (Tables 5 and 6). Of course, for better understanding and predictive ability further additional indicators and index could be implemented.

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[6] Data deriving from PUMS 2019.

[7] Analysis conducted with Archicad software set on 21 July at 4:00 pm.

[Sch 1] Table 5. Tree Planting. Indicators and values for ES quantification. Source: Authors' Elaboration

Project site Location					ES Regulation Indicators									
					Energy Saving		Pollutants Removal				Climate change effects reduction		Rainwater Management	
					Energy Saving KWh (*)		Pollutants Removal (**)				CO2 (***)		Rainwater Canopy Interception (****)	
					KWh/ tree *year	KWh/tree *year	KWh/tree*year				Kg CO2eq.* tree/year	Kg CO2eq.* tree/year	l/* tree/year	KgCO2eq./ mc* year
							O3	PM10	SO2	NO2	Co2eq	assimilated		
U.M.		Nr.	m											
			Tree height when planted											
Celtis Australis	Viale brenta-	36	8/10	Low	136	66,4904	0,13	0,143	0,265	0,186	55,428	325	2150	0,5418
Liquidambar styraciflua	Via Oglio	89	8/10	Low-medium	136	66,4904	0,13	0,127	0,35	0,11	32,78	320	1450	0,3654
Tilia cordata	Parco Comunale	98	4-6	Low	136	66,4904	0,3	0,152	0,32	0,11	32,78	231	2000	0,504
Pyrus calleryana	Via Sile-GamboloParkingMarket viale Brenta corso Lodi	111	4-6	Low-medium	67	32,7563	0,05	0,05	0,1	0,05	14,9	84	200	0,0504
Prunus CerasiFERA Pissardil	Parking via Sile	39	4-6	Low	67	32,7563	0,05	0,05	0,1	0,05	14,9	77	200	0,0504
Photinia red Robin	Viale Brenta	80	1,8	Low			0,08	0,05	0,1	0,09	26,82	23		
(*)	Values defined from Scientific Literature (CNT, 2010; McPherson E., et Al., 2006).CO2eq production value. per KWh produced it is assumed to be 0.4889 Kg (ISPRA 2017)													
(**)	The unit values were taken from the qualiviva database and from the simulation made with the I-Tree eco v.6 software on the project area. For the determination of the CO2 equivalent, the assumed value is 298 Kg of CO2 eq. per kg of NO2 removed (IPCC, 2007)													
(***)	The unit values of CO2eq per year were taken from the qualiviva database and averaged from past simulations made with the I-Tree eco v.6 software on the project area													
(****)	The unit values were taken from the simulation made with the I-Tree eco v.6 software on the project area and reported to the average ten-year rainfall (1086 mm of rain / year) measured by the ARPA control unit via Juvara, Milan station ID 502 . For the calculation of the CO2 equivalent, the value of 0.252 Kg / mc * year was taken from the analysis of the carbon footprint of the company CAP Holding SPA for the years 2016 and 2017 (CAP Holding, environmental balance), referring to the activity rainwater treatment (networks and purifiers).													

[Sch 1] Table 6. Bioswales-Grass-Meadows and Semi-permeable surface. Indicators and values for ES quantification. Source: Authors' Elaboration

Project site Location				ES Regulation Indicators									
				Pollutants Removal					Climate change effects reduction		Rainwater Management		
				KWh/tree*year				Kg CO2eq.* tree/year	Kg CO2eq.* tree/year	l/* mq/year		KgCO2eq./ mc*year	
				O3	PM10	SO2	NO2	CO2eq avoided	CO2 Assimilated	average rainfall * coeff. runoff	CO2eq avoided		
U.M.	mq												
Bioswales	2550	Viale Brenta- Vie Oglio-Sile-Gambolota-Polesine	depression consisting of grassing and planting of small and medium-sized carpeting shrubs resistant to periods of drought and temporary flooding	0,004492	0,0006490	0,001982	0,002329	0,694042	0,25	1016	0,256032		
Grass and meadow	6785	New designed Park	Grass and Meadow	0,002871	0,0005570	0,001118	0,001465	0,43657	0,16	1016	0,256032		
Semi-permeable Surface	24327	Viale Brenta- Vie Oglio-Sile-Gambolota-Polesine	Streets-Walkside							304,8	0,0768096		
(*)	Values taken from scientific literature (CNT, 2010; McPherson et al., 2005) for the type of bio-basin planted with small and medium-sized shrubs. For the determination of the CO2 equivalent, the assumed value is 298 Kg of CO2 eq. per kg of NO2 removed (IPCC,2007)												
(**)	The unit values were deduced with respect to the average ten-year rainfall (1086 mm of rain / year) measured by the ARPA control unit via Juvara, Milan station ID 502 and a prudentially set runoff coefficient equal to 0.8. For the calculation of the CO2 equivalent, the value of 0.252 Kg / mc * year was taken from the analysis of the carbon footprint of the company CAP Holding SPA for the years 2016 and 2017 (CAP Holding, environmental balance), referring to the rainwater treatment (networks and purifiers).												

## 8. Evaluation of the results

### 8.1 Improvement of urban microclimate - Reduction of the effects of albedo - Increase in permeability and shading of surfaces

With respect to the pilot project, the surfaces subject to material replacement and albedo variation were measured. In the current state, the surfaces with albedo included in the value ranges between 0.04-0.12 represent the 68%, those between 0.13-0.25 the 27% and those between 0.26-0.55 the 4% of the total surface of the Study Area. The use of high-reflectance surfaces (albedo between 0.26-0.55) for the reconstruction of the pavement and roads (viale Brenta, via Oglia, Via Sile and via Polesine) and of the two parking lots has resulted in a greater reflective surface (+13%) (Figures 7, 9 and 10).

The replacement of these surfaces with semi-permeable pavements (sidewalks, roads and parking lots), new trees and grassy areas (new park and bio-basins) has considerably increased the percentage of rainwater drainage on the Study Area (Figure 8, Tables 7 and 8). The study included the quantification of the number of liters infiltrated into the soil and the amount of avoided CO<sub>2</sub> emissions (CO<sub>2</sub>eq) into the atmosphere due to minor use of the sewage and rainwater purification system on the basis of the annual precipitation media. (Table 8).

The planting of tree species on the selected streets, as well as the forestation of the municipal area included in the block made it possible to implement the amount of shade produced by the trees during the summer phase. The ability to mitigate the temperature of the air and of the surfaces due to shading was considered in the time interval of 25 years (Figure 11), the time necessary for the trees to reach maturity.

### 8.2 Improvement of the urban microclimate - Measurement of perceived temperature indices

The evaluation of this environmental aspect concerned only an in-depth study on one East West street (viale Brenta).

The first adopted methodology aimed at the simulation of the urban microclimate was used to understand the effects of the urban heat island on this axis.

The methodology for determining the benefits generated by the green infrastructure with reference to the actions aimed at facing the UHI, was based on the different measurements between the current state and the project state of the Ta (Air temperature), Hr (Humidity ratio) indicators and the thermal comfort Universal Climate Thermal Index (UCTI).

The ENVI-Met software (version 4.4) was used for the elaboration of the modeling of the area (current and project status) as well as for the measurement of the indicators and indices described above.

The measurement of the PMV (Predicted Mean Vote) and UTCI indices was carried out by setting, as input data, the biophysical parameters of the people as follows: age 65, male sex, weight 75 Kg, height 1.75 m, static isolation of the clothes (Static Clothing Insulation, CLO): 0.20, walking speed 1.0 m/s. The indicators and indices were calculated and measured in the hottest hours of the day 21.06.2018 (from 14:00 to 18:00) (Figures 12 and 13).

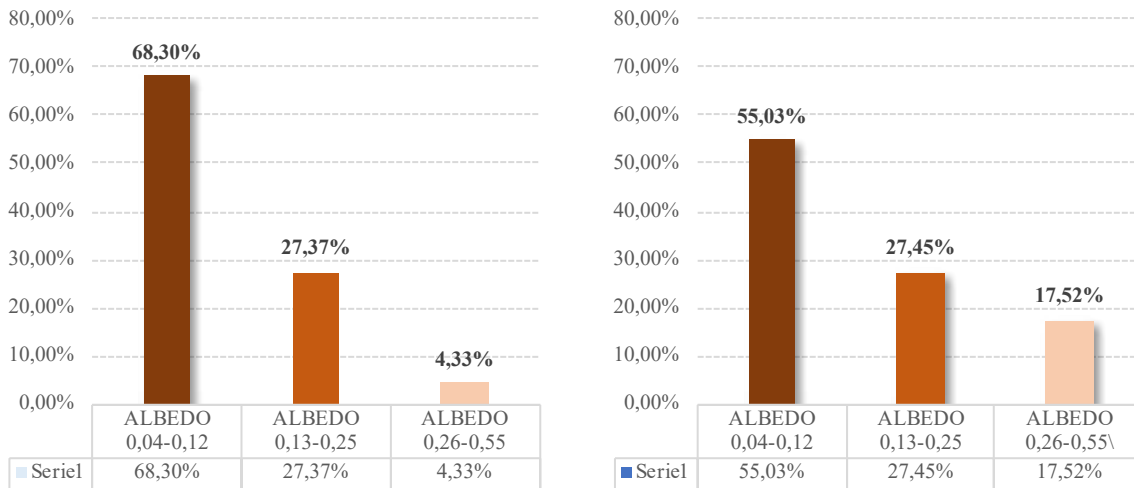
### 8.3 Air pollutants removal

The quantification of air pollutants removed was calculated by applying the UFORE (Urban Forest Effects) model to the new plantations planned on the Study Area.

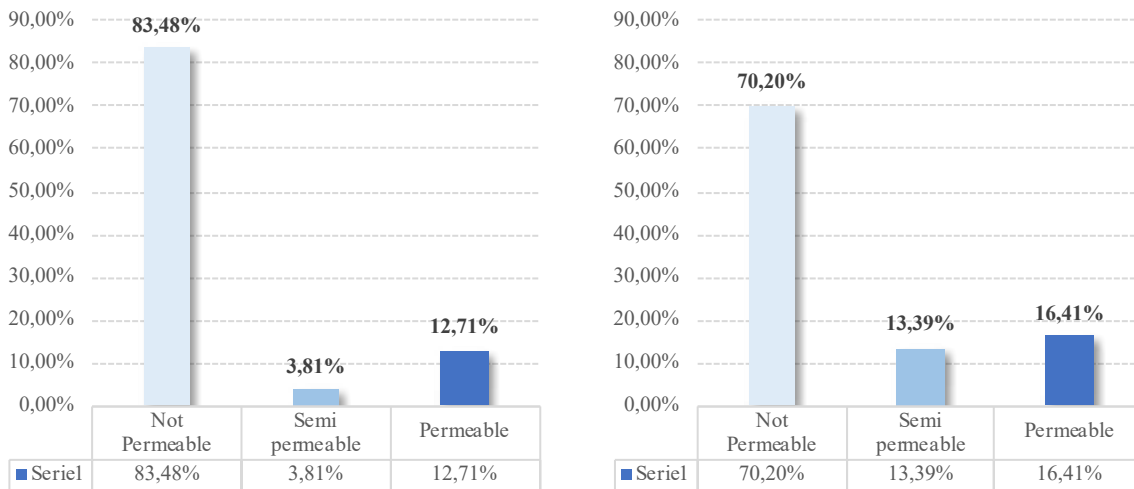
Through the use of the I-Tree software (I-Tree Version 6.1.37) and of the table information (Qualiviva Database, 2015) it was possible to define, with respect to the planned NBS, the removal (kg/year) of the major air pollutants (Table 9) generally investigated as causes of disease.



[SCh 1] Figure 7. Albedo Classification and Quantification in Current State (Left) and in the Project State (Right). Source: Authors' Elaboration



[SCh 1] Figure 8. Permeability Classification and Quantification in the Current State (Left) and Project State (Right). Source: Authors' Elaboration



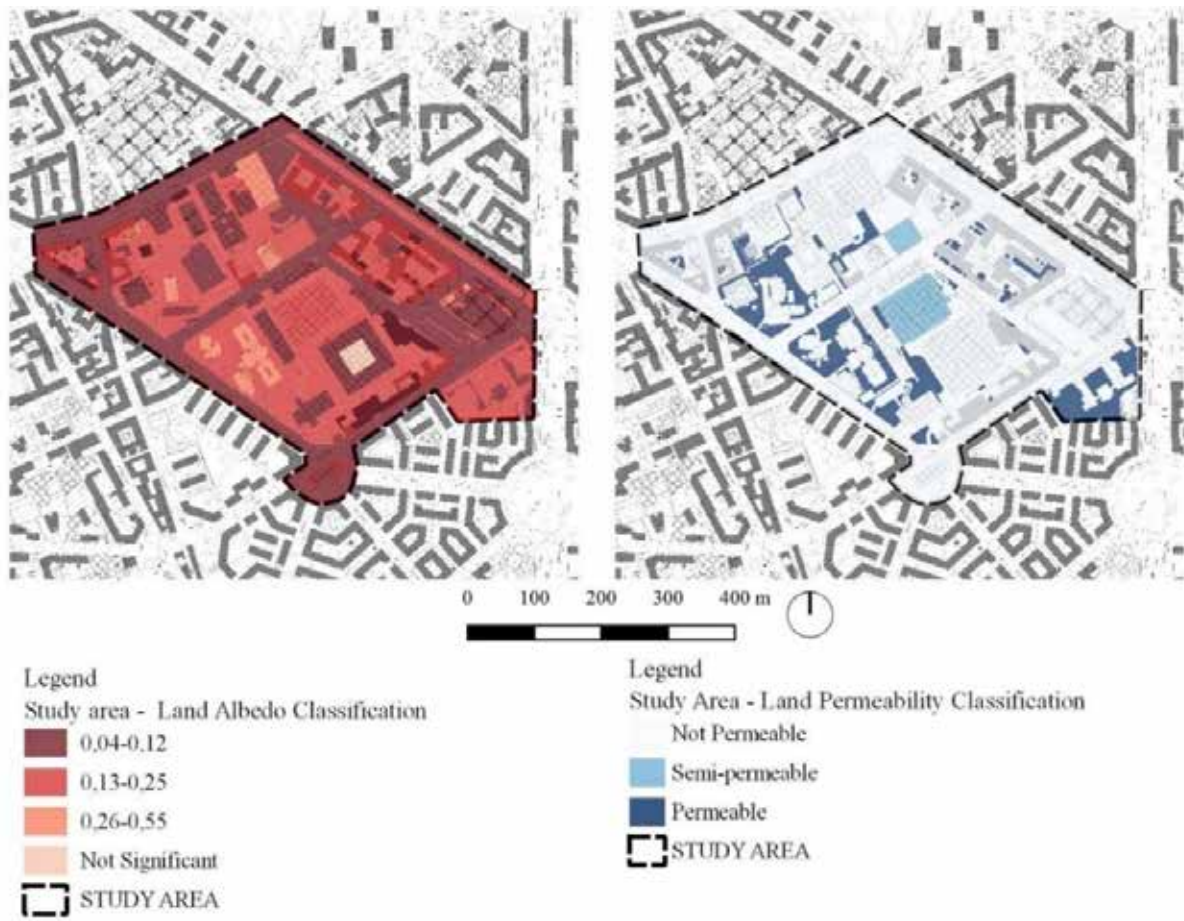
[SCh 1] Table 7. Run-off Calculation related to Tree Planting. Source: Authors' Elaboration

Tree planting. Sustainable Rainwater Management - Run-off Calculation					
		Run-off through crowns of trees		Avoided emission of CO2 (CO2 eq.)	
		l/anno*tree	l/year	KgCO2eq./tree*year	KgCO2eq./year
Celtis Australis	36	2150	77400	0,5418	19,5048
Liquidambar styraciflua	89	1450	129050	0,3654	32,5206
Tilia Cordata	98	2000	196000	0,1575	15,435
Pyrus calleryana	111	200	22200	0,0504	5,5944
Prunus Cerasifera Pissardii	39	200	7800	0,504	19,656
<b>TOTAL</b>	<b>373</b>		<b>432.450</b>		<b>92,7108</b>

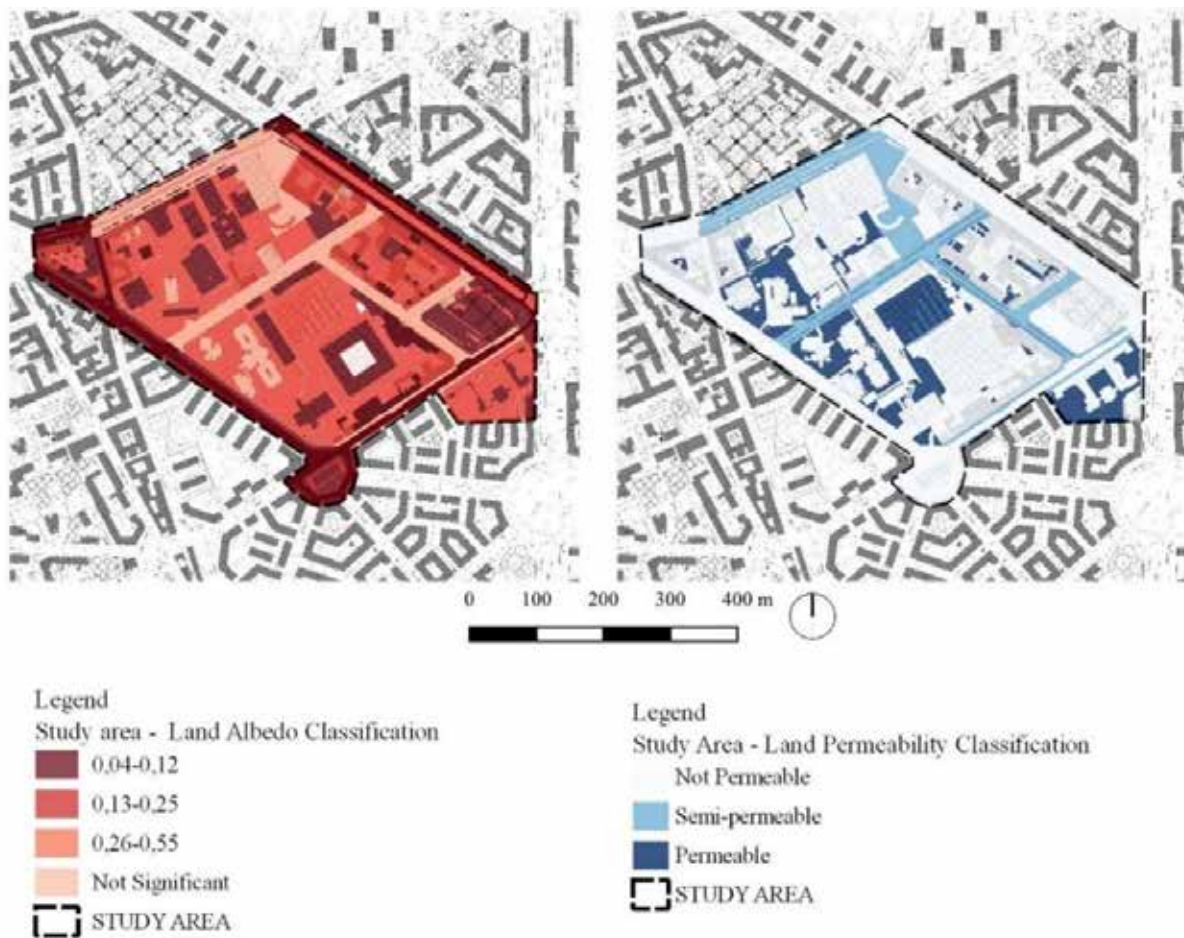
[SCh 1] Table 8. Run-off Calculation related to Rainwater Sustainable Management. Source: Authors' Elaboration

Sustainable Rainwater Management - Run-off Calculation					
		mm/year	l/year	KgCO2eq	
				run-off index (*)	Mean Annual Rainfall
Bioswales	2550	1	1013	2583150	650,9538
Grass and meadow	6785	1	1013	6873205	1732,04766
Semi permeable surface streets	13269	0,3	1013	4032449,1	1016,177173
Semi permeable surface walkside	11058	0,3	1013	3360526,2	846,8526024
<b>Tot surface in study area</b>	<b>33.662</b>			<b>16.849.330,3</b>	<b>4.246,031236</b>

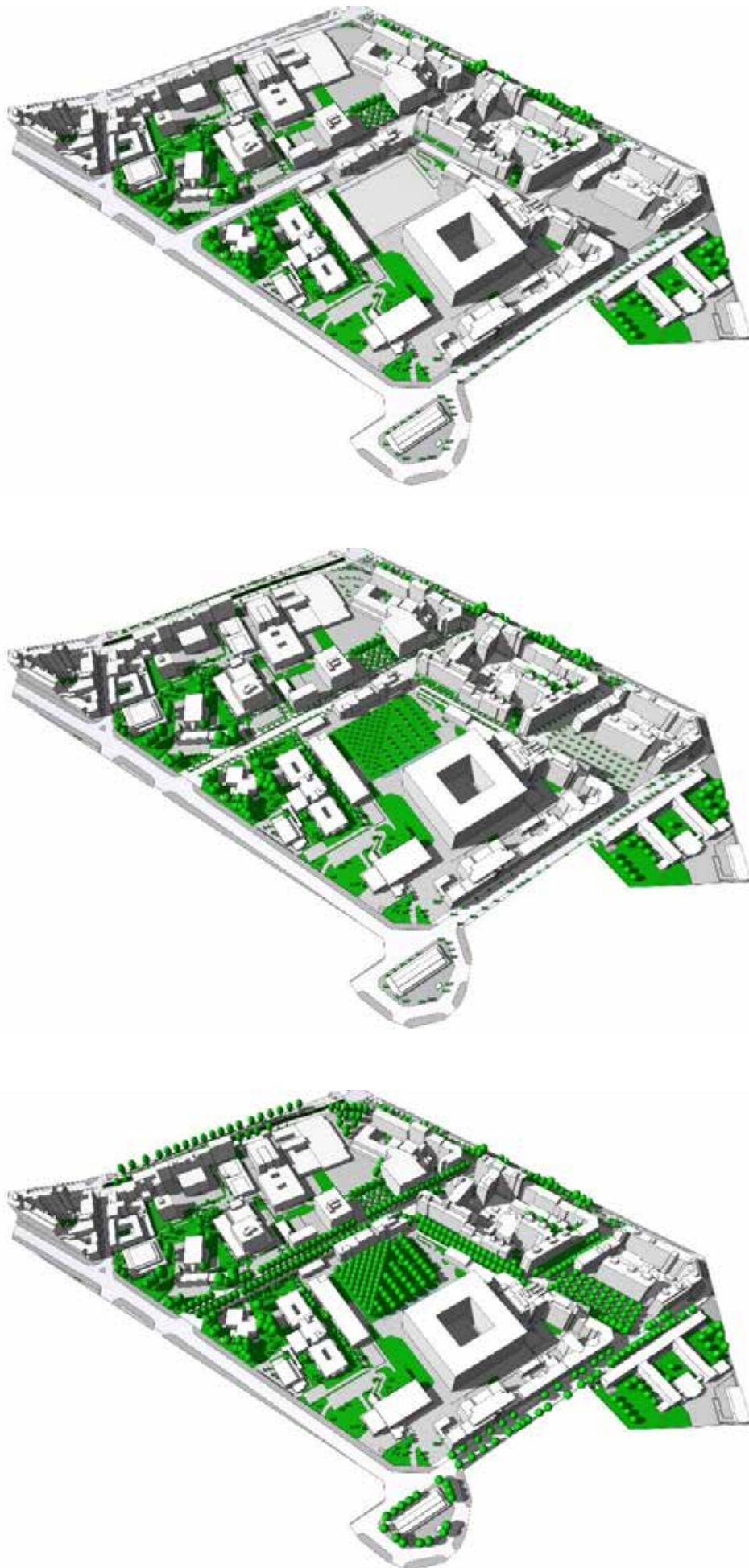
[Sch 1] Figure 9. Land Albedo and Permeability classification – Current State. Source: Authors' Elaboration



[Sch 1] Figure 10. Land Albedo and Permeability classification – Project State. Source: Authors' Elaboration



[Sch 1] Figure 11. Arboreal Heritage in the Study Area in the Current Status (A), in the Project Status at T=0 years (B) and in the Project Status at T=25 years (C).  
Source: Authors' Elaboration



## 8.2 Improvement of the urban microclimate - Measurement of perceived temperature indices

The evaluation of this environmental aspect concerned only an in-depth study on one East West street (viale Brenta).

The first adopted methodology aimed at the simulation of the urban microclimate was used to understand the effects of the urban heat island on this axis.

The methodology for determining the benefits generated by the green infrastructure with reference to the actions aimed at facing the UHI, was based on the different measurements between the current state and the project state of the Ta (Air temperature), Hr (Humidity ratio) indicators and the thermal comfort Universal Climate Thermal Index (UCTI).

The ENVI-Met software (version 4.4) was used for the elaboration of the modeling of the area (current and project status) as well as for the measurement of the indicators and indices described above.

The measurement of the PMV (Predicted Mean Vote) and UCTI indices was carried out by setting, as input data, the biophysical parameters of the people as follows: age 65, male sex, weight 75 Kg, height 1.75 m, static isolation of the clothes (Static Clothing Insulation, CLO): 0.20, walking speed 1.0 m/s. The indicators and indices were calculated and measured in the hottest hours of the day 21.06.2018 (from 14:00 to 18:00) (Figures 12 and 13).



[Sch 1] Figure 12. UCTI Simulation of the Current Status at 16.00 pm of 21.06.2018. Source: Authors' Elaboration - ENVIMET Simulation



[Sch 1] Figure 13. UCTI Simulation of the Project Status at 16.00 pm of 21.06.2018. Source: Authors' Elaboration - ENVIMET Simulation

[Sch 1] Table 9. Removal of Air Pollutants through Tree Planting. Source: Authors' Elaboration

Tree planting. Removal of Air Pollutants										
	Nr.	Pollutant removed per unit								C02eq 298 Kg C02/Kg N02
		O3		PM10		S02		N02		
		Kg/tree*year	Kg/year	Kg/tree*year	Kg/year	Kg/tree*year	Kg/year	Kg/tree*year	Kg/year	
Celtis Australis	36	0,130	4,68	0,143	5,148	0,265	9,540	0,186	6,696	1995,408
Liquidambar styraciflua	89	0,13	11,57	0,127	11,303	0,35	31,150	0,11	9,790	2917,420
Tilia Cordata	98	0,3	4,9	0,152	14,896	0,32	31,360	0,11	10,780	3212,440
Pyrus calleryana	111	0,05	14,43	0,05	5,550	0,1	11,100	0,05	5,550	1653,900
Prunus Cerasifera Pissardii	39	0,05	11,7	0,05	1,950	0,1	3,900	0,05	1,950	581,100
<b>TOTAL</b>	<b>373</b>		<b>47,280</b>		<b>38,847</b>		<b>87,050</b>		<b>34,766</b>	<b>10.360,268</b>

## 9. Conclusions

The paper presents the first outcomes of applied research consisting in a design-based experimentation, investigating the relationship between some solutions for the implementation of urban resilience and the health and safety of population. Each NBS provide specific Ecosystem services (regulation, socio-cultural, etc.) that impact on urban environment and thus on health. The applied methodology reveals the importance of site-specific analysis and site-specific design solutions. Indeed, it should be noted that the impact of design solutions on environment and health can significantly vary, due to specific local conditions, at the micro-scale. It is therefore necessary to integrate predictive tools in the design process in order to optimize the impacts of transformations with respect to the real problems encountered not only at the territorial level where policies pay more attentions. The predictive tools that implies simulations at the micro-scale are in these terms particularly important, helping designers and decision-makers in optimizing the solutions, overpassing only quantitative approach and supporting site-specific approaches. Therefore, guidelines promoted by local authorities for interventions on urban open spaces, based on a site-specific design approach that include predictive assessments, would be particularly important in order to foster a virtuous process of regeneration of urban contexts.

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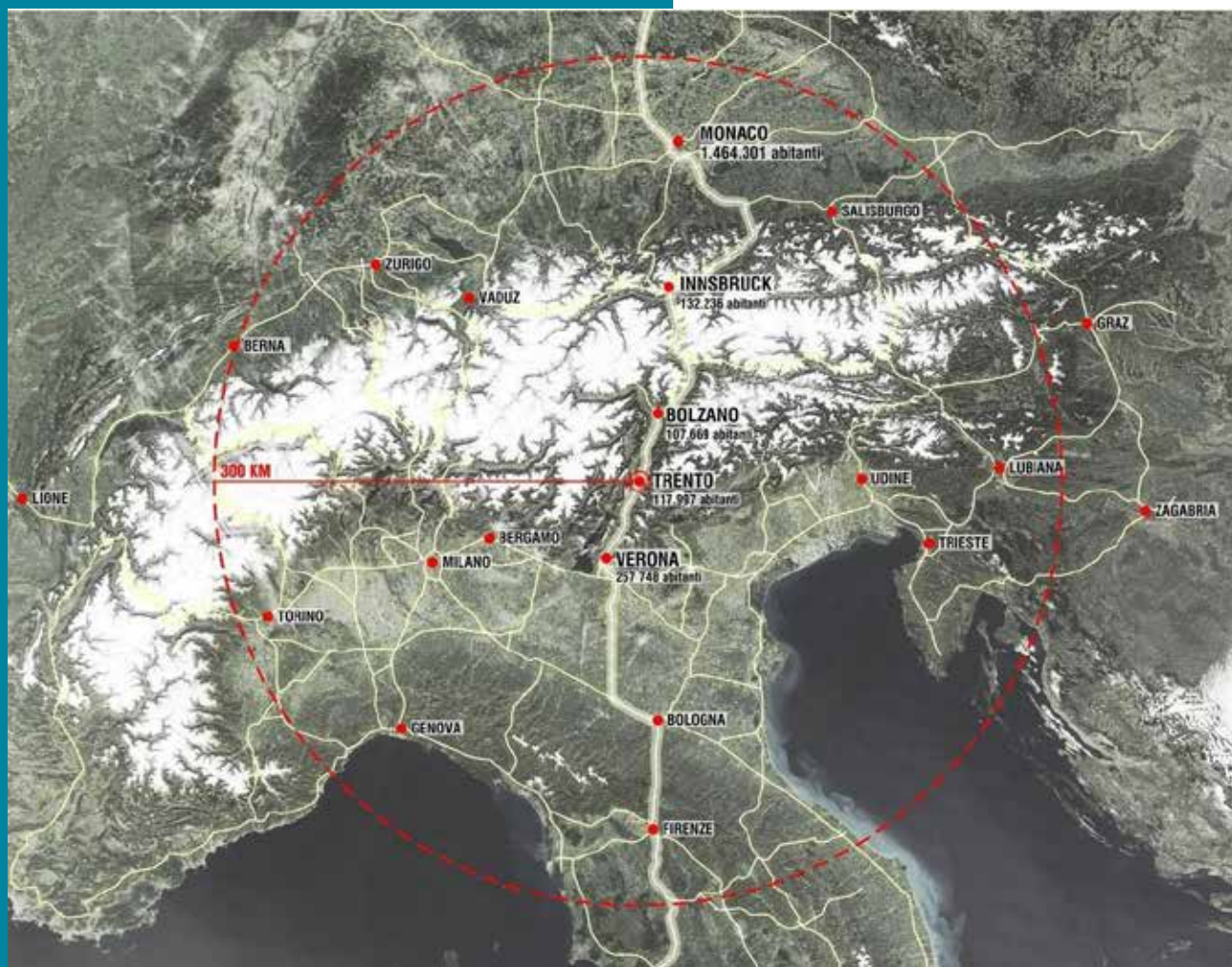
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# KEYWORDS

RESILIENCE; SLUMS; CHILDREN;  
INFORMALITIES; GREEN SPACES



[Sch 2] Figure 1. Trento Alpine city. Source: graphic elaboration by Mannocci S., 2019.

# [SCh 2] Trento Urban Transformation. Designing Healthy Cities through Adaptive Urban Planning

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## 1. Background

The drastic decrease in non-renewable natural resources and the negative effects of the climate crisis have made the environmental issue central to debates about the evolution of the 21st century city. In fact, the impacts of global warming are particularly evident in the urban environment: heat waves, flash storms, unexpected fires and hurricanes are increasingly common events that exacerbate existing problems in more urbanized areas, compromising the safety and well-being of citizens. According to the recent United Nations Department of Economic and Social Affairs scenarios (UN DESA, 2019), the global population was less than 1 billion people until the 1800s; by 1930 it had doubled, and 30 years later it reached 3 billion. By the millennium it had reached 6 billion, and by 2015 it measured more than 7 billion. Now, the world's population is expected to increase from its current figure of 7.7 billion to reach 8.5 billion in 2030, 9.7 billion in 2050 and 10.9 billion in 2100, with most of the projected growth expected in urban areas (EEA, 2019). The exponential growth of the global population has produced an increase in anthropogenic pressure on the territories, causing what is called "Great Acceleration" (Steffen et al., 2011; Steffen et al., 2015): since 1950, the changes occurring to the Earth System are directly related to anthropogenic actions that have induced a very rapid and profound change in terrestrial conditions (e.g., temperature rise, loss of biodiversity, mass extinctions, water stress). The change is occurring on such a scale that human activities have significantly altered the Earth system since the Holocene leading to a new human-dominated geological epoch called the Anthropocene (Waters et al., 2016). The United Nations' report "Cities and Climate Change" states that 75% of global CO<sub>2</sub> emissions are produced in urban environments and are largely caused by transportation and buildings. These data show the central role played by cities: they

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### Attribution

The research, the themes and the structure of the contribution and relative conclusions have been elaborated collectively by the authors. Coordination of the T.U.T. research project: Mosè Ricci. The affiliations of the paragraphs are as follows: 1, 4.2, and 4.3 Silvia Mannocci; 2, 2.2, 2.3, 3, 4, and 4.1 Anna Codemo; 2.1 and 5 Sara Favargiotti

## ABSTRACT

*Urban areas constitute key hubs of interventions to drive towards sustainable development: affordable housing, mobility, provision of services, ageing, urban health, social segregation, environmental footprint, and climate action have been shaping urban transformation with unpredictable scenarios. Such challenges require an update of urban planning tools, which need to mirror the complexity of urban patterns and to enhance their capacities to focus on multiple pathways and plurality of goals.*

*The paper presents the research conducted by the Trento Urban Transformation (TUT) research group at the University of Trento as scientific support to the revision of the General Urban Plan of Trento, an alpine city in the north-east of Italy.*

*The research project aims to propose innovative, adaptive, and incremental planning tools to allow flexibility, preparedness to extreme events, and capacity to learn from the past.*

*The proposed city plan draws on a new vision, namely "Trento Leaf Plan". It defines a strategic vision to cope with urban challenges for a healthier and more resilient habitat.*

*The paper introduces the general approach proposed, and focuses on three tools that have been experimented to shift from a quantitative system based on control to a metabolic, interdisciplinary, and multiscale plan: spatially explicit vegetation and ecosystem services models, the figure of chief resilient officer and integration of environmental criteria in planning tools.*



are the main reason for environmental crises, but at the same time they experience the negative effects of these crises and therefore can become priority places to act to provide solutions. As Curitiba Mayor Jaime Lerner stated, "Cities are not the problem; they are the solution." (Planning Report, 2007). At the international level, the adoption of strategies and goals enshrining the need for a more responsive urban development aims to implement the adaptive capacity and the transformation into inclusive, safe, resilient, and sustainable environments at the local level (SDG, 11). The ability of cities to cope with major changes is called urban resilience, which is defined as 'the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience' (Resilient cities network, 2021). The introduction of the term resilience in the vocabulary of urban planning and architecture established a novel systemic and dynamic understanding of urban processes. In this view, the traditional objectives of urban planning aiming at ensuring "an urban life that is at the same time beautiful, healthy, comfortable and economical" (Piccinato, 1938) are combined with the research of models solving the environmental crisis, in the context of constantly changing contemporary cities. Thus, an interdisciplinary and interscalar approach is introduced in spatial planning, to understand the dynamics of the urban environment and to overcome the dualism of humanity and nature. Such approach constitutes the trigger to the necessary ecological transition, guided by the concept of biophilia defined by Wilson as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). Particularly, the principles of Biophilic Urbanism propose approaches in which urban planning and design processes are influenced by the beneficial qualities of nature. To this end, the regeneration of the urban environment is developed through nature-based, climate positive, and sustainable urban areas for healthier communities (Tabb, 2021). From this point of view, the resilient approach aiming at ecological transition based on biophilic design is an effective response to a state of emergency and an opportunity to reinterpret what we have already planned by proposing new ways of intervention in the urban context. The Trento Urban Transformation (TUT) research project of the Department of Civil, Environmental and Mechanical Engineering (DICAM) of the University of Trento provided scientific support to the revision of the General Regulatory Plan, PRG, initiated by the technical offices of the Municipality of Trento. For the TUT research project, an interdisciplinary group was established, composed of professors and researchers with expertise in urban planning, architecture, landscape planning and environmental engineering. In this framework, the research project aims to investigate and test new approaches to urban planning and new design devices for an "open urbanism" (Sennet, 2020), i.e. able to build a flexible environment, not overdetermined or completely defined a priori, able to overcome the rigidities of traditional urban regulation and able to respond in an adaptive manner to the challenges due to the environmental crisis and pandemic; to preserve the benefits of coexistence in the city but avoid the most dangerous threats.

This contribution reports the ongoing activities of the TUT research group and focuses on a twofold objective: the creation of a flexible and open vision for the city of Trento and the development of tools and strategies to trigger processes of ecological transition to improve citizens' health and well-being. Specifically, the paper focuses on the development of a methodological approach to integrate climate-related issues, including health and wellbeing, in the current planning practices. The proposed method aims to constitute a shift from the traditional plan based on zoning and standards to performative planning tools capable of addressing the current global and local challenges.

## 2. Trento: alpine city in global urban challenges

The study is carried out in Trento, an alpine city of around 120,000 inhabitants in the north-east of Italy (Fig. 1). The city lies along the Adige valley and is surrounded by mountains. The urban development has been strongly influenced by topography: urban areas are located in the valley floor, while small villages and large natural environments are in the hillsides.

The urbanization of the valley floor has been increasing and leading to problems such as urban heat island effect and stormwater management issues. Despite the increasing urbanization, several areas have been abandoned due to the disposal of several activities, generating urban void and degraded spaces. Thus, urban, and peri-urban development increased land consumption, negatively affecting biodiversity, accessibility and wellbeing. Such challenges, combined with the global ones, constitute a complex system of issues that need to be integrated in the local planning practices.

The Province of Trento promoted studies to acknowledge the climatic condition of the area and to develop its climatic variability. The good system of datasets and their relative studies allowed the definition of trends and possible future scenarios. The topography influences the climatic conditions, being responsible for example of the thermal inversion in summer. In general, a growing trend of temperature is evident in the last 150/200 years, while minor changes have been detected in the precipitations (Codemo et al., 2018). Moreover, Eccel (2015)

reported a drier climate, mainly due to temperature increase. In the city of Trento, the mean temperature trend is increasing, especially in the last decades, and many stations registered an increase of maximum temperature. However, so far, the index of heat waves has not been increasing. The simulations of future trends show a decrease in precipitation and in rainy days, and an increase of mean and maximum temperatures. Moreover, consecutive dry days are expected to increase as well as summer days (Eccel et al., 2016).

## 2.1 Trento: a landscape in landscapes

In 2000, the European Landscape Convention defined “Landscape” as “an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (ELC, 2000). The human and social perception of the anthropic landscape is placed at the center of the interpretation as well as of the actions in the territory.

Accordingly, landscape design is a valuable resource for regenerating, restoring, and renewing urban, peri-urban, and rural areas, often obsolete or abandoned. Land recovery and transformation processes find an opportunity in urban agriculture to improve the quality of life in cities, interpreting the abandoned areas as reserves capable of managing climatic, ecological, and social complexities. Indeed, natural areas offer unique and precious resources for cultivating biodiversity by providing ecosystem services and public space of quality and happier lifestyles.

The biodiversity loss has significant impacts to health and well-being. Numerous studies have investigated the impacts of climate change on biodiversity and on human health based on the concept of biophilia intended as the “the innately emotional affiliation of human beings to other living organisms” (Wilson 1993, p. 31).

Natural areas and ecosystems can contribute positively to human health in various ways, such as:

- I. by providing ecosystem benefits and services that sustain life and regulate against detrimental health effects from climate, floods, infectious diseases, etc.;
- II. as botanical sources for both traditional and modern medicines; and
- III. by providing direct benefits to physical, spiritual, and mental health through time spent in nature (MacKinnon et al. 2019).

Integrating climate change, biodiversity and human health requires new methodological and operational approaches based on inter-and-transdisciplinary working. Thus, a change of perspective is necessary, based on values such as social integration, climate adaptation, enhancement of environmental and ecosystem services (protecting against erosion, facilitating pollination, supporting tourism and biodiversity) in a perspective of sustainable development and circular economy for urban regeneration.

Within this perspective, TUT research promotes an urban plan and design methodology with the care, promotion, and management of landscape at the center. Indeed, Trento's urban challenges consist of the valorization of landscapes through the preservation of natural ecosystems, the regeneration of “marginal” areas and the promotion of multifunctional landscapes for community, microclimate, productivity, and excellence.

A change of perspective in the opposed relations between city and country leads therefore to an integrated vision of the peri-urban territory that assumes a vital and active role with new productive functions and attractions. This happens in Trento, “a city of landscapes”, where the complexity of the territory requires a holistic approach to the territorial policies and urban design, able to properly represent the different challenges and specificities of the territory (Favargiotti, 2020).

In Trento, an ecological approach to landscape design represents an opportunity to take care of the lands, by locally supporting actions of mitigation to climate change, risks protection (mainly from floods and storms), ecological connectivity and biodiversity conservation alongside helping to valorize itineraries at different altitudes and for different targets.

Biodiversity and healthy natural ecosystems underpin and sustain human livelihoods and well-being by providing essential services such as food, clean air and water, and protection against floods, coastal storms, and other natural disasters (Dudley et al. 2010). This approach can become an opportunity to reconnect society with its landscape identity and geographical characteristics (urban, rural, regional, territorial), make initiatives economically sustainable and scalable, build a comprehensive and flexible framework to guide cities to implement projects adapted to multifunctional use on different scales.

## 2.2 Impacts of climate change in Trento

Even with the reduced dimensions of the city and the presence of large natural areas, Trento is expected to be affected by the most common climate change effects occurring in urban areas.

According to recent reports collecting studies about climatic conditions of Trento (e.g., Codemo et al., 2018), relevant effects of climate change in Trento will include: urban heat island (UHI) effect and increase of temperatures, hydrogeological risk related to extreme precipitation increase, water scarcity due to dry periods. Urban heat islands constitute a microclimatic phenomenon by which temperature in urban areas is higher than in the rural surrounding ones. The phenomenon is due to urban surface characteristics, urban morphology, and anthropogenic activities, such as traffic and heating systems. The study by Giovannini et al. (2011) reports that the intensity of UHI is around 3°C, but in some areas, it can reach 6°C. The effect is exacerbated by the temperature increase, generating risks for human health and ecosystems. Moreover, such effects have been affecting air quality and inducing critical issues for pollutants dilution. However, the values measured in the Trento stations are within the maximum limits imposed by law and the number of exceedances and threshold values is decreasing. Regarding, rainfall, no net trends are observed, however the values analyzed in the study by the Municipality of Trento (2019) show the first signs of the effects of climate change: the intensity of rain, the days of intense and very intense precipitation have been slightly increasing. Furthermore, the analysis reports an increase in consecutive non-rainy days, an index linked to drought. Finally, the analysis shows a slight increase in cumulative annual precipitation, especially in the autumn season, underlining the presence of intense rain events and the increase in non-rainy days. It should be noted that extreme events, in addition to being characterized by intense rains, are also constituted by strong gusts of wind. In the studies carried out in Trentino, an evaluation of wind gusts trend was not possible, due to the difficulty of recording and spatializing punctual phenomena. The risks of changing precipitation are linked to hydrogeological safety and could cause floods with damages in the built environment and scarce availability of water resources, weighing on sanitary, industrial, and agricultural use.

## 2.3 Climate adaptation and mitigation strategies

The new Provincial Energy and Environmental Plan (PEAP), for the period 2021-2030, has been recently approved. The PEAP sets the objective to decrease emissions by 55% compared to 1990 levels. To achieve it, the plan follows 12 strategic lines concerning deep energy requalification of buildings, increase of Renewable Energy Sources (RES), experimentation of energy communities, enhancement of sustainable mobility (Provincia Autonoma di Trento, 2021). The PEAP states the importance of updating planning tools and introducing mitigation and adaptation in current planning practices. Furthermore, within the "Trentino Clima 2021-2023" work program, the "Provincial Strategy for Mitigation and Adaptation to Climate Change" will guide the administrative action of the province to manage actions tackling climate change impacts. Specifically, regarding the city of Trento, the Municipality joined the Covenant of Mayors in 2014, activating procedures to involve citizens in the development and implementation phases of the Sustainable Energy Action Plan (SEAP). The plan is divided into two phases: emissions inventory (BEI), and identification of actions to reduce the emissions of the inventory. The Municipality of Trento's strategies concern the energy efficiency of buildings owned by the municipality, the progress of projects as pilot cases: for the management of ventilation, heating and cooling of large buildings, the construction of new efficient urban infrastructures, such as street lighting, the introduction of regulations for buildings (Andreucci, 2018). While mitigation efforts are clear, a strategy to adapt to the effects of climate change has not been implemented, as well as the introduction of related parameters in planning policies.

## 3. Adaptive urban planning: the Trento Leaf Plan [1]

Based on the local vulnerabilities and the challenges that contemporary cities will have to face, the TUT research project proposed a systemic approach to urban transformations based on resilient and adaptive urban planning tools. The proposed method constitutes the baseline for the review of the Trento Urban Plan, adopted by the municipality in 2018[2]. The city plan draws on the Trento Leaf Plan vision, which constitutes a communicative means driving urban transformations towards ecological transition. The revised plan aims to shift the quantitative system based on control to a metabolic, multidisciplinary, and adaptive one, allowing flexibility to future changes. It focuses on health and quality of life, regeneration of the existing built environment and climate-energy transition.

The contribution of the TUT research team to implement the vision is the introduction of an innovative and adaptive planning process: the plan is based on three paradigms focusing on cooperation, flexibility, and performance, and rather than working by objectives, it sets five challenges. The three paradigms constitute the baseline actions to effectively integrate the urban challenges in the urban plan, by understanding the

context of the contemporary city and the Alpine area of Trento, by focusing on sustainability development, and by creating a dialogue with the community.

Plan as an “urban narrative” represents the capacity of interpreting the existing built environment to re-discover and re-active urban spaces. Plan as a “shared urban action” overcomes the traditional participatory processes, and enables an open-source urban planning, based on co-creative processes in all the phases of the policy cycle.

Plan as “performance” reinterprets the urban transformations based on land use in transformations based on required performance. In this view, the criteria to regenerate the built environment are based on socio-ecological measurable parameters.

Five challenges, in accordance with the goals of the European Urban Agenda, have been set for the future development of Trento, and they can be implemented through different action policies.

The aim of the challenges is to allow the transformation of the physical space in a flexible way, through devices that can change over time according to the needs.

- **Eco-Trento:** a sustainable city, prepared to tackle the issues related to climate change and biodiversity loss, and capable of re-using the existing space by avoiding land consumption.
- **Welcoming-Trento:** a city capable of improving the sense of belonging, by recognizing the presence of different identities and enabling integration and quality of life.
- **Accessible-Trento:** a city based on sustainable mobility, by improving the quality of supralocal transports and slow connections.
- **Smart-Trento:** a city that becomes innovative and competitive by creating a network between research and production.
- **Bella-Trento:** a city that preserves historical, cultural and landscape heritage, evaluating the beauty of urban landscape and improving attractiveness and wellbeing.

The adopted strategy is not a conventional general urban plan, rather a clear vision of the city and related networks derived from the interpretation of the city's need and resources, that can be implemented in different stages and with various tools in a long-term perspective (Giroi, 2006; Guallart, 2012).

The proposed approach is based on interaction and standardization of the different components, and studies the relationships and changes occurring in the urban environment. In agreement with the definition of Kennedy et al. 2007, the approach is metabolic, referring to the environmental sustainability issues as well as to the organic system. Indeed, the plan focuses on safe, healthy, and flexible public spaces, reduction of the urban footprint by rehabilitating existing spaces, the role of citizens as the main actors in the interventions, sustainable mobility, and the exchange of experiences. The proposed approach has been developed through a continuous collaboration between researchers and Municipality: it was built on a technical table as a task force composed of representatives from the University of Trento, the City of Trento, and professional associations.

This co-creative approach provided the opportunity to have a broader overview of the challenges related to urban transformations through different scales and steps of intervention. Moreover, the method has been tested through case studies in specific areas by doctoral thesis and by master thesis developed in the Department. Moreover, the proposed approach constitutes the baseline to integrate societal challenges and the local ones in the urban planning tools. The first experimentation developed in cooperation with

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[1] In the present paragraph the main considerations about the Leaf Plan and the structure of the Plan refer to the following publications: Ricci, M., “Adaptability: The Leaf Plan concept” in A. Battisti, D. Santucci (eds), *Activating Public Space: An Approach for Climate Change Mitigation*, München: TU München Press, 2020, p. 65-75. DOI: 10.14459/1543270md2020 and Ricci, M.; Favargiotti, S., “Trento Leaf Plan. Cinque sfide per il metabolismo urbano” in *ECO WEB TOWN*, v. 1/2019, n. 19 (2019), p. 1-10. [http://www.ecowebtown.it/n\\_19/pdf/B9\\_EWT\\_19\\_Ricci\\_Favargiotti\\_stampa.pdf](http://www.ecowebtown.it/n_19/pdf/B9_EWT_19_Ricci_Favargiotti_stampa.pdf)

[2] Comune di Trento (2018). *Il futuro della città di Trento si costruisce oggi. Obiettivi e percorso della variante generale al Piano Regolatore Generale./The future of the city of Trento is being built today. Objectives and process of the overall revision to the Urban Plan.* Retrieved from: <https://www.comune.trento.it/Aree-tematiche/Ambiente-e-territorio/Urbanistica/Il-nuovo-PRG-Piano-regolatore-generale/Obiettivi-e-percorso-della-variante-generale-al-Piano-regolatore-generale-2018/Scarica-il-documento-Il-futuro-della-citta-di-Trento-si-cos>.



representatives of the Municipality is the revision of urban agreements, to define new requirements in the processes of the negotiations between public and private, as explained in section 4.3. The intention of this first experimentation is to develop a methodology that can be integrated in the current urban and landscape planning tools (e.g., Landscape Chart, Regulatory Plan, Mobility Plan) or to constitute a base for the development of future plans (e.g., climate adaptation plan).

#### 4. Planning tools for healthy and resilient cities

Eco-Trento is one of the challenges identified in the revision of the Urban Plan. The ecological and environmental issues have been recognized as essential since the early stages of the research project. The specific goals of the challenge are related to the enhancement of ecosystem services, mitigation and adaptation to climate change and the implementation of green and blue infrastructure. These goals are set to improve the performance of the urban environment mainly in terms of temperature regulation, sustainable water management, energy transition, and inhabitants' health. As mentioned in the previous paragraphs, Trento has not adopted a climate resilience urban plan yet. Thus, the last phases of the research project have been focusing on the definition and integration of specific tools in the planning practices to drive towards ecological transition. The proposed tools have been developed to be integrated in the current planning tools rather than to create new plans to address the ecological challenges, in order to promote a shift from quantitative to performative planning. This paragraph describes three tools of landscape planning and management that have been studied in the framework of TUT, with different potential uses in the policy cycle.

##### 4.1 Spatially explicit ecological oriented maps

The growing availability of datasets (e.g., drones, airborne imagery, vectorial data) can be a useful tool to spatially represent urban issues, including social, physical, and ecological aspects. Within the most common are land use and land cover studies, built infrastructure layers, social-demographic surveys, and economic data (Wellmann et al., 2020). Recently, a growing number of studies have been analyzing ecological and environmental aspects of urban areas that can be useful for green urban infrastructure planning and climate adaptation. For example, many studies classified urban areas in different levels of heat-related risks (e.g., Morabito et al., 2015, Norton et al., 2015) or hydrogeological risks (e.g., Kubal et al., 2009). Moreover, the definition of bioclimatic zones or Local Climate Zones (according to Stewart and Oke., 2012) has become increasingly common to determine the relationship between urban morphology and microclimate. Spatially explicit studies represent an important asset for planning practices, since they can determine different levels of priority of interventions, and they can support in the decision of the type of actions. In the framework of the T.U.T. research project, two studies focused on the formation of knowledge as well as in its application in urban policies. The first one is the map of ecosystem services (Cortinovis and Geneletti, 2020) and the second one is the map of pervious surfaces and canopy cover (Fig. 3) with airborne images (Codemo et al., under review). Such tools constitute a dynamic map that represents and evaluates the present condition and can be updated to monitor the changes. The integration of supply and demand of urban ecosystem services as well the map of vegetation in terms of perviousness and canopy cover, can be used as tools for a performance-based approach, limiting negative impacts of urban transformations. The aim of the maps is to drive urban transformations by requiring a specific performance according to the location of the interventions. Their application is very flexible, in terms of uses and design tools, since they do not define predetermined transformations, rather functions to be achieved in specific areas (Pelorosso, 2020)

The map of permeability and canopy cover can be used as a baseline to determine the distribution of functions related to microclimate regulation (Zardo et al., 2017) and run-off mitigation (Li et al., 2018) in a very detailed way (resolution of 20cm). The ecosystem services supply and demand maps provided by the study regards the following services: microclimate regulation, habitat provision, recreation, noise mitigation, air purification, runoff mitigation and food provision.

The aim of the maps is to advance from the common standards for green or permeable areas of the urban plans, by assessing different types of urban greening and measuring the capacity to support different ecosystem services (Fig. 4). Thus, by setting minimum requirements in terms of services (e.g., cooling, sustainable water management), the plan allows flexible transformations and types of actions, but limits the negative effects of transformations.

Moreover, spatially distributed maps enable a whole view of the city, and can be useful to determine priorities of regeneration and cluster of typologies of interventions required. Finally, being the maps easy to update, they can be used to monitor the status of the parameters. The maps of canopy cover and pervious surfaces

can constitute a tool to support subordinated planning tools and strategic planning tools. For example, they can support the integration of performative indicators, such as microclimatic wellbeing, in the Building Code.

#### 4.2 Resilience management

Urban resilience is a cross-cutting topic that not only examines aspects related to adaptation and mitigation to climate change but makes a broader reflection on the crisis of urban metabolism and the forms of technical and constructive rationality on which the city and its relationship with natural resources has been built so far (Zupi, 2016). Indeed, cities are complex systems in which the idea of a single “stable” state is replaced by that of a “shifting steady-state mosaic” (Holling, 1986).

It is not possible to predict how the urban ecosystem will evolve and change because it is a complex system, composed of numerous variables interconnected at multiple levels. Its changes are sudden and unpredictable. The awareness that the urban ecosystem is a dynamic, complex, and unpredictable environment has significant implications for city planning and management. It is necessary to accept the inevitable changes that will occur as a normal part of the urban evolution process and through planning and design adapt to the changes in a more flexible and responsive manner (Lister, 2007). This kind of awareness requires an interdisciplinary and multi-scalar approach to solving the problems that anthropized territories have been facing.

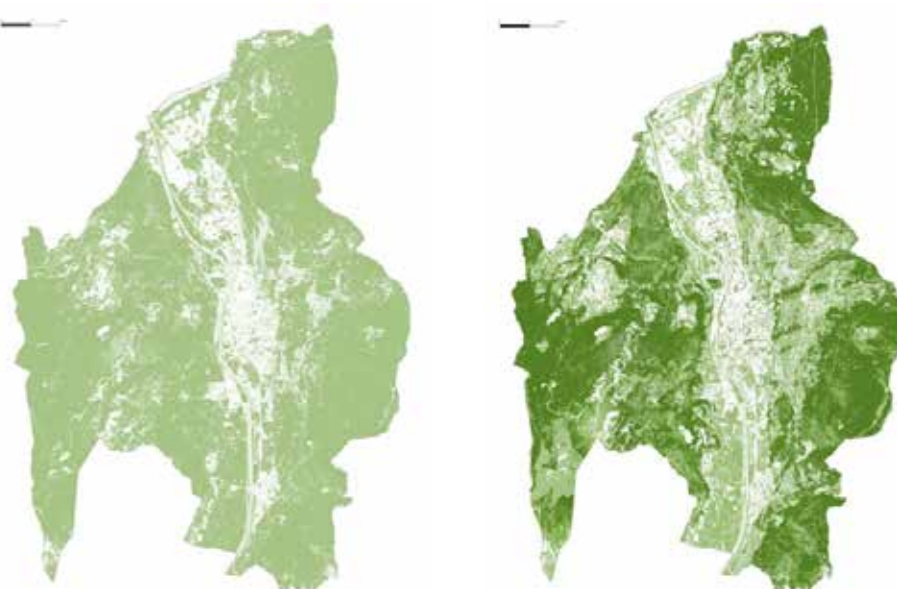
Urban resilience is an opportunity to deeply change the way we manage urban transformation. In this sense it is not a new Plan, but an organizational proposal for a complex structure aimed at managing all aspects of the urban system (Caudo, 2016).

To support, investigate and test new processes of urban transformations’ adaptive management, large city networks have been created with the aim of supporting city administrations to collaborate effectively, share knowledge, and lead meaningful actions to implement urban resilience.

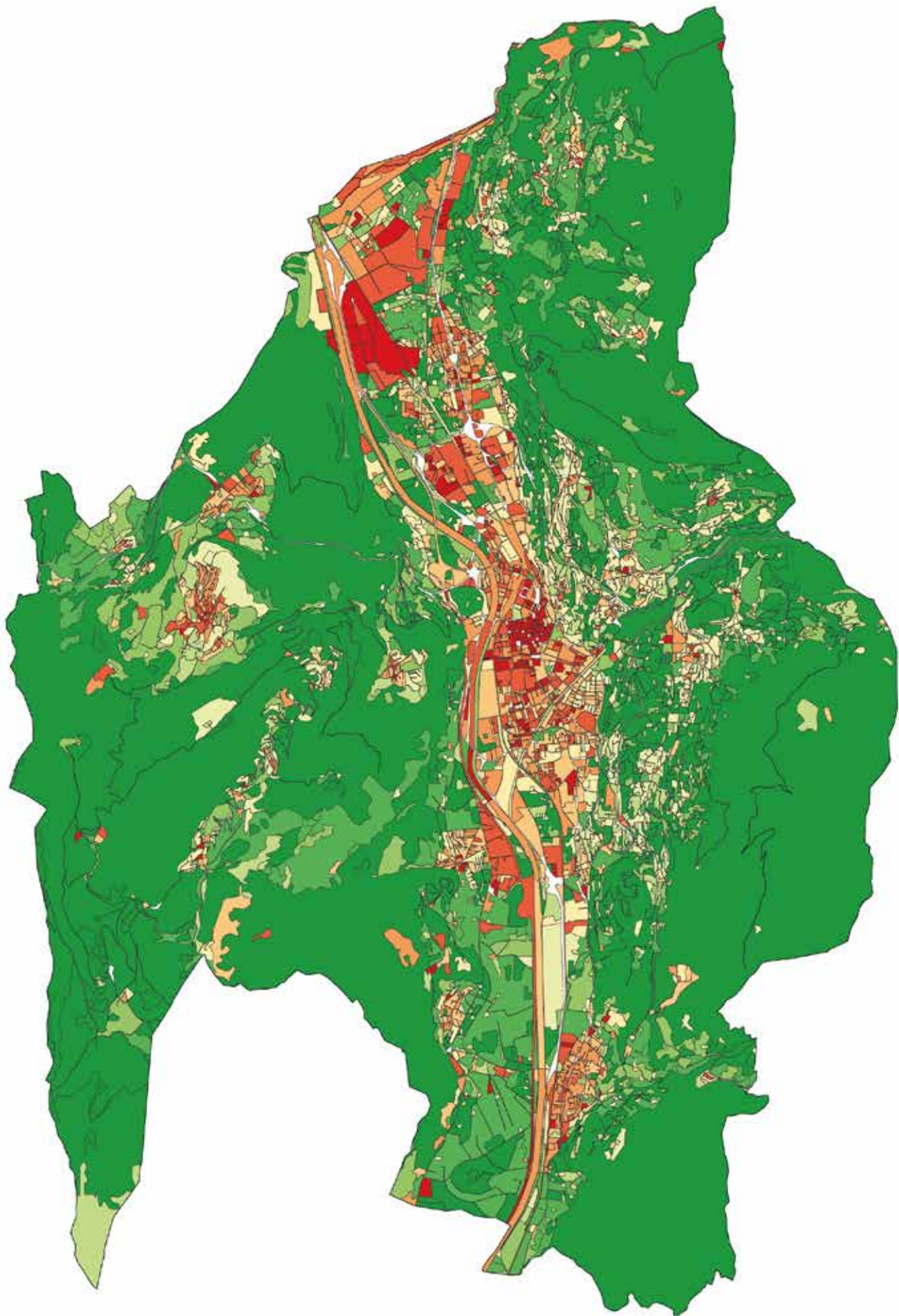
One example is the 100 Resilient Cities (100RC) program, an initiative spearheaded by the Rockefeller Foundation that proposes a vision of resilience including not only catastrophic events, such as fires and floods, resulting from changing climate conditions, but also other chronic stressors that communities face, such as high unemployment, endemic violence, inefficient public transportation systems, and pandemic crisis.

The 100 Resilience Cities platform allows the network member city to access a catalog of tools and services -provided by platform partners (e.g., private sector companies, NGOs, and research institutions)- aimed at strengthening urban resilience.

Moreover, this platform is an opportunity to find new answers. One of the innovations introduced by the program is the inclusion of the professional figure of the Chief Resilient Officer (CRO): an expert in urban



[SCh 2] Figure 3. Spatially explicit map of permeability (a) and canopy cover (b) of the city of Trento. Source: Codemo et al., under review.





resilience, whose task is to act as an intermediary between municipal offices for the construction of integrated resilient practices.

Between 2013 and 2016, the Rockefeller Foundation launched the “100 Resilient Cities Challenge,” a process for cities to be selected to join the 100 Resilient Cities program and obtain economic (approximately \$1 million for each selected city) and technical support to implement urban resilience. The economic support is intended to cover for two years the expenses for the inclusion within the municipal administration of the professional figure of the CRO. The CRO is central to the process promoted by the Rockefeller Foundation and its main responsibilities are as four. First, facilitating communication between the different offices of the administration to avoid wasting resources and promoting synergistic actions between the different projects carried out by the administration. Second, establishing contacts between the different stakeholders (government officials, private sector representatives, active citizenship, non-profit organizations) working on the territory to implement urban resilience. Third, activating, during the first six to nine months of his or her tenure, a participatory process with local stakeholders to identify the city challenges to become resilient and assess the actions needed to achieve the goal. Following the evaluation process, with the assistance of 100RC the CRO implements the identified initiatives. Finally, ensure that the projects implemented maximize their effects by achieving multiple resilience goals with a single project. In the framework of TUT, the adoption and local adaptation of the figure of the Chief Resilient Officer could facilitate a holistic view of the city, being able to coordinate multi-scalar actions to achieve important goals even through the sum of small synergistic actions. Adaptive, resilient, and responsive planning is closely linked to practice as well as research (Lister, 2015). It is therefore useful to connect specialists with different skills, municipal technicians, academics, stakeholders, and citizens, who based on their experiences and skills can build innovative solutions. The professional figure of the Chief Resilient Officer is recognized as an important piece in the transition to what Sennet calls “Open Urbanism”.

### **4.3 Procedures for collaborative and resilient urbanism: the new process for urban development agreements**

One of the TUT research group's objectives is to investigate how to trigger adaptive and flexible governance processes through the revision of traditional planning tools. Particularly, as a result of a specific request from the Municipality, the process of forming and evaluating Urban Development Agreements was investigated, in order to establish how to assess the actual “Public Interest” resulting from each proposed agreement. Urban Development Agreements are urban planning tools which, based on a private initiative, establish an agreement between the public and private sectors, modifying or introducing new provisions to an existing regulatory plan. The possibility of varying the provisions of the existing zoning plan is only granted in cases where a justified Public Interest is being pursued.

In the Province of Trento, Urban Development Agreements are regulated by National Law n. 241/1990, art. 11 and Trentino Provincial Law n. 15/201, art. 25. Particularly important is the discussion on the definition of “relevant public interest”. In the field of urban planning and specifically in the regulations concerning urban agreements, there is no “a priori” definition of public interest (Gualandi, 2008) but it is up to the individual local administrations to define which are the priority Public Interests they wish to set to protect the territory and guarantee the best social and economic development of the communities they administrate (Moro, 2010).

This is because the concept of Public Interest is based on social, economic needs, and requirements that change over time and vary for each community. Local authorities' task is to identify the most suitable criteria and actions to respond to the needs and requirements that arise in the community. For this reason, it is not possible to define a relevant public interest a priori, but each urban and territorial context has its own peculiar needs deriving from its history, economy, social composition, and culture.

The purpose of “planning by agreement” is to obtain the private sector's consent to achieve the best land use in the interest of the community, which would otherwise not be possible (Urbani, 2005). Municipal administrations assess the positive effects of the individual projects and interventions proposed in terms of public interest. The assessment must consider the specificities of each urban context and ensure that the transformations cooperate in a holistic way to achieve the objectives set for the evolution of the city and the well-being of its community. As explained above, urban agreements can modify existing land-use regulations, being what in literature is called “upstream agreements” (Urbani, 2005).

In other words, these tools introduce modifications or new projections to the current regulatory plan. Therefore, they can offer the public body and the private project proponent greater freedom of action in

terms of admitted land uses. The analysis of case studies and approved Urban Development Agreements in Trento has allowed the identification of three characteristics of Urban Planning Agreements:

- **Flexibility:** they overcome some of the regulatory plan's rigidities, allowing the proposition of innovative projects;
- **Adaptability:** they enable the local administration with more control over the building intervention, through the request of specific conditions and requirements;
- **Site-specific:** they evaluate urban transformations and projects without generalizations, but according to the specific context in which they are located.

However, there are potential advantages and disadvantages associated with having the above-mentioned opportunities. From one point of view, Urban Planning Agreements can facilitate the realization of innovative projects and land transformations that would not be allowed by the prescriptive rules of the PRG, offering the possibility to overcome the rigidity of traditional urban planning and the constraints dictated by zoning.

Urban Development Agreements can also be used to facilitate new public policies, such as the ecological transition of the city, by providing greater freedom of action to respond to urgent and specific community needs. On the other hand, the freedom granted through an urban planning agreement may also have potential disadvantages. The risk is that decisions taken through an Urban Development Agreement are made in a fragmented and unplanned way based on use and market values, rather than on the constitutive and conforming values of the territory. Moreover, evaluating single interventions could lead to losing the necessary overview of the urban context.

In the specific case of the city of Trento, the problem encountered is the generic nature of the criteria for assessing the relevant Public Interest, and the absence of measurable parameters to support the formation of Urban Development Agreements.

In many cases, the benefit to the community is reduced to a simple increase in quantitative standards and does not become an opportunity to implement innovative urban transformations. The process proposed by the TUT research group is part of the innovative approach proposed for the revision of the General Regulatory Plan based on the challenges, and interfaces with the planning tools for healthy and resilient cities outlined above: Spatially explicit ecological oriented maps (see 5.1) and the coordinating figure of the Chief Resilient Officer (see 5.2).

The proposed process can be divided into three steps (Fig. 5):

- definition of public interest;
- formulation of the agreement;
- evaluation of the agreement.

The first step is the clear definition of the Public Interest, which in the case of Trento is identified in the five Challenges that the city set, according to the strategic document elaborated for the 2019 General Regulatory Plan review. The second step supports the formulation of the agreement through the identification of the performances to be achieved with the proposed urban transformation.

A handbook of actions and an abacus of project references contain the recommended modes of intervention in relation to each challenge. The proposed actions are associated with measurable parameters and thus become a useful tool for public decision-makers to objectively assess the actual benefits. The abacus proposes a collection of references, which can be constantly implemented, useful for guiding project choices and for sharing innovative urban regeneration projects.

The third step is the project evaluation, consisting of the concertation of requirements and incentives between the public and private sectors, and the location of public interest interventions resulting from the granted transformation. Spatially explicit ecological oriented maps (see 5.1) and the coordinating figure of the Chief Resilient Officer (see 5.2) support the allocation phase of urbanization charges, guaranteeing an overall vision of the city and the maximization of the benefit for the community.

## 5. Planning tools for healthy and resilient cities

The future state of systems, communities, and individuals has conventionally been of interest for decision makers, as well as policy makers, practitioners, and scientists. It might be said that the future has always been unknown. Yet, nowadays, in the age of Anthropocene, this topic is extremely urgent and poses new governance challenges. Risk assessment is more difficult due to the increasing complexity, especially concerning the capability to forecast events or to reliably guide decision making (Miller, 2015).

The main threats that affect Western countries, like climate change, environmental degradation, globalization, security, migration, automation, crisis, and poverty, are characterized by non-linear, unpredictable, and unstable dynamics.

Lately, the interest in empty spaces, vacant lots, depopulated villages, and obsolete areas in cities and territories and on their recovery is now an inevitable phenomenon in European urban planning, as an emerging dilemma to the well-known debate on the impacts of growing cities and soil consumption in urbanization.

Indeed, understanding and qualifying the impact of those transitory urban space patterns in medium and large cities and their metropolitan areas is a fundamental concern as the growing challenges need urgent measures to ensure human well-being and cities livability and to reactivate the urban metabolism (Favargiotti, 2020).

To do so, the contamination of disciplinary boundaries between landscape, architecture, urbanism, ecology has expanded and redefined the practice of designers and their field of operations.

Following this, such relevant themes as uncertainties, climate change, resilience, urban adaptation, nature-based solutions, call for a re-definition of design methodologies in public and private practices.

It can do so through sharing knowledge, data, perspectives, and design experiences among the fields of urban, landscape and ecological design, as well as environmental and social studies.

The Trento Leaf Plan constitutes a methodological approach to shift from traditional planning based on zoning, to more flexible and adaptive planning tools, capable of addressing the societal challenges.

The Leaf Plan constitutes the baseline to introduce an approach based on challenges that can be developed through multiple actions.

The present study proposes three tools that have been developed during the research to support the transition of the current planning tools.

With the TUT research we are promoting a new perspective and design approach in response to urban challenges in Trento, in order to rethinking policies and spaces through new paradigms and models guided by strategies of adaptation to change and time.

Underneath a holistic vision of the "Leaf Plan", an ecological framework for the city transformation, the research project offers urban planning strategies and tools capable to promote the ecological transition as well as to improve the well-being of citizens in Alpine cities



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# KEYWORDS

*RESILIENCE; SLUMS; CHILDREN;  
INFORMALITIES; GREEN SPACES*



Photo Credit: Angela Colucci

# [SCh 3] Green Spaces and Slum-dwelling Children's Resilience during the COVID-19 Pandemic Lockdown in the Philippines

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## 1. Introduction

As a global health crisis, the coronavirus (COVID-19) pandemic has become a source of what Zygmunt Bauman (2006, 3) calls "liquid fear," or "a vision of the world that includes insecurity and vulnerability". Like in many contexts, the pandemic has permeated in various aspects of life and has affected everyone from different social status, age groups, gender identities, among others. Needless to say, children are no exception to the consequences of the pandemic. Although children have generally less cases of COVID-19 than adults, their lives were nevertheless gravely impacted and transformed in many ways (UNICEF 2020). As they experience new realities imbued in the uncertainties and unpredictability of a pandemic context, children have become more vulnerable than their pre-pandemic lives. Of particular concern are children living in poverty from developing countries such as the Philippines. Indeed, the pandemic has taken its toll on young Filipinos, who have expressed unpleasant emotions such as fear and worry over the pandemic's conditions as their parents lost their jobs, schools closed, and people they know have been infected by COVID-19 (World Vision Philippines 2020). The growing insecurity from the threat of infection has been a source of anxiety, stress, and other mental health issues among Filipino children (ibid). Moreover, there has been an increased number of child abuse cases during lockdown, including internet traffic and physical exploitations (Thomson 2020).

However, this work shows that despite their fragile conditions, slum-dwelling children have shown their version of resilience. This article takes the case of San Jose del Monte City (SJDM), Philippines to show that while children feel pandemic-induced anxieties, they are able to manage their everyday lives through their exposure to the green spaces that surround their slum environment. San Jose del Monte City is a mid-tier city in the province of Bulacan (Philippines), which is currently accommodating an increasing population that is projected to reach approximately 1.9 million people within the next 30 years (City of San Jose del Monte, 2020).

As the city's population increases, so do issues of vulnerabilities among children who need to live with the precarity and instability found in slum areas. To this end, the interest of this paper is on slum-dwelling children's act of resilience against their vulnerabilities, as supported by the literature that put forward the capacities of disadvantaged children to strategise the informalities of their spaces (See Stodulka 2014; Bolotta 2017, 2019; Agarwa et al. 2021). This work applies the approach of seeing children as agents of

## ABSTRACT

*This chapter examines how green spaces in slums have contributed to children's resilience and well-being during the COVID-19 pandemic lockdown. Although children appear to be less vulnerable to COVID-19, studies have shown that their mental well-being suffers from the pandemic, especially for children in low-income households. In a case study, this work shows how slum-dwelling children managed their everyday anxieties of the pandemic through their exposure to nature that surrounds their informal settlement in San Jose del Monte (SJDM) City, Philippines. Through remote qualitative interviews with 9-12 years old children, this work examines how children benefited from the interstitial green spaces in slums in terms of mental well-being and food security. In general, the children share the opinion that the green spaces in slums serve as a source of resilience. Aside from providing fresh air and food for household consumption, trees and plants around the slum were beneficial to how children manage their stress during the pandemic. Although the children expressed their frustration that the COVID-19 pandemic has caused extensive disruption to their lives, they have found ways to feed and occupy themselves through the green spaces that surround their slum neighbourhood. These discussions also point to important areas of concern in terms of the potential of children to facilitate resilience amidst their marginalised conditions. Developing an understanding of who has been able to be resilient in the pandemic, and in what ways, is crucial in order to draw lessons from where it is least expected.*



resilience against the spatial constraints created by their urban conditions. The focus is on the particular views of slum-dwelling children regarding the green spaces in their neighbourhood and how they think such spaces contributed to their overall resilience during the pandemic lockdown. Thus, this paper examines the urban contexts and practices in which exposure to green spaces can cultivate the well-being of marginalised young people.

## 2. Literature on Green Spaces and Children in Slums

Taking Holling's (1996) account on ecology-oriented resilience, urban systems carry a threshold of stress before transitioning to another state of equilibrium. Likewise, as an urban unit, slums can accommodate a given level of stress to which they can adjust and manage. As such, the topic of green spaces in slums has drawn further attention in the literature in the last decade (French et al. 2013; Gopal and Nagendra 2014; Agarwal et al. 2021). Green spaces have proven to be particularly pertinent to community resilience at times of crises. For instance, aside from reducing ambient air temperature and controlling urban flooding and rainfall runoff, green spaces promote both physical and mental well-being of urban residents (See James et al. 2016; Mennis et al. 2018; Reid et al. 2018). As studies have indicated, the rich presence of green spaces and other natural environments promote community bonds that foster collective empowerment among vulnerable populations including children (Colding and Barthel 2013).

Given the current literature on green spaces and resilience, this work ventures on the growing multi-disciplinary research linking the resilience of vulnerable populations and green spaces. To date, little attention has been paid to slum-dwelling children's views on the green spaces surrounding them. Most studies focus on experimental methods on measuring children's exposure to nature and natural environments, level of interaction with natural environments and health outcomes (See Fjørtoft 2004; O'Brien and Lomas 2017; Tillmann et al. 2018; Agarwal et al. 2021). Whereas there are studies on young people's resilience through outdoor exposure (See Ritchie et al. 2014), slum-dwelling children receive far less research in terms of being participants in such studies. To address the gap in the literature delving into green spaces and slums in mid-tier cities (Gleeson 2013), this work provides a child-oriented analysis of green spaces, with emphasis on informal settlements as an area of exploration. As a mid-tier city, San Jose del Monte City enjoys lush green areas and interstitial spaces compared to bigger cities. In particular, children benefit from green spaces both in short and long terms (Engemann et al. 2019). The focus of this paper is thus on the resilience among slum-dwelling children during the pandemic and how green spaces serve as sources of grit and tenacity among these young people in the context of a mid-tier city.

It is of particular interest for this paper to analyse how slum-dwelling children themselves perceive the benefits of green spaces and how they relate it to their resilience during the pandemic (See Veitch et al. 2007). The key theme investigated was resilience, through borrowing the concept of children's "situated resilience", which focuses on the "existing agency as well as [their] limits to adaptation" (Tschakert and Tuana 2013, 78) to discuss an ability to make choices in the context of insecurity and uncertainty. Likewise, this paper adopts the notion of situatedness in the sense of "acknowledging the voices, subjectivities, and strategies of children" (Choi, Yeoh, and Lam 2018, 2). In viewing the "situatedness" of resilience among slum-dwelling children, this work unpacks the various aspects of green spaces in the slum neighbourhood where children derive their sources of resilience, while at the same time recognising their own limitations to be resilient. In other words, the situated resilience of children is examined through letting children identify both the enabling and constraining aspects of green spaces as well as the limitations imbued in such spaces in slum context.

## 3. Methodology

This study's participants were children from an informal settling area in San Jose del Monte City, Philippines. Residing in a rather secluded hill away from the main road, these children are exposed to green spaces on a daily basis as part of their residential environment. With the assistance of a local faith-based organisation, an online interview took place with 9–12 years old children (n=25). Such an approach positions children's knowledge and perspectives as crucial elements to foster inclusivity among vulnerable subpopulations of society, such as children. During the quarantine period, using a digital platform was the only possible means to reach out to the participants for reasons of travel restrictions and general medical safety.

The interviews took place during the Modified General Community Quarantine (MGCQ) or "the transition phase between GCQ [General Community Quarantine] and the New Normal .... limiting movement and transportation, the regulation of operating industries, and the presence of uniformed personnel to enforce community quarantine protocols" (Inter-agency Task Force for the Management of Emerging Infectious Diseases (2020). In such a context, while children were highly encouraged to stay indoors, they could engage in outdoor physical

activities provided that they followed the minimum public health protocols such as wearing masks and physical distancing. All the children who took part in this study live with their parents, siblings and/or stepparents, with an average household size of five. After being given information about the purpose of the study and information about the voluntary nature of participation, both the participants and their parents gave an oral consent. To ensure the anonymity of the participants, their real names were not reported in this work, using pseudonyms instead. To follow distancing protocols and keep a friendly environment for the children, the interviews were done by groups of three or four peers, making 7 triads and 1 quartet (Corsaro 2015). Question prompts to start conversations with children include: How much do you spend time in green spaces nearby during the pandemic? Do you like to hang out near green areas? Tell me about your mini gardens. What do you like about your mini garden? What sorts of things are there? What do you plant there? Do you like to spend time there during the pandemic? What do you like to do there? Who plants the food in your mini-garden? Who is usually in the mini-garden? Do you ever go there by yourself? What would you like to change about the mini-gardens?

When children refer to green spaces in this paper, they pertain to the green areas on the hill where their slum dwellings stand on. In such spaces, they walk, play, relax, and plant some green edibles, among other activities. In the interviews, children narrated how they benefited from the interstitial green spaces in slums in terms of mental well-being and food security. They talked about the changes and challenges that have taken place in their daily lives during the pandemic, their spatial conditions, and the meaning and relevance of green spaces for them. The children also expressed interest in the research topic on green spaces in smaller cities, saying it was important for them to know more about what other children think about their spaces and what was happening around them during lockdown. Guided by grounded theory (Glaser and Strauss 1967), this study borrowed the steps from Braun and Clarke's (2006) for a thematic analysis (TA) but modified where needed. The participatory data analysis took place over two weekends in workshop format. First step, the children and researcher talked about the drawings to familiarize ourselves with the data from the drawings. The children shared what they drew about their play spaces, explaining each component and why they think those belong to "children's spaces". In the second step, initial themes were generated, which served as the foundations to the development of further discussion points in our analysis. For the third step, children identified salient themes from the discussions of their drawings. The fourth step included reviews of data for them to further explain the meaning of the themes' children gave and their reasons why they group certain concepts together.

#### 4. Findings

The slums spaces in which the slum-dwelling children routinely live were generally compressed into a relatively small size of housing units, with a floor area of approximately 10 to 29 square meters on average. This was one of the key challenges that the children raised during the interviews. During the interviews, the children mentioned their growing fear of COVID-19 and the uncertainties on whether they could go back to their normal lives. They initially developed unpleasant associations with everything related to the pandemic such as masks and face shields. One child even noted that "dealing with slum life would be easier than dealing with a pandemic" (11 years old). The global health crisis hit their private lives suddenly and the once familiar and free spaces in their city have turned into restricted ones. Then the opportunities for playing and children's independent mobility shrank, the habit of gathering together to play stopped, and the way these children lived their daily lives changed. As one respondent said,

*"As I heard different information about the pandemic, I experienced many feelings all at once, feelings that I did not even understand—I was shocked by the unexpected lockdown and I denied it [the pandemic] at first. The first days of quarantine and social distancing were strange and scary" (10 years old)*

However, the children stated how they found ways not to feel trapped. They constructed their ideas about being resilient during the pandemic from their day-to-day lived experiences, encompassing their pandemic encounters from 2020. Their understanding of adaptability and sense of agency were grounded on the need to take actions to ensure safety but at the same time allow for some degree of mobility. However, let it be clear that the children did not see the restrictions during the lockdown as a denial of their agency and freedom. Instead, during the pandemic, the children found ways to accept the restrictions of their movements for the sake of safety while simultaneously looking for safe ways for themselves to lessen the anxiety they felt during the pandemic.

In general, the children share the opinion that the green spaces in slums serve as a source of resilience. One respondent explained,

*"We don't have much over the pandemic situation, but we have some spaces that make us feel peaceful amidst our situations. The plants, flowers, trees, insects, and birds in the hill provide us with a sense of security and freedom" (12 years old).*

Despite the sense of losing control of their lives during the lockdown, these children were grateful to have green spaces nearby. The children admitted that the initial implementation of the lockdown was challenging. As one respondent noted, "We had nothing. We had nothing to do, nowhere to go, even nothing to eat. It's just days and days and days" (10 years old). Spending most of their time at home was a considerable challenge for them as their usual activities involved roaming around the other parts of the city.

#### **4.1 Sense of Stability**

The children felt a sense of stability and ease in seeing green spaces despite their deprivations, making them mentally resilient, at least in the short-term. The respondents described green spaces as a venue of stability in the sense of providing an atmosphere of having a constant view to see, which gave them a sense of stability and a degree of confidence and hope that the future will regain some sense of certainty. Aside from providing fresh air and food for household consumption, trees and plants around the slum were beneficial to children's visuality, helping them to manage their stress during the pandemic. Although the children expressed their frustration that the COVID-19 pandemic has caused extensive disruption to their lives, they have found ways to feed and occupy themselves through the green spaces that surround their slum neighborhood. They also claim that trees and plants allow them to get closer to nature, which gives them a sense of relief from their fears and worries about the pandemic uncertainties. The children also appreciate such green spaces as a contribution to the ecological health of their slum-dwelling community, which also maintains social ties among other children in their slum neighborhood. The children have expressed that their resilience comes from the culture of sharing surrounding the green spaces in their neighborhood. Sharing, in this context, refers mostly to how the slum neighborhood treats the green spaces as communal and something for all. For instance, the neighborhood shares some edible greens growing in the hill, such as malunggay or drumstick tree (*Moringa oleifera*) and alugbati or Malabar spinach (*Basella alba*). The children's appreciation of green spaces was intertwined with an informal sharing of the ecology surrounding the slum area, which fostered a sense of stability amidst their uncertain contexts.

*"My father told me that we share the hill, we share nature. We don't get selfish because no one will live 'solo flight'. The green spaces help me learn sharing and unity. So, I take that lesson from the elderly and not only think for myself" (12 years old).*

#### **4.2 Food Security**

Although their families are determined to keep income flowing, parents of 15 children have inevitably lost their jobs. As such, aside from harvesting wild edible plants on the hill, households demonstrated resilience through engaging in small urban farming activities to survive and avoid hunger. While these families receive some aid—in cash and in kind—from the local government, the amount of food assistance and money are not enough to feed and sustain the entire family. Thus, slum-dwelling households decided to use vacant lots near their houses to plant vegetables for their own consumption. Since children postponed going to school due to quarantine restrictions, they have also occasionally helped in small urban gardening and learned to plant vegetables to assist their parents grow vegetables for household consumption.

*"You've just got to be creative so that you can survive and not feel hungry. Then you get used to it" (11 years old).*

The small gardens are negligible compared to other urban gardens that can be seen elsewhere. But there was pride, felt in terms of the menial productivity, albeit their contribution is small compared to their parents. This highlights agency as the children served as co-champions against hunger in their own households. In this regard, two children spoke of themselves as in the process of maturing:

*"Because of this mini-farming, I felt I have grown up a little. I see myself and other children as reliable people whom our parents can trust to accomplish tasks" (10 years old).*

*"Sometimes, I think it's like school because we learn new things about plants that we eat. It makes me think about the environment even more" (9 years old).*

All of the children also talked about their firm resolve to carry out their own personal and smaller-scale

gardening projects in the future without being supervised by adults. Despite the anticipated new restrictions, they were confident about planting edible greens because it is one shared activity that allows them to safely practice distancing in an open-door area. They built these smaller gardening projects with their desire to be prepared for unexpected crises such as a pandemic. Half of the children even claim that while they wish to have stable jobs in the future, they understand that farming is a desirable and enjoyable alternative to be more resilient than just earning money from regular salary.

### 4.3 Sustainable Resilience

Not only did the children in the sample claim to have learned more about the environment, they also said that they felt a sense of reciprocity in taking care of the green spaces. In this sense, resilience takes the rhetoric of sustainability because human beings act to maintain the ecology that helps them to be resilient as marginalized groups. This future-oriented resilience draws children to be more intentional in how they treat the green spaces surrounding them and to take action within their abilities. The mindset to give back to nature materializes through children's actions such as picking up and repurposing garbage, being available for weeding, planting some seeds, and/or sharing information with each other about plants. Often, these actions reflected children's appreciation of the ecological benefit they received and experienced from the green spaces. Put differently, the slum-dwelling children were repaying the favor to nature, from which they received strength to be resilient. Thus, this reproduces a cycle of continued resilience.

*"Each day, plants take care of us, so we need to take care of them too. It helps me to feel that I am doing a good thing. Nature has helped me enough in this pandemic. I want to take care of it too" (9 years old).*

*"Knowing that nature is OK, makes me OK too. When I see green spaces, they don't always look healthy. So, every day I think of ways to keep the plants healthy-looking. I have a desire to see the environment of our neighborhood in good conditions because it will be good for us too" (10 years old)*

There is also awareness that taking care of the green spaces requires more than intention. Whilst intention mattered, children also referred to sustainable resilience as a way forward in the long term, which is beneficial not only to them but also to the future generation. For these children in the sample, such visions provide positive emotions and improve their interaction with the environment. Given their appreciation of the green spaces on the hill where they reside, some children wished for cleaner green spaces they routinely access in the entire city. In their slum neighborhood's vicinity, the respondents often see piles of garbage such as plastic bags and bottles that are not only unpleasant to the sight but also detrimental to nature.

*"I'd like to see the hill as a clean space where we can go and play. In fact, I'd rather see trees than buildings and I hope this hill will stay as it is now" (11 years old).*

## 5. Discussion

In examining the case studies of slum-dwelling children in San Jose del Monte City, this work presents threefold implications for each of the above-mentioned findings. First, children are able to re-imagine a sense of stability based on their current spatialities. Second, green spaces together with urban communities play a huge role in how children find resilience. Third, the spatial and economic contexts in slums highlighted the nuances and relevance of green spaces in the resilience of marginalized groups specifically. The interviews with slum-dwelling children have unpacked the role of child-nature interaction in the resiliency of young people, particularly as a way of coping with the mental health threats, establishing food security among households and allowing children to think about resilience in the long term.

### 5.1 Sense of Stability

That most of the respondents claim to appreciate and grasp the importance of green spaces to their resilience is not surprising. The findings regarding children-nature affinity show consistency with previous literature. For instance, the statements of children about their reduced feeling of anxiety also confirm previous findings concerning improved cognitive function and creativity after being exposed to nature (See van den Berg and van den Berg 2011; Ferraro 2015; Schutte et al. 2017).

Moreover, the efforts of children in urban farming resonate with studies that highlight the role of micro-gardens as sources of food security at times of food crisis (See Colding and Barthel 2013; Purcell and Tyman 2015; Calvet-Mir et al. 2016; Roggema 2016; Appolloni et al. 2020). In addition, the experiences of slum-dwelling children in San Jose del Monte City reflects the connection between children's resilience and the system

surrounding them, which Ungar (2021, 11) refers to as a “multisystemic” process wherein “resilience of one system has the potential to influence the resilience of other co-occurring systems”.

Further, as with previous literature, the interviews in this study hint at the necessity to advocate for urban planning and design that promote age-inclusive, sustainable, and shared resiliency in the city. The case of the informal settling children in San Jose el Monte City suggests that children's resilience is invested in their capacity to connect with nature as well in their ability to share with their communities the desire to sustain and enhance green spaces. Notably, this is not to dismiss the realities of suffering from vulnerability since the respondents from 11 to 12 years old are aware of their disadvantages compared to other children of higher-income families, even if everyone was affected by the pandemic in one way or another. This could be suggestive of the continued underrepresentation of slum-dwelling children in mid-tier cities. It could, however, also indicate that championing the resilience of slum-dwelling children in mid-tier cities will require purposeful refocusing from slums in global cities to smaller cities and disruption of slum-dweller stereotypes as spaces of “apocalyptic and dystopian narratives” (Roy 2011, 224). Taking into account the uncertainties and liquidities of slum life across urban contexts, children are actively involved in situating themselves and dealing with the unprecedented and transformative case of the coronavirus pandemic as well as the generational exclusion associated with benign children.

### **5.2 Food security through being part of a community**

The statements of children are also indicative that food security is tethered with being part of a community. As with the arguments of childhood scholars on the importance of children's affinity to their communities (See Christensen and O'Brien 2003; Liebel 2004; Abebe 2013; Abebe and Bessell 2014), the slum-dwelling children in this study situated themselves as a community member and thus did not explicitly distinguish their food security as an individual from the collective resilience of their informal settling community. In this regard, all of the children emphasise the slum community's food security through its coexistence with the green spaces and they made reference to wildlife such as insects and birds as part of their personal connection and appreciation of the green spaces. Moreover, while the respondents all provided personal accounts on their food security through green spaces, this does not mean that they themselves see food access and security as exclusively coming from green spaces. What is important in terms of analysis is the caution not to misuse the idea that children's resilience during the first wave of the COVID-19 pandemic was mainly reliant on the green spaces and the resources thereof. The point, rather, is that children see food security as part of the larger context, beyond their own households. This implies that green spaces that provided food security not only served as sources of resilience as a reaction to the pandemic but also as a way for children to practise agency in general terms. To this end, those who work on behalf of disadvantaged children in the city—be they social workers, teachers, health practitioners, researchers, among others—need to streamline that the relationship between food security and community is a complex system that is informed by an urban ecological system and that children's resilience comes from different resources available in green spaces, which they reciprocate and share with their communities.

### **5.3 Sustainable resilience from the perspective from marginalized children**

The interviews also facilitated an exploration of how the spatial conditions of slum-dwelling children provide an account of the dynamics of sustainable resilience in the lives of slum dwellers. One of the most salient observations in this study, rarely discussed in the literature, was that slum-dwelling children develop the desire to reciprocate nature toward sustainable resilience.

Whereas in other urban informal settling conditions where young people are less pro-active in sustaining green spaces for their own resilience (See Mosavel et al. 2015), the slum-dwelling children in San Jose del Monte City demonstrated adamant intentions to secure their future sources of resilience. This reflects young people's general inclination to perform “reciprocal obligations” (Glanville and Bienenstock 2009, 1514), which is an important aspect of resilience. It is important to pay attention to the readiness to serve nature with the expectation of a sustained partnership with nature sparks discussions on children's agency to act not only for their resilience at present but also for the future. Beyond the wider urban contexts of socio-economic, spatial, and political inequalities, the resilience of slum-dwelling children is “situated”, that is, examined from children's own observation of their resilience and limitations based on their experiences. The respondents in the sample provided an account of resilience that counters the stereotypical discourse of sheer vulnerability that describe low-income groups residing in slums. Their accounts also lend perspectives on the capacity of children to respond to their situations against the backdrop narrative of children as passive victims of urban challenges. This is not to condone the inequalities that slum-dwelling children experience. Rather, the point is

to emphasize that children are capable of an elaborated understanding of their situation and their capacity to be resilient. Such a discursive shift in seeing children as agents is relevant to furthering their adaptive capacities in urban settings. This work supports that a resilience framework can be empowering by providing hope in an otherwise overwhelming context of uncertainty and risk. However, it is crucial to recognize that debates between resilience and vulnerability frameworks may be permeated by romanticization of children that are neither necessary nor appropriate.

## 6. Conclusion

The COVID-19 pandemic has created a transformative reality in the lives of slum-dwelling children in many ways. While it cannot be denied that these children experience exclusions and vulnerable conditions during this pandemic, these children were able to cope with their situations through the presence of green spaces in their slum vicinity. Going back to Bauman's (2006) notion of liquid fear, the children in the sample were able to apply strategies to deal with their insecurities and anxieties. This is not to overlook the spatial and social exclusions children experience in the urban world. The point, rather, is to emphasize that the opportunities and life chances of slum-dwelling children, whose vulnerability comes from lack of awareness and access to social services, can be further addressed if there is more information on children's resilience from their own voices. Conversations from this study have provided a perspective that the term resilience comes in many forms. Yet, let it be clear that the insights on urban resilience generated from this work are carefully situated from the specific and local experiences and perspectives of children in San Jose del Monte City. Overall, this work has implications to the fields of urban studies and children's geographies in terms of understanding resilience in urban informalities from children's perspectives. This is also suggestive of the need for post-lockdown recovery strategies to pay attention to how children can participate in resilience planning, such as decision-making processes.

As a way forward, future research and practice in urban planning will benefit from further exploring how green spaces become sources of agency and empowerment for slum-dwelling children. Such research directions follow the theoretical and empirical works on urban informalities previously mentioned in the introduction (See Stodulka 2014; Bolotta 2017, 2019; Agarwa et al. 2021). First, it is important to have a deeper understanding of children's sense of reciprocity with urban green spaces. As the interviews have indicated, children are forward-looking in terms of how the green spaces in their slum setting can be sustained towards keeping them resilient at times of crisis. Second, children's perspectives that take into consideration their backgrounds such as gender, disability, stage of childhood, among others are instructive for researchers and practitioners in further understanding the version of resilience that children perform. Third, in the context of pandemic-related mental health and wellbeing concerns among children in low-income groups, it is necessary to pay close attention to the different ways children understand their own capacities to adapt and be resilient. Although the children in the sample generally expressed the usefulness of green spaces for coping with their vulnerable realities, such coping is not homogenous. Some children have more profound connections with green spaces than others, which needs further exploration.

The discussions in this work point to important areas of concern in terms of the potential of children to facilitate resilience amidst their marginalized conditions. These perspectives can be of best use to researchers, decision-makers, and practitioners to develop urban policies and practices that critically take into account both the capacities of children to be resilient through green spaces and at the same time the structures that hinder their abilities to get to access green spaces in the city. As the fragility of slum-dwelling communities expand during the COVID-19 pandemic and new variants emerge, it is timely and relevant to anticipate the needs of marginalized children as lockdowns and distancing seem to remain necessarily part of the new way of life indefinitely. Finally, developing an understanding of young people who have been able to be resilient in the pandemic, and in what ways, is crucial in order to draw lessons from where it is least expected.

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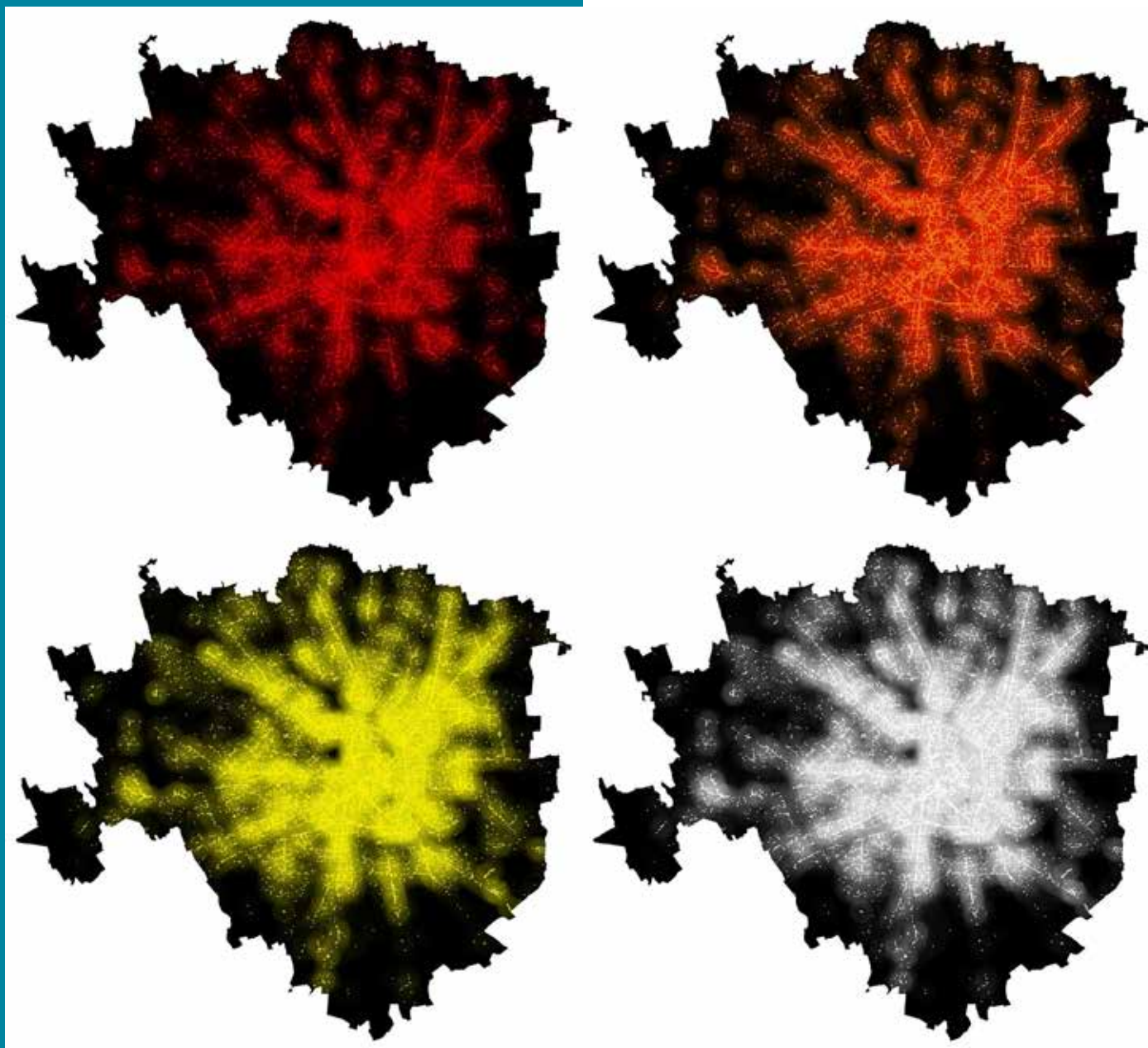
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Photo Credit: Angela Colucci

# KEYWORDS

URBAN MORPHOLOGY,  
PERFORMANCE INDICATORS, URBAN  
DESIGN, URBAN HEALTH



*Heatmaps representing the total number of open activities during the colored zones restrictions. Source: author elaboration*

# [SCh 4] Lessons from the Pandemic: Mapping Urban Resiliency and Robustness

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## 1. Introduction

In the last two years COVID-19 hugely impacted people's health and habits on a global scale.

In particular, cities have received a lot of media attention as they have been the scene of over 90% of cases (United Nations 2020). The unusual conditions that urban systems were asked to adapt highlighted the differences between cities and between areas of the same city. The restrictions that have been imposed and the difficulties in carrying out normal daily life and restoring a pre-pandemic condition, pushed many to wonder if COVID would definitely change our cities or even spell their end. In order to answer, it would be necessary to understand how long it will be able to change the way we live our cities. There is not agreement on this front. We cannot predict the emergence of new viruses (Geoghegan and Holmes 2017) and we do not know if this virus will become just one of the endemic viruses of our communities, will be eradicated, or will never disappear (Ryan 2020).

Even without certainty on the evolution of the pandemic we can certainly say that rethinking cities tailored to COVID would be a serious mistake given on one side the unpredictability and variety of potential challenges on the horizon (natural or anthropogenic disasters), and the persistence of many unsolved wicked problems (Rittel and Webber 1973) already characterizing urban settlements worldwide (pollution, poverty, congestion, access to services etc.). In fact, as much as today the pandemic seems to us a top priority, it is good to remember that the World Health Organization (WHO) has also other big challenges to face (WHO 2020) in addition to the major trends underway such as climate change and the loss of biodiversity. The attention of urban studies in the last years shifted from the concept of sustainability to that of resilience (Stumpp 2013) trying to limit sectorial views encouraging a more holistic approach. Even if the research community, and also the civic society, agrees on the fact that cities need to become resilient and robust systems able to adapt to a wide range of changing conditions easily and rapidly, this transition is still not straightforward.

There is no doubt that the pandemic has been a dramatic sanitary event that made even more evident the problems existing since long time in urban contexts. However, it gave the opportunity to look at our cities and habits from different, sometimes unimaginable, perspectives. This article wants to learn from the pandemic how to shape more resilient and robust cities. For doing that, it first reviews

## ABSTRACT

*This article contributes to highlight the role of urban form in the debate of urban resilience and robustness using the elements of IMM methodology to read the impact of COVID-19 on urban systems. Milan is used as case study to map how the pandemic restrictions impacted different areas.*

the existing literature on these terms and the different facets of their opposite (fragility and vulnerability), identifying a specific position for the discourse on urban form in the dimension of robustness, identifying in the Integrated Modification Methodology (Tadi, Zadeh, and Biraghi 2020) a good framework to work within for trying to evaluate the ability of urban modifications to increase the resilience of a system (section 2). It then reviews how evolved in the literature the debate on how urban structure affects the performances of urban systems, shows how the pandemic put in crisis also rooted practices of urban planning and collects some of the initiatives taken by the most proactive municipalities worldwide to mitigate the impact of the pandemic often taking advantage of this exceptional situation to boost already ongoing plans and projects (section 3). Section 4 presents some experiments conducted by the authors on the case study of Milan, focusing mainly on ground floor activities, investigating how some of the restrictions imposed for the containment of the infections unevenly affected different areas of the city, with proved consequences on the proximity level and potential ones on the infection rate (not proved). The conclusions (section 5) trace different possible research lines both at the theoretical and practical level to verify what hypothesized here based on structural properties, to extend this approach to new experiments and to implement a comprehensive urban resilience assessment framework.

## 2. Theoretical backgrounds

### 2.1 Urban resilience and robustness

The concept of resilience has been for the first time introduced by Holling (1973) in ecologic context as “the persistence of relationships within a system” and “the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist”. Concerning the similarities of the cities and living organisms as both are known to function as a complex system, the concept was later borrowed to urban studies as “urban resilience”. According to OECD the “urban resilience” in simple words, can be defined as “the ability to absorb, recover and prepare for future shocks” (OECD 2021).

As noticed in the work of Stumpp (2013), in many cases the transition from sustainability to resilience has been more a change of label than a change of paradigm. Speaking about resilience to climate change (Morecroft et al. 2012; Jabareen 2013) is comparable to studying environmental sustainability but is no more enough. As confirm, there is “a whole spectrum of global environmental changes that interplay with interdependent and rapidly globalizing human societies”. Resilience can thus be against a chronic or slow onset stress or compounding long-term stressors. This holds true for resilience in cities when considering sudden crises (natural or man-made) as well as interacting long-term trends (e.g., climate change, biodiversity loss, rapid urbanization, declining public services, increasing violence and growing social exclusion) (Patel and Nosal 2016).

Many authors described resilience in different ways but most of them agree on the need of developing properties as system robustness, redundancy, and rapidity/reactivity (Norris et al. 2008; World Bank 2015). Related to the disaster and addressing its risks, “urban resilience” and the related actions to increase it could be divided to two sets. The first is called “preparedness” and refers to the anticipation of expected and unexpected disasters taking measures to increase the flexibility and adaptive capacity accordingly (Labaka et al. 2019). According to the first part of Urban resilience definition by Klein, Nicholls, and Thomalla (2003), in this stage resilience is defined by “the amount of disturbance a system can absorb while retaining a state similar to the original” this often relates to the robustness and unaffectedness of the city which happens before the shock event (Pirlone and Spadaro 2020).

Robustness in a city comes from being proactive. In other words, it is essential to anticipate the future shock, predict its possible results and prepare for that. A ‘robust city’ is safe, stable, and unaffected by external and natural shocks, often by means of additional and better technology and physical infrastructure (Meriläinen 2020).

The second part of resilience often related to self-organization, is known to be more reactive. This means that after the shock, regardless of the previous preparedness and its defects which can have led to losses in the system, it is important to act based on the current exact situation and condition to “quickly return to normal” (Pirlone and Spadaro 2020).

According to Meriläinen (2020), the first requires a “top-down” approach while the latter is more related to a “bottom-up” one. Previous studies point out that resilience, as much as the shock itself, is site-specific (Vale and Campanella 2005). Therefore, for a proper definition of resilience in a specific context it is essential to understand how different components of the specific context are functioning together. Because city resilience is a complex, multidisciplinary phenomenon, focusing on a single or small number of contributing factors ultimately results in partial or inaccurate conclusions and misrepresentation of the multiple causes

of the phenomenon (Jabareen 2013). Adaptiveness, which is highly linked with resilience, requires the synergic work of all actors who live or work in a city.

Looking to the opposite terms, having a negative meaning, two terms can mainly be found in the literature: fragility and vulnerability. Fragility is often discussed related to social aspects and is particularly used in the Italian context and for booming cities in developing countries (Muggah 2014). According to Selby and Desouza (2019), fragility is framed as a function of unresolved fractures of social compacts that degrades a city's ability to function over time and stress exacerbates its effects. On the other side, vulnerability is often discussed in environmental issues specifically with specific attention to climate change. According to Salas and Yepes (2018), its most accepted definition is the degree to which a system (entity) is susceptible to, or unable to cope with, adverse effects of environmental threats. More precisely, it is a function of the character, magnitude, and rate of the threat to which a system is exposed, its sensitivity, and its adaptive capacity. In other words, vulnerability has been conceptualized as an entity's susceptibility to harm from exposure to environmental (unavoidable) threats. The advantage of these terms is that they are easier to be measured respect to resilience.

## 2.2 Assessing urban resilience

It is clear that applying resilience to systems involves identifying how processes are interrelated and can therefore create cascading chains of disruption (vulnerability) and recovery (resilience) (Pirlone and Spadaro 2020). Knowing the importance of identifying the contributing factors in urban resilience, different previous studies have established various sets of categories and sub-categories trying to explain different components of urban resilience. Ostadtaghizadeh et al. (2015), for example, in a systematic review of assessment models for community disaster resilience, summarize ten models that attempt to measure community resilience and suggests that the concept can be understood using five dimensions: 1) social, 2) economic, 3) institutional, 4) physical, and 5) natural.

Measuring urban resilience is important to allow decision makers to address city fragilities and vulnerabilities, and a wide variety of work exists to guide selection of indicators and metrics (Patel and Nosal 2016). An example is the Fragile Cities web portal ("Fragile Cities" 2021), that collects statistical data for many world cities and use them to compute customized fragility indexes.

However, a key aspect to be deepened is the assessment scale of urban resilience. The city in fact risks being a too broad scope and the indicators used, also to cope with data availability, if on one side can be acceptable for the social, economic, and institutional dimensions, they can hardly be used to guide modifications of the physical and natural ones. To properly investigate the physical dimension, narrowing down the scale of analysis is crucial, intervening on the different sub-systems the city is composed. In this article, the city is considered a dynamic Complex Adaptive System (CAS), generated by the superimposition of a huge number of components connected to each other and organized in subsystems, which are themselves complex adaptive systems. In fact, their arrangement and the architecture of their links define specific unique and provisional physical-formal organizations that we refer to as an urban system. The city, in fact, as a complex system, simultaneously involves many systems, including energy, built structures, water and sewers, food production and distribution chain, waste management, transport, health and biodiversity, but also economic, social, and cultural systems. In this sense, the city can be defined as a system of systems.

The Integrated Modification Methodology (IMM, Tadi, Zadeh, and Biraghi 2020) seems a promising framework to perform this additional step in the assessment of urban resilience. IMM is a model-based approach able to define through an objective qualitative and quantitative representation, the structure of city as a CAS and its performance in a defined time. In IMM, urban diagnostic analyses patterns of problems and the malfunctioning conditions of the system. The identification of the nature of malfunctioning condition by systematic investigation makes possible eventually to quickly recover the system from unpredictable behavior when faced with unexpected perturbations. Its multi-scale nature allows to investigate urban subsystems from the block up to the city scale. The IMM city dismantling into components (Volumes, Voids, Networks and Type of uses) and their integration for the description of more complex urban properties (Key Categories) are here adopted to frame both literature and experiments. The mapping experiments of section 4 refer to the Type of Uses Component and to the Proximity Key Category, that are only a small part of the aspects usually investigated (Porosity, Permeability, Accessibility, Interface, Effectiveness, Diversity).

A combination of this approach with tools like the vulnerability analysis matrix (Jabareen 2013) and decision-making methods in conflicting multi-criteria scenarios (Zionts 1973) could significantly increase the awareness on the preparedness level of urban form in the different contexts. As this study moves from the physical dimension of resilience, the following sections try to show how to ensure robust built environments working in the domain of prevention and uncertainty-oriented planning.

## 2.3 Robust urban structures

It is now commonly accepted that urban form can have a significant impact on environmental performances and people's quality of life (Jabareen, 2006; Nijkamp and Finco, 2009). The current global scenario sees extremely varied settlement phenomena ranging from the formation of boundless urban agglomerations (mega-cities), mainly in developing countries, to the creation of new cities (new towns) also in Western countries, to cities that contract (shrinking cities) to cope with changed boundary conditions. Considering the great variety of physical, but also economic and social contexts, it is difficult to think of an urban form or a building typology capable of solving all the problems of our cities. Most of the recent literature in urban studies focusing on environmental sustainability deal with the optimisation of urban form according to a specific aspect to improve the overall system performance. This often-created paradoxical situations due to the lack of a systemic and holistic approach (Bettencour 2013) because the optimisation of one component (catalyser) might have negative impacts on others (reactants, Tadi et al. 2020). The switch to the resilience paradigm made this aspect even more evident and the questions that were usually told, immediately obsolete and incorrect.

For example, the property of redundancy, desirable in resilient systems (Norris et al. 2008; World Bank 2015), is incompatible with the optimization processes.

We are still far from a full understanding of how to achieve a robust urban structure but at this stage, the key aspect is identifying the right path to be followed. This path is long, complex and requires holistic methodologies, as the one proposed, to be travelled but is also the only possible one to avoid the mistakes generated by methodological shortcuts. An example can be the evolution of the concept of density, characterized by very contradictory results in the correlation with social, economic, and environmental factors, that was initially condemned to the point of creating urban sprawl, then become in many policies the "panacea for a sustainable life" (Boyko and Cooper 2011), and now attacked again as responsible for the spread of COVID-19. The reasons for this swing of success can be found both in a deterministic planning approach and in the nature of the concept itself, too generic to precisely determine modification of the urban structure. The attention has now swift to the concept of compactness or city of short distances, characterized by a high density of use, short travel distances and associated with a higher quality of life (Schwarz 2010), but again, there is no agreement on its definition and measurement.

Many studies try to find correlations between one or more specific morphological aspect and performance aspects (air and noise pollution, CO2 emissions, energy consumption etc.) falling in the trap of simple and partial outcomes. The two aspects, structure, and performance, can be independently investigated and morphological aspects deserve more attention and better methods. This can be done only with methodologies able to look at the very local scale to grasp the fine grain differences between urban structures and modifications. The next section contains a collection of critical urban aspects that the recent pandemic highlighted putting in crisis also aspects well routed in the contemporary planning practice

## 3 COVID stress-test: learnings

### 3.1 Observable trends

Coronavirus is neither a problem nor a crisis. Coronavirus falls into the category of wicked problems (Rittel and Webber 1973) which, without a global mitigation strategy, will perpetuate the domino effects and feedback loops (OECD 2017). The pandemic has exacerbated problems already present since long time in urban contexts. Similarly, many of the solutions in response to it are processes already underway since some time that have seen a sudden acceleration (teleworking, home deliveries). We start talking about blended city, characterized by an approach both online and offline not only to work but to the way of life (BBC, Chee 2021). As Norman Foster (2021) said: "Every crisis has accelerated and amplified the inevitable". In fact, many polls show that most people don't want to go back to normalcy, made up of travel, office, and large inequalities (Pomeroy and Chainey 2020).

Large European cities have seen an exodus of hundreds of thousands of people, sometimes as much as 10-20% of their population. These inhabitants, mostly temporary, preferred smaller towns more in contact with nature once the need for work ceased. This may create a demand for new or improved local services by emerging a pattern that includes dispersed groups of commercial, cultural, employment and public space offerings that serve dispersed populations (BBC, Kayden 2021). In support of this hypothesis there are the data relating to the resumption of commercial activities after the restrictions imposed, which in the case of Manchester have seen small towns perform better than the city centre (Maginn and Hubbard 2021). Although we are inclined to consider the compact urban structure typical of city centres as more resilient, the current commercial and tertiary offer is oversized and cannot do without mass transport, which has however suffered a 90% reduction in use revenues (MSCI 2021). Until now, public transport has been strongly

promoted for its competitiveness in terms of environmental impact with respect to the use of cars (Gutiérrez, Miravet, and Domènech 2020). However, the pandemic has shown that it is preferable to invest in pedestrian and cycling infrastructures, activities that are less vulnerable or more resilient, safe from the point of view of contagion and even more sustainable for the environment and for the mental and physical well-being of people (Capolongo et al. 2020).

The use of public transport has in fact accelerated infections due to the proximity between people, both inside and outside the vehicles, which it inevitably entails, and the restrictions imposed by local governments, although theoretically useful in the initial stages of an epidemic (MUG et al. 2020), are often difficult to respect and therefore not sufficient. Those who had the opportunity have taken refuge in the use of cars and consequently traffic congestion, after the forced decline in times of lockdown, has already regressed, exceeding pre-Covid levels in some cities (BBC, Simons 2021).

With regard to air pollution in relation to the pandemic, two aspects can be identified. The first is that the majority of cases and deaths have been found in those cities where people are exposed to greater air pollution. This is both because the atmospheric particulate matter acts as a transport vector for many chemical and biological contaminants, including viruses (Setti et al. 2020), and because the virus in question attacked the respiratory tract. The other aspect was the evident drop in the concentration of some specific contaminants as a result of the lockdown periods, the closure of production plants and the reduction in travel (Collivignarelli et al. 2020).

Another aspect highlighted by the pandemic is that of inequalities. From India to the United States, we have seen an explosion of cases, especially among the poorest strata of the population, many of whom are forced to live in extreme conditions that favor, if not ensure, the spread of the virus (Albert Henry 2020). It therefore appears evident that it is not density (Carozzi, Provenzano, and Roth 2020; Hamidi, Sabouri, and Ewing 2020) that promotes the spread of the virus, but the lack of density management, i.e., overcrowding and the consequent lack of access to adequate housing, health, education, transport services and sources of water, energy and public green spaces (Gandhi S 2021). Tadi et al. (2021) presented an example that well represents all these aspects comparing two nearby areas in Istanbul, Şirinevler e Ataköy, showing the relationship between morphological features (and the related socio-economic implications) and the spread of the virus.

### 3.2 Cities resilient initiatives

What we have learned from the recent pandemic is that large urban centres are now more vulnerable to external shocks and events. However, we know that more collaborative and integrated cities are better prepared to manage these events than those that are not (Costa and Peixoto 2020). Unpredictable events, natural, health, environmental disasters could happen anywhere and at any time and cities, as complex systems, are particularly vulnerable in the face of these events without an adequate resilience capacity. The cases presented in this section are just a limited sample of all the ongoing initiatives currently on the planning tables of municipalities worldwide.

Barcelona can be surely considered as a pioneer municipality as it started already in 2013 to implement strategies for improving its performance. The first step has been the Climatic plan 2013-18 (Ajuntament de Barcelona 2014) that introduced more than 500 Supermanzanas, 400m x 400m super-blocks generated by the aggregation of 9 blocks on a 3 x 3 grid, converting more than the 60% of car space into a mix-use pedestrian one for social interaction. It then Approved an Urban Resilience Plan in 2016 with the goal of becoming a “self-sufficient city composed of productive neighborhoods at human scale and speed, within a hyper-connected metropolitan area with zero emissions” (Ajuntament de Barcelona 2016).

In 2020 The European Investment Bank approved a €95 million loan to help Barcelona complete around 40 projects, with a focus on climate action and social inequalities. Among those there is an extension of the supermanzanas project starting in 2022 aiming to create 21 green streets and squares dedicating to the pedestrians use up to 33.4 hectares (Ajuntament de Barcelona 2020).

Another very active is Paris, guided by its major Anne Hidalgo and her intention to apply the 15 minutes city (Moreno et al. 2021) principles. Car-free transit and pedestrian infrastructures have already been doubled (Sisson 2020) and the plan is to maintain after the pandemic 50km of traffic lane temporarily reserved to cyclists (The Local fr 2021).

London officials began a “Streetspace” project in 2020, creating temporary bike lanes and widening pedestrian zones as commuters tried to avoid the dangers of crowded subways and buses. The project aims to make it easier and safer for people to keep up social distancing, encourage people to walk, cycle or scoot, prevent an increase in car use and enabling deliveries, emergency services and essential vehicle journeys from becoming gridlocked and keep London's air as clean as possible to protect everyone's health and tackle the climate emergency (London Assembly 2020).



From New York arrives the six-foot city (Sadik-Khan and Solomonow 2020; Popescu 2020), a vision of a future cities that respects the recommendations of the epidemiologists enlarging sidewalks and converting car space into pedestrians one for allowing safe, socially distant mobility, crating open-air commercial districts, and making outdoor classrooms and civic activities. In addition, the Transit Tech Lab announced the COVID-19 Response Challenge to adopt new technologies, ranging from air filtration to digital monitoring, to restore confidence in public transportation (BBC, Haot 2021).

Milan started interventions of tactical urbanism already in 2018 with the conversion of car streets and parking into temporary squares that then became permanent after a phase of monitoring. The approach is characterised by minimal non-invasive interventions like painting the ground and positioning urban furniture like benches, pots, and ping-pong tables (fpsshare 2021). During the pandemic, the Piazza Aperte (open squares) project has been launched gathering 65 new proposals for similar interventions around the city (Comune di Milano 2020). In the meanwhile, the municipality also announced a project that foresees the destination of 23 kilometres of road for the exclusive use of cyclists, always following a tactical approach, and the creation of new area with a speed limit of 30km/h (Urban 360 2021). All these initiatives are coherent with the 15 minutes city model that the Major decided to pursue even if an official comprehensive plan has not been implemented yet.

It's not by chance that all these initiatives focus on soft mobility. In fact, municipalities needed to find an alternative to public transportation able to perform well for both pandemic and climate change issues. Intervening on the Network and Void components, modifying the street area, they had freedom of action and the opportunity of enhancing the value of their own property. Working on other components requires more time and agreement with a multitude of actors (Volume) and the modification strategy is not so straightforward (Type of Uses) as the experiments in the next section tries to demonstrate.

## 4 Milan shops case studies

### 4.1 Object of the analysis

To make a step towards a fine grain investigation of the resilience/robustness of urban systems it is necessary to look at the local scale, that of neighborhoods, blocks, and single streets, and to map the level of preparedness of the different city components. This article, aware of the more general framework previously outlined, focuses only on the Type of Uses component in the city of Milan during the different phases of the pandemic. More precisely, it wants to show how the "colored zones" restrictions unevenly affected the city.

The purpose of this maps is not to propose any ready-made solution for the displacement of activities in the city nor to move any critic to the restriction measures adopted. They wish instead, to highlight the complexity in downscaling resilience planning and how even consolidated planning practices, result of long-time optimization processes, can generate vulnerable places for this specific kind of risk (the pandemic).

The "colored zones" (Ministero dell'Interno 2020) are a measure imposed by the Italian government in order to fight the spread of COVID and they are characterized by a progressive opening of commercial activities and services following intensity of the pandemic. Even if the guidelines were provided by the Italian Ministry of Interior at a national level, every region and every municipality was allowed to adopt stricter measures. Lombardy region was the most affected one, with the highest number of both total cases and deaths (Google 2021) and also among those adopting more severe measures.

The four zones ranged from red, corresponding to the lockdown periods where only essential functions were left open, to white, where all the shops and restaurant were open but with a limited capacity and the need for the customers of wearing personal protection equipment. A lighter zone (e.g., orange) always allowed the opening of the activities open also in the stricter zone (e.g., red). Table 1 summarizes all the zones and the

[Sch 4] Table 1. Activities allowed to remain open during the colored zones restrictions. Source: author elaboration

Zone	Open activities
Red	food shops, basic necessities, news agencies, tobacconists, pharmacies and Para pharmacies, laundries, hairdressers and barber shops
Orange	all shops, excluded those inside malls on holidays and days before holidays
Yellow	Bars and restaurants with limitations of opening time and capacity
White	All the shops and services

activities that were allowed to open.

The investigation has been articulated in three phases. First, the whole city has been considered showing the impact of the restrictions, in terms of number of open shops, both for the city and for each “Nucleo di Identità Locale” (NIL), 88 neighborhood-like areas in which the city has been divided. Then, a focus on the malls, how they have been affected by the closures and how their partial opening impacted on the surrounding areas has been performed. Finally, areas with a high concentration of essential activities (open during the lockdown) in a limited physical space have been identified using a clustering algorithm highlighting the potential risks of such “hotspots” for the spread of the disease.

## 4.2 Data sources and processing

Open datasets regarding the commercial activities are often missing, incomplete, divided into many separate and partially overlapping layers. It is the case also for the city of Milan that presents a collection of georeferenced point layers available on the Open Data city portal updated to 2018 (Portale Open Data | Comune di Milano). These data have several limits that required a pre-processing. The actual division does not match the categories of the different colored zones, for many features the attribute table is incomplete, some activities are included in more than one dataset sometimes with a slightly different location (few meters) and some others doesn't even have a valid corresponding geometry as the attributes for the georeferencing are missing.

The OpenStreetMap (OSM) data have the advantage of adopting a unique classification criterion and the relevant attributes (or keys) are available for a good percentage of the geometries (98%) but the total number of features (5'582) is still significantly lower than the authoritative datasets (16'505). For this reason, the data of the Municipality, namely the following layers, have been used:

- ds555\_uffici\_postali\_milano\_final (post offices); ds290\_economia\_botteghe\_storiche\_2017 (historical shops).
- ds589\_grandi-strutture-di-vendita-nel-comune-di-milano\_5pzf-etyy\_final (large sales structures);
- ds612\_negozi-e-locali-storici-georeferenziati-nel-comune\_puf6-2m2d\_final (historical shops);
- ds690\_tabaccai\_ordinari\_e\_speciali (tobacconists);
- economia-artigianato-settore-alimentare\_2018\_coord (food artisanal shops);
- economia\_esercizi\_vicinato\_sede\_fissa (shops);
- economia\_media\_grande\_distribuzione\_coord (medium and large distribution);
- economia\_panificatori\_coord (bakeries);
- economia\_parrucchieri\_estetisti\_centri\_abbronzatura\_coord (personal services);
- economia\_pubblici\_esercizi\_fuori\_piano\_2018\_coord (bars and restaurants inside other activities);
- economia\_pubblici\_esercizi\_in\_piano (bars and restaurants);

Regarding the malls, as no official dataset exists, a new one has been created starting from the OSM shops polygon layer and integrating information from the websites of the different malls and other online sources

The pre-processing consisted in extracting subsets of specific layers and group them according to the zone classification; removing the duplicate geometries after merging the different source layer into a new single one; deleting the features without a corresponding geometry. A new field was added to classify the activities in small, medium, and large sales structures based on the commercial surface. This operation was done to differentiate large sales structures during the phases of the pandemic and to have a simple attribute to be used for scaling the catchment area of the points while doing the heatmaps. All these operations and the following maps and analysis have been done using QGIS 3.16.4.

## 4.3 Results

### *Activities*

The first aspect that has been investigated is how different areas, characterized by heterogeneous urban structure, were affected by the restrictions imposed. Figure 1 collects a map for every color zone showing a heatmap and the single points concurring in its generation. The heatmap was created by generating a simple round buffer around every point with a radius corresponding to the sale structure size classification (400m; 800m; 1'200m). The buffers were then displayed in the color of the corresponding zone using an opacity of 1% and selecting addition and overlay respectively as layer and feature blending mode. A summary of the data used to construct these maps is reported in Table 2

From these maps it is possible to notice how if one side the city centre maintained a significant number of open activities also during the red zone, it is also the area where in the other maps, especially the yellow and white zones, an overall increase in brightness can be noticed. It is also clear how important commercial systems (north-west axis), visible in the white map, resulted more fragmented in the red one with a final effect of passing from a continuous line to a dotted one.

Also, peripheral areas with a small number of activities in the white zone were significantly affected, almost disappearing from the map in during the red zone. In Figure 2 the NILs are classified according to the ratio between the activities open during the red zone (R) and those open during the white zone (W).

As this metric will be used other times in the article, we'll refer to it as R/W. From this map, also the north-east commercial axis made of Corso Buenos Aires, Via Padova and Viale Monza becomes more evident. In addition to what emerged from Figure 1, it can be noticed that certain areas, in black, had no open activities during the lockdown (Stephenson; Parco dei Navigli; Ronchetto delle Rane).

These areas have less than thousand inhabitants and very low population density values and experienced a desert of function during the harder months of the pandemic with no proximity at all.

Also, larger and more populated areas (Parco Forlanini – Cavriano, 0.15; Maggiore – Musocco – Certosa, 0.24) experienced a closure of more than three fourth of the activities. Interesting is also the case of three recently developed areas as Tre Torri (City Life), Cascina Merlata and Scalo Romana that scored respectively 0.1, 0.25 and 0.28. This highlights that the presence of essential activities is still poor and didn't follow the arrival of new residents in the area. The last thing that can be noticed is how the railway ring often separates areas belonging to different classes.

### Malls

Passing to the analysis malls, it is necessary to remember that this list doesn't come from any official source, and it is the result of the integration of different online sources. For this reason, there might be other structures in the city at least comparable to those included in this sample. One example is The Oriental Mall, located in Via Paolo Sarpi, excluded because it wasn't possible to get the information about the number and the typology of shops inside it.

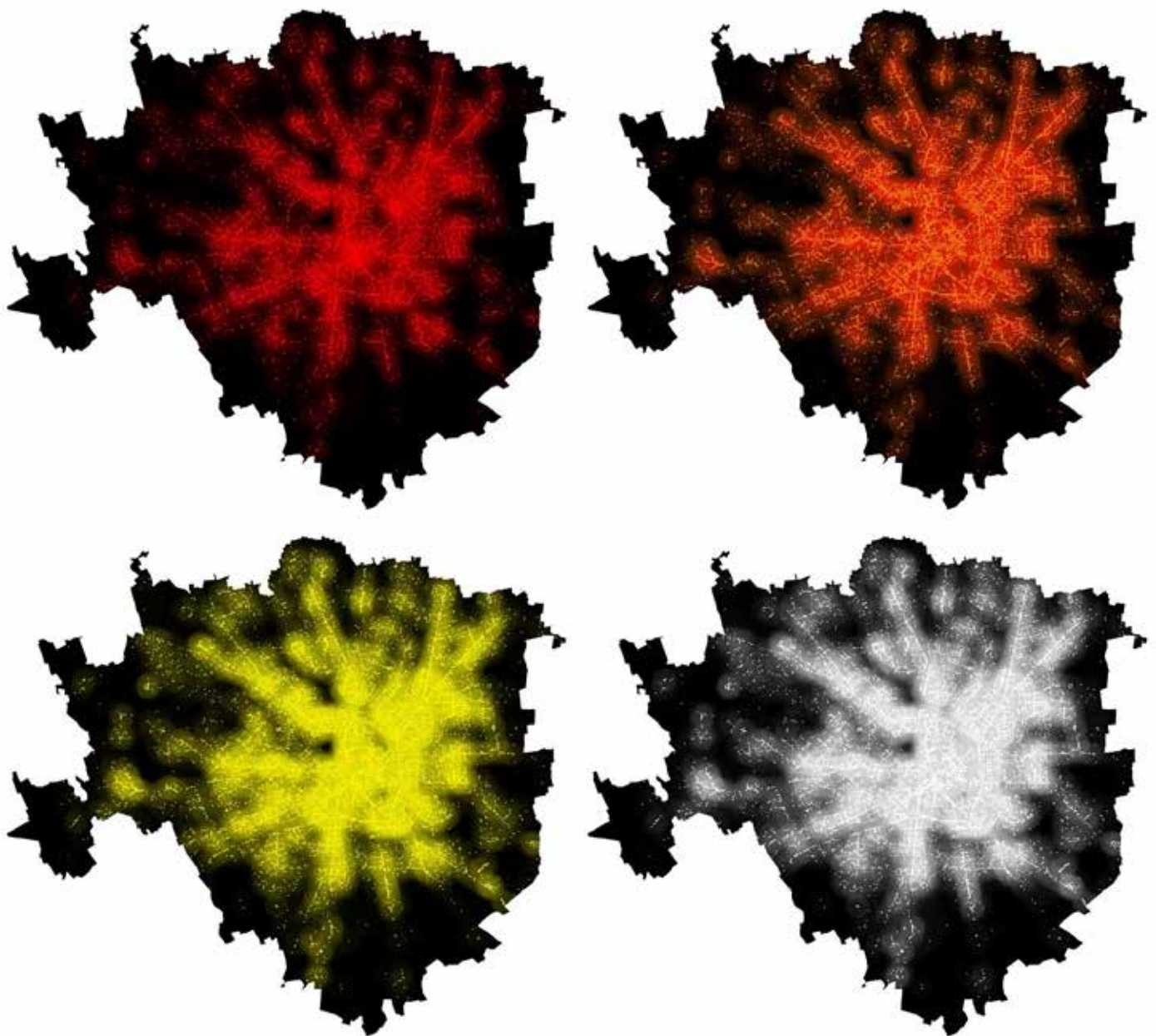
Similarly, to what done for the whole city, the activities open during the red zone were compared to those open during the white zone. The reason for looking at malls is that the restrictions imposed forced them, on holidays and days before holidays, to practically be in the red zones for at least 3 days per week even during the orange and yellow ones. In Table 3 the malls and the NILs they belong are compared showing the R, W and R/W value for the sole mall, for the NIL it belongs and for an 1km buffer area around the mall centroid.

This last column has been computed because the NILs consistently vary in size and to also consider those activities nearby the mall but laying in a neighboring NIL.

The Mall column mainly helps us in distinguishing different types of malls and their attractiveness at the city and metropolitan scale. The recently open City Life Shopping District has the lowest value (0.08), that is coherent with its metropolitan echo, while Centro Commerciale Bonola (0.16) has a more local character. Unicenter is a very small sale structure in comparison to the others and mostly contains essential activities in an area characterised by urban sprawl and a relatively low density as Bovisasca NIL. This explains its very high value of R/W (0.75). The NIL column adds details to what presented in Figure 2 and shows the need of overcoming administrative geographical units to perform this analysis. In fact, the range of the values is smoothed in the last column (1km buffer) where, however, interesting differences still emerge. Centro Commerciale PiazzaLodi R/W value (0.45) is significantly higher than that of Centro Commerciale Bonola (0.31). This can be easily explained by the morphology of the surroundings (Figure 3), by the accessibility to the mall, mostly intended for pedestrian in the first case and for cars in the second, and by the size of the mall itself.

[Sch 4] Table 2. Comparison between the total number of features and those with a valid geometry. Source: authors elaboration

Zone	Total number of open activities	Total number of open activities with a valid geometry
Red	8'320	7'744
Orange	16'505	14'037
Yellow	20'381	16'933
White	20'794	17'166



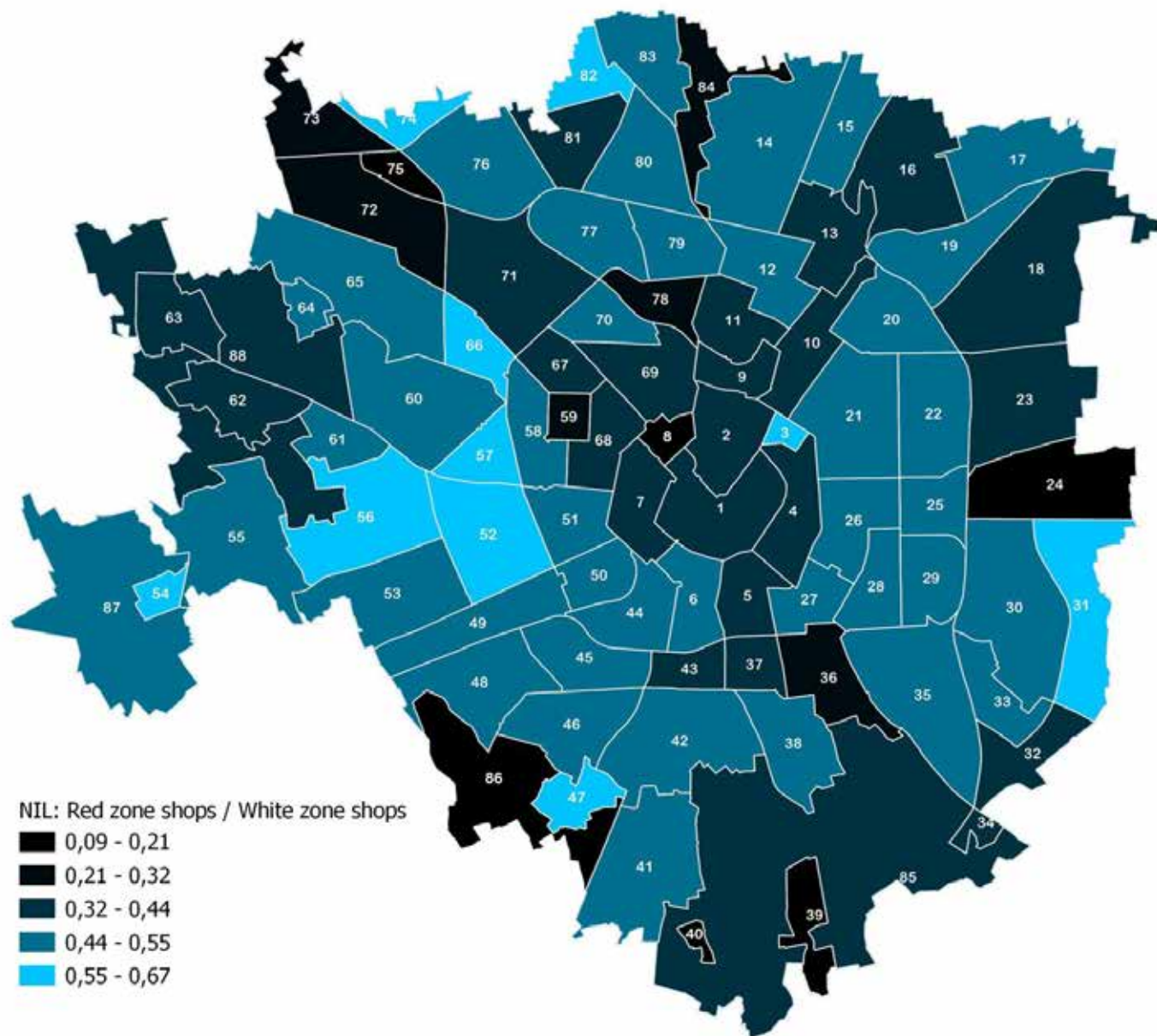
### **Clusters/Hotspots**

The last aspect that has been investigated is the identification of potential hotspots for the spread of the virus. The assumption is based on the direct observation and report (Milano Today 2020) of long queues outside the few open shops during the pandemic (e.g., up to 3 hours for the post office and 40 people for the bakery) generated by the limited number of open activities, by the limited capacity of the activity in order to maintain the safety distance and by the fact that people were not working or in smart mode.

For this reason, those areas characterised by a high concentration of activities always open during the lockdown (red zone) in a limited space have been identified using the DBSCAN clustering algorithm of QGIS testing different maximum distance values (25; 50 and 100m) as input. At 25m, the largest clusters were in Via Marghera (10 activities), Corso San Gottardo (9) and Via Paolo Sarpi (9); at 50m in the area of the former Lazzaretto (41), mainly in Via Panfilo Castaldi, Via Lazzaro Palazzi and Via Lecco, and again in Via Paolo Sarpi (26, with Via Messina and Via Aleardi) and Corso San Gottardo (23); finally, at 100m, in a large area on the south of Piazza Duomo (119), particularly in the blocks around Via Torino, Via Mazzini and Via Orefici, and again in the Lazzaretto (53) and Paolo Sarpi (48) area. Figure 4 compares the three areas that presented clusters at least at two distances showing them at the same scale with a red convex hull grouping the activities concurring in the formation of the cluster on a figure-ground map.

According to the authors, the most representative and potentially risky clusters are those at 25m both for

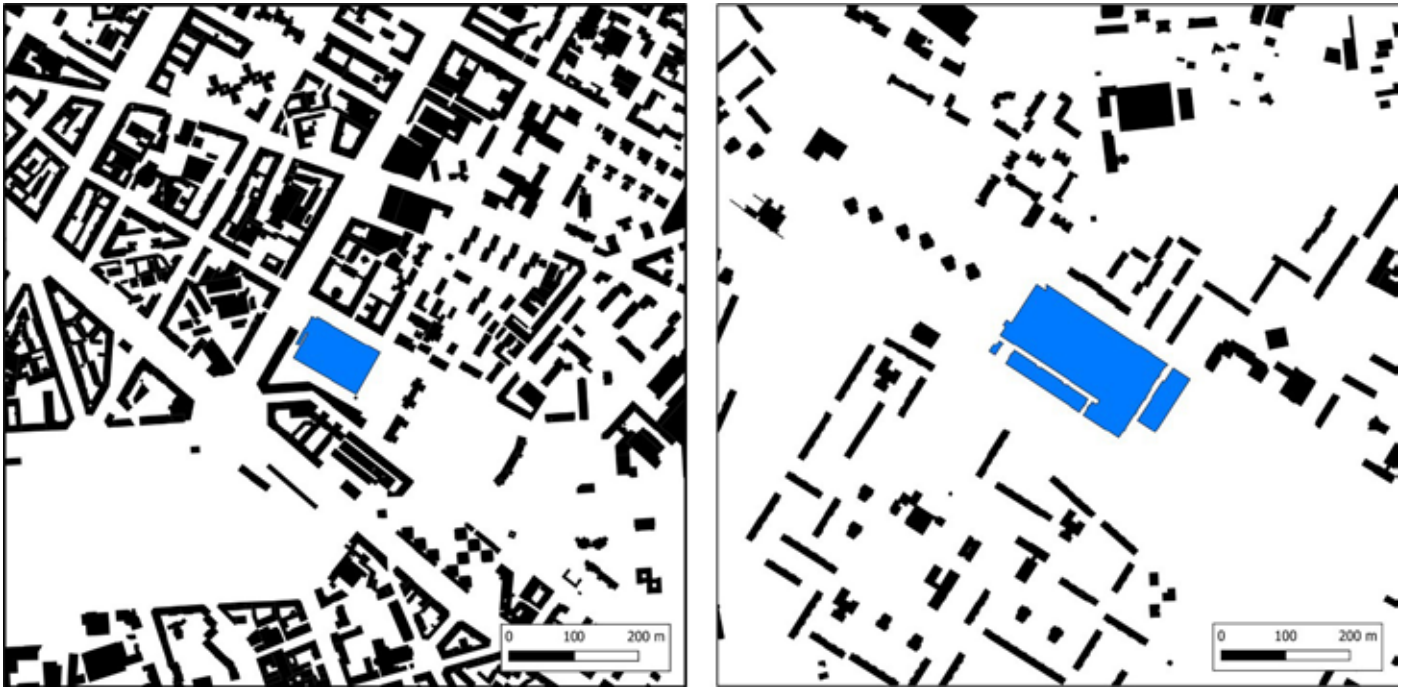
[SCh 4] Figure 2. NILs classification according to the R/W ratio [R = activities open during the red zone (R); W = activities open during the white zone (W)]. Source: author elaboration



[SCh 4] Table 3. Comparison of the Malls in the study and the impact of the restrictions on the number of open activities in the mall, in the NIL and in 1km buffer area. Source: author elaboration

NIL	Mall name	Mall			NIL			1km buffer		
		R	W	R/W	R	W	R/W	R	W	R/W
BOVISASCA	Unicenter	6	8	0.75	21	51	0.41	26	72	0.4
VILLAPIZZONE - CAGNOLA - BOLDINASCO	Portello	5	45	0.11	185	501	0.37	196	446	0.41
Q.RE GALLARATESE - Q.RE SAN LEONARDO -	Centro Commerciale Bonola	10	62	0.16	68	178	0.38	40	97	0.31
TRE TORRI	City Life Shopping District	7	92	0.08	12	116	0.1	207	500	0.36
UMBRIA - MOLISE - CALVAIRATE	Centro Commerciale PiazzaLodi	3	30	0.10	117	240	0.49	316	676	0.45
BICOCCA	Bicocca Village	8	48	0.17	45	126	0.36	69	169	0.35
STAZIONE CENTRALE - PONTE SEVESO	Stazione Centrale	9	89	0.10	181	515	0.35	448	1037	0.41
PORTA GARIBALDI - PORTA NUOVA	Stazione Garibaldi	6	22	0.27	95	229	0.41	408	937	0.43

[Sch 4] Figure 3. Ground maps of the context of Piazza Lodi and Bonola malls, highlighted in blue. Source: author elaboration



the closeness of the activities and also because they usually interest a single street. While Via Paolo Sarpi is a pedestrian area, with the whole street width at disposal, Corso San Gottardo is not but luckily it has quite large sidewalks. However, its cluster interests both sides of the street for a length of nearly 100m. Great concentration of people may discourage pedestrians to walk through and, in this case, no alternative path with a similar length could be found. Looking at 50m clusters, in the first two cases we have simply an extension of the 25m ones involving side streets while in the area of Lazzaretto, the upper part of the cluster is generated by a grid of four perpendicular streets with very narrow sidewalks. Finally, clusters at 100m are probably less warning as it's difficult to imagine having great concentration of people in such large areas. However, in a case like Paolo Sarpi, the sole in the whole city where clusters emerged also at shorter distances, this information can be relevant with the area of potential risk becoming significant.

#### 4.4 Discussion

These maps and data show aspects made visible by the pandemic restrictions with the purpose of demonstrating how they significantly modified the normal urban system behaviour. They all highlight potential vulnerabilities of the Type of Uses Component that can be seen as a lack of preparedness to this specific kind of crisis.

This doesn't want to be a critic to the city planning, also given the unpredictability of what happened, nor to paint in a negative light a specific area, that could have had a better performance respect to the one here described. Their purpose is to reflect on how each crisis might suffer or benefit from different arrangements of urban components, with implications at a very local or fine grain scale.

Looking at the proposed experiments from a different risk perspective, like that of climate change, interesting things can be noticed. From the first one, we can notice that great concentrations of optional or occasional activities in few areas require people to commute and a certain share of this movement is still polluting and congesting our streets. If malls confirm their negative performance as energy-intensive structures often promoting the use of cars, grouping essential activities in a car-free zone with high accessibility is surely a positive thing.

The complexity of these issues discourages any ready-made and globally acceptable solution while requires a full understanding of urban system structure and performances and the integration of the different dimensions of resilience. Vulnerable structures, unable to effectively perform under different crisis scenarios, can and should be rethought. On the contrary, as seen in the clusters example, a structure that well answers the challenges of climate change, that however surely remains a priority issue respect to COVID, shouldn't be modified every time for the new emergencies.

The laws and the measures temporarily modifying urban structure and consequently its performance should be tailored to the needs of every context, possibly exploiting the advantages of smartly managed cities.

[SCh 4] Figure 4. Areas of potential risk of exposure due to the concentration of open activities during the red zone. Source: author elaboration



## 5 Conclusions

This article wants to make a step in the direction of defining an operative methodology for assessing urban resilience at the various scales. It assumes IMM methodology as a good theoretical infrastructure to operate in this direction but recognizes the need to delineate a more comprehensive and exhaustive resilience framework. This could be done by creating a matrix-like model showing the implications of any experienced and future risk for cities on the different urban components, identifying those structures, maybe not yet in place, able to perform positively in the widest range of conditions. As resilience is a context-specific property, the outcomes of this model should possibly be weighted according to the risks' probability of occurrence, which varies case by case.

New experiments can also be done to simulate how the restrictions imposed affected the other urban components and explore the emergence of both positive and negative aspects. For example, the presence of private open-air spaces or the proximity to green infrastructures (Porosity KC), the change in transportation offer and demand (Effectiveness KC) or the suspension of mobility restrictions (Permeability KC). These additional studies, as well as the one here presented, would then greatly benefit from a comparison with dynamic performance data (social network, sensors) to understand the reliability of preliminary structural simulations as the one presented.

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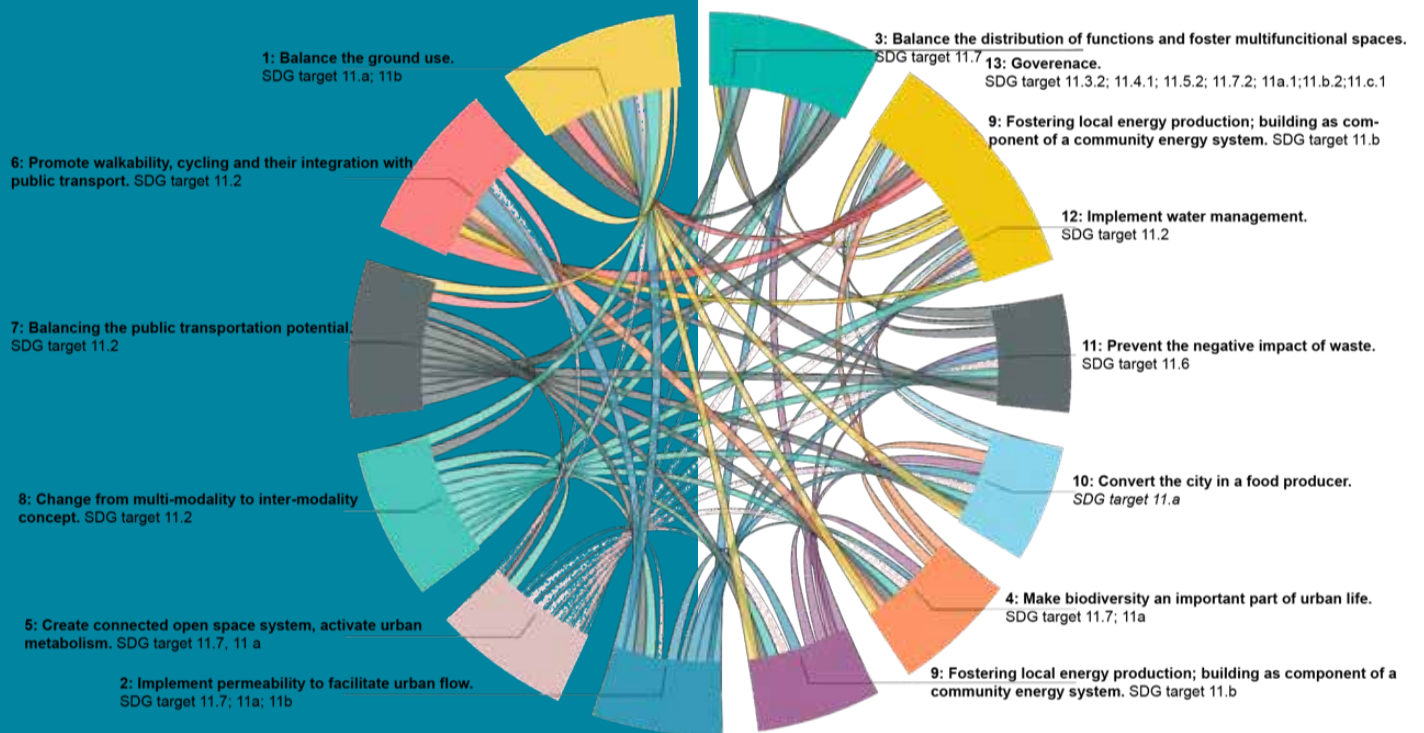
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# KEYWORDS

URBAN MORPHOLOGY,  
PERFORMANCE INDICATORS, URBAN  
DESIGN, URBAN HEALTH



*Design Ordering Principles (DOP), their connections with each other, and its correlation with Sustainable Development Goals. Source: IMM Design Lab*

# [SCh5] Assessing Link of Urban Morphology and Health. A case study in Milan

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## 1. Introduction

Since the COVID-19 pandemic is a global challenge in many aspects, new research questions have raised in many fields, including architecture and urbanism. This pandemic crisis gave the opportunity to investigate if the cities are resilient for crisis. It is not the first health issue humanity faced, there were other contagions before: malaria, plague, Spanish flu, and many other infection diseases. The city has also role in some chronic diseases such as respiratory infections, cardiovascular, and lung diseases.

Before the pandemic, literature related to cities and health was quite limited. There are different risk factors in the urban environment which may cause a chain relation and has negative impact about epidemiology of emerging infectious diseases. For instance, poor housing can lead to proliferation of insect and rodent vector diseases and hence inadequate water supplies as well as sanitation and waste management. Additionally, overcrowded housing in high-density populations in the slums can be a breeding ground for some infectious diseases such as tuberculosis. Another risk factor is the density of inhabitants and the close contact between people. This areas in cities are potential hot spots for rapid spread of merging infectious diseases e.g., severe acute respiratory syndrome (SARS) and the avian flu (Neiderud, 2015).

As National Intelligence Estimate highlighted, environmental and climate change has negative impact on malaria; migration and urbanization have on HIV-AIDS (National Intelligence Council, 2000). Regarding the malaria migration, urbanization, socioeconomic conditions, and a lack of adequate communication between relevant stakeholders were defined as the main obstacles to control the diseases effectively (Enwereji, 1999).

Urbanization and the growth of megacities are two of demographic factors have impact on health (Institute of Medicine 2003, 6). Increased population growth and urbanization, much of it unplanned, has contributed greatly to the dramatic increase in some species of mosquito abundance that infect people diseases (Institute of Medicine, 2003, 120). Once any infectious virus appears in a major urban area, it spread through transportation ways and causes local, national, or even global distribution in only a matter of days.

As insights from the pre-COVID-19 researches, it can be said that there was a consensus of large urban areas are more vulnerable to transmission of infectious diseases. Based on the accelerated

## ABSTRACT

*Despite some previous efforts to study the relationship between urban design and health, the COVID-19 pandemic has attracted more attention on this topic, including all living beings. It has also created awareness of the urgency of reconsidering how cities are designed and lived in.*

*Therefore, the ways of design more resilient cities and rehabilitate them by transforming them into healthier ones and making them become prepared for any possible similar risks in the future are fundamental for post-pandemic cities. This link between cities and health (including mental and physical) might be related to urban morphology, besides environmental and social parameters. This study aims to evaluate the role of the built environment on health and well-being, which affect not only the process of the spread but also the recovering process. In order to achieve this aim, the problem is precisely investigated by focusing the health-related subjects in the context of IMM (Integrated Modification Methodology), which is a holistic, model-based, and objective methodology.*

*This article will present the metrics and indicators to understand the weak parts of the existing structure, and DOPs which could be the items in the design process of a healthier and more resilient city for the post-pandemic era.*

*The abandoned railway yard of Farini and surrounding in Milan has been selected as a case study to implement the methodology and eventually make evident how to improve a proposed masterplan.*

research interest in last two years about the relation between COVID-19 and territorial characteristics, many key factors considered as effective in pandemic consequences. In the existing studies conducted so far, some factors have been investigated which may affect the contagion of the COVID-19. These factors could be classified into four different categories i.e., environmental quality, socio-economic impacts, management and governance, and transportation and urban design (Sharifi and Khavarian-Garmsir, 2020). Even the parameters besides the last category, are inevitably connected to the approach of architecture and built environment. Therefore, the existing situation which comes from the global coronavirus pandemic crisis conditions points out the urgency of rethinking the way of how urban areas are built, maintained, and lived in.

Some cities have taken some actions such as investing to cyclability, considering social distances as a necessity in urban life, or building shelter for homeless people. However, these solutions are not efficient for long-term. Each of these issues highlights to changes in urbanization after pandemic to offer inhabitants healthier, resilient, and sustainable environments without risk factors like high air pollution and as a result, a life with low possibility to have chronic and/or epidemic diseases. Another result of pandemic is the tremendous increase in online shopping since people do not opt for going to supermarket or commercial shops to prevent social contact with possible infected cases. This issue should make all related actors think about proximity of shops in urban environments. A study (Fezi, 2020) conducted in the context of health engaged urbanism and its multi-scale interpretation about different key attributes. For instance, it highlighted how the shop distribution in the cities affects proximity shopping and in turn the possibility of preventing spread at urban scale. Another novel research (AbouKorin et al., 2021) measures the effect of urban morphology on transmission in European cities. It is found that cities with linear morphologies have the lowest infection rates in comparison with the ones with gridal and radial formed cities.

This research used IMM (Integrated Modification Methodology) to a selected area in Milan, the Farini railway yard and its surrounding. In this paper, only the parts that shows the relation between urban morphology and health issues have been shown from the context of a comprehensive project.

Briefly, the existing structure and the environmental performances of the project area is represented numerically by metrics and indicators respectively. Afterwards, some principles amongst Design Ordering Principles are explained that taken into account to produce masterplan. Last but not least, an optimization way represented to improve the proposed masterplan which based the performed analysis. With the enlightenment of metrics, indicators, and Design Order Principles this paper investigates and applies alternative evaluation methods and urban design solutions to overcome the urgencies that emerged during the COVID-19 pandemic for the future.

## 2. Methodology

The methodology of this research belongs to the framework of IMM. Due to its holism and wide context, the most related parts to the scope of this paper have been selected to represent in this paper. It consists of 4 different phases and this paper covers all the phases partially.

The main idea of this methodology is based on that urban design can directly play big roles on the quality of our lives and the environment that we live in. It has a multi-layer, multi-scale, and holistic approach. IMM approach to sustainability is aligned to the UN Sustainable Development Goals 2030.

The required data is obtained from different sources or obtained by the authors manually. The data sources are as follows: DBTR (Topographic Regional Database) of Lombardy, SIT (Territorial Information System) of the Municipality of Milan, and Daytime Surface Temperature Hotspots by SIT. Additionally, the analysis which includes demographic data is performed the data provided by ISTAT (Italian National Institute of Statistics).

The Farini area, located in the north of Milan, is used as the case study for this research (figure 1). It is one of the abandoned railway yards in the city. It could be read as a huge void due to the fact that a big part of the land is occupied by rails. This area is under development by the Municipality of Milan.

### 2.1. Assessment Metrics

The quantitative metrics have an important role to understand and interpret the existing structure of the area through IMM framework. The values depend in the range from 0 to 1, they have been normalized in need. There are six spatial assets to represent each Key Category (Tadi et al, 2020).

Key categories show a functional symbiosis between all subsystems (i.e., void, volume, types of uses and links) regarding the functional interdependency between them (Biraghi et al, 2017). In this study, only the most related metrics with health issues have been presented as shown in Table 1.

The quantitative metrics in table 1 shows spatial issues that are related with health of living beings directly or

[Sch 5] Figure 1. Location of local project area and surrounding. Source: author elaboration based on Google Earth aerial view



[Sch 5] Table 1. Selected metrics among all the 42 metrics of IMM. Source: author elaboration

	Key Category	Brief Definition		Metric	Input
1	Porosity	different arrangements of buildings and void to measure the compactness level	1	Void Volume Ratio	void volume/total volume
			2	Net Floor Ratio	floor area/block area
			3	Net Courts Area Ratio	closed court area/block void area
2	Permeability	how structure to let people move into the urban network	4	Directness	linear distance/network distance
3	Accessibility	the uneven distribution of functions and public transportation stops	5	Number of Key Functions	number of activities within the catchment area of 5 min.
			6	Network Measure	pedestrian areas within 2.5 min public transport catchment/total area.
			7	Attractors	distribution of employees in each census section
			8	Generators	distribution of the population for each census section
4	Interface	movability in morphological cavities	9	Block Built Parameter	block perimeter with buildings aligned/total block perimeter
5	Proximity	morphological quality that urban context offers to walk through primary types of uses	10	Mixed-use Share	number of employees/ number employees and residents
			11	Surface Share	surface of window-shops/total street level surface
			12	Simultaneous Proximity	residents in proximity area/total residents
			13	Street Discomfort Ratio	length of comfortable streets/total length of streets
6	Effectiveness	how built volumes are covered by walkable area of transportation simultaneously	14	Employees Density	number of employees per unit of area
			15	Volume Density	total Building Volumes per unit of area
			16	Population Density	number of residents per unit of area
7	Diversity	emerged by superimposition of city elements: types of uses, voids, volumes, and links respectively	17	Number of Types of Uses	total amount of Type of uses
			18	Diversity Index	total types of uses/total number in a given context
			19	Coverage	total type of uses (except residential) x total floor areas (except residential) over the total building's floor area

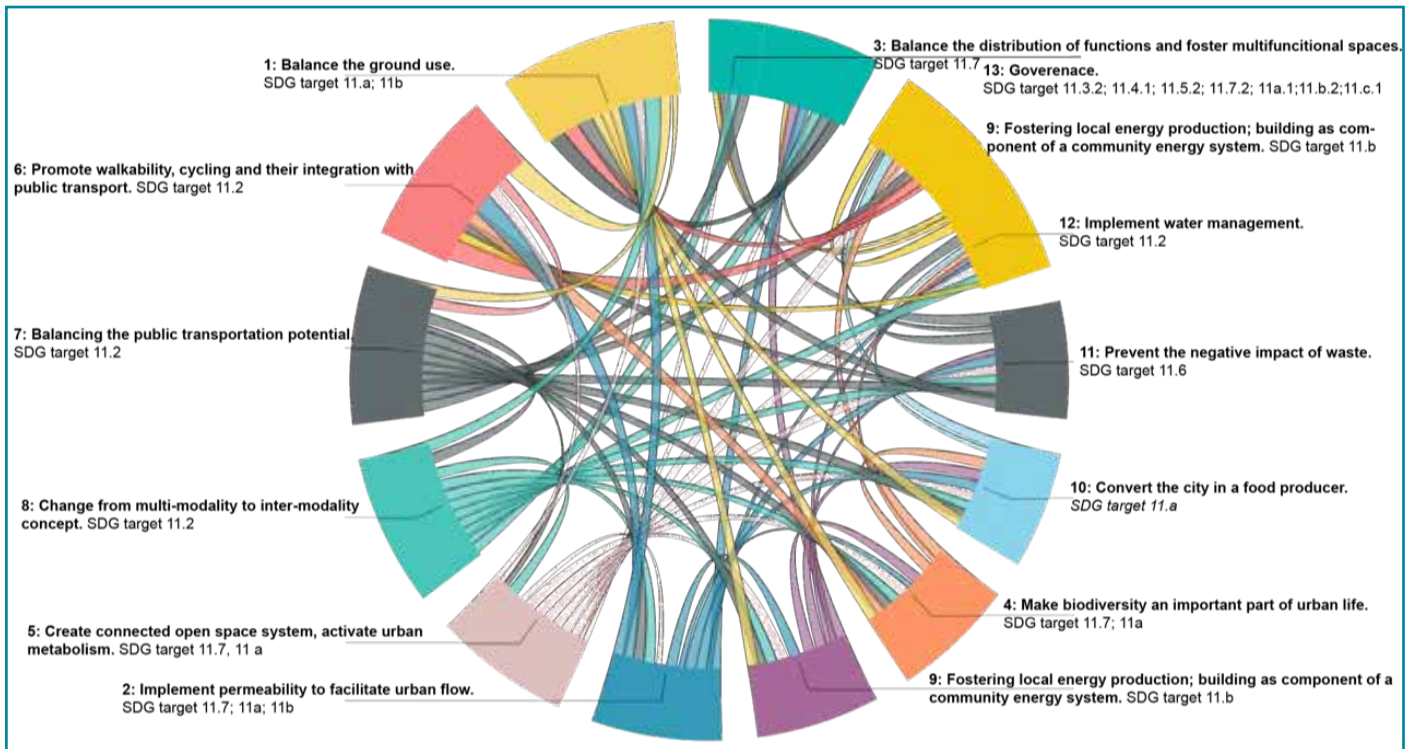
indirectly. Void Volume Ratio, Net Floor Ratio, and Volume Density give clues about the physical structure of built area that might be related to urbanization activities. Net Courts Areas Ratio and Block Built Parameter are alternative ways to study the number of open areas in built environments. Directness and Street Comfort Ratio show how users can walk or cycle easily and comfortably, instead of using public transportation. On the other hand, Number of Key Functions, Network Measure, Mixed-use Share, Surface Share, Simultaneous Proximity, Number of Types of Uses and finally Diversity Index makes evident different phenomenon about the activities both in terms of the function of entire building (i.e., office, commercial, ...) and the various ground floor types (i.e., bakery, pharmacy, bar, market, ...). All these metrics points out a way to understand how close contact might increase between people. On the other hand, Attractors, Generators, Employees Density, and Population Density considers the main subject in the city, the people in terms of user density. Whereas Attractors refer to number employees in the area, Generators represents number of residents in the area.

## 2.2. Performance Indicators

Indicators are a core set of elements based specifically on environmental themes but interlinked with other social and economic themes. They are used in the IMM, for comparing the characteristic performance of the system, prior to and after the transformation design process (Tadi and Manesh, 2014). Performance indicators are tools which are useful to measure energy and environmental performance and they are almost 150 in total as a spreadsheet produced by IMM Design Lab. The choice criteria among all indicators as the same criterion considered in the case of assessment metrics: having strong ability to represent the link between urban and health.

[Sch 5] Table 2. Selected Performance Indicators among 150 of IMM indicators. Source: author elaboration

DOP	Indicators	Inputs
1	1 SDG 11.3.1 Ratio of land consumption rate to population growth rate (UN-Habitat, 2020a)	Land consumption rate/population growth rate
	2 SDG 11.1.1 Proportion of urban population living in slums, informal settlements, or inadequate housing (UN-Habitat, 2020b)	Number of people living in Slum/Informal Settlements households, inadequate housing households and total population
	3 Number of buildings per hectare	Number of buildings/total land area
	4 Urban Built density	Total volume of buildings/total area
	5 Block Density (Salat et al., 2011)	Number of blocks in each area/total area (ha)
2	6 Heatmap Street indicator	Global Temperature (in C°), Length-Temperature product (mXC°), Total Length (in m)
3	7 Ratio between numbers of residents and activities	Number of residents/number of activities
	8 Housing diversity	Low-income housing/Total housing (in 2009)
4	9 Proportion of the resident living 300m of a park (Chan et al., 2014)	Residents live in in a 300 m distance from parks/total population
5	10 Extent and number of parks (%)	Numbers of parks/tot area ha
	11 Lawn Cover Ratio (LCR) (%)	Total green surface/total open surface
	12 Percentage of Residents within Walking Distance of a Recreation Area %	Residents live in in a 400 m distance from recreation areas/total population
6	13 Length of biking roads	The proportion of roads dedicated to bike.
	14 Number of bike parking spots	Number of parking spots/total residents
	15 Bike Sharing	Total number of bike sharing points
	16 Population with walkable access to bike trails	Population within 400 m to bike trails/total population
	17 Number of key functions in a walking distance from residential buildings (ITDP, 2018)	The number of key functions located in a 300 meters distance from the residential area
	18 Car free or minimal car traffic streets (ITDP, 2018)	The km of street dedicated to minimal car traffic or car free street
	19 Pedestrian street paths - walkways (ITDP, 2018)	Total pedestrian street area/total street area
	20 Number of people that are within walking distance of frequent transit stops (ITDP, 2018)	Population within 5 min catchment area from public transport stop/total population
	21 Physically permeable frontage. Number of entrances per 100 meters of block frontage (ITDP, 2018)	Number of entrances/numbers of 100*100 blocks
	22 Sidewalks that are lined with continuous ground-floor activity (ITDP, 2018)	Length of sidewalks face with activities/Total length of sidewalks
	23 Shade and shelter (ITDP, 2018)	Area of canopy of trees and area of shadow elements/total area
	24 PM <sub>10</sub> Annual average concentration in Milan (UN-Habitat, 2020)	Level of fine particulate PM <sub>10</sub>
	25 PM <sub>2.5</sub> Annual average concentration in Milan (UN-Habitat, 2020)	Level of fine particulate PM <sub>2.5</sub>
	26 NO <sub>2</sub> Annual average concentration	Level of fine particulate NO <sub>2</sub>
10	27 Number of Urban farms within a given locale/community (Pansing et al., 2013)	Number of community gardens in the study context
	28 Access to community gardens (Pansing et al., 2013)	Population within 400 m to community gardens/total population



### 2.3. Design Order Principles (DOPs)

DOP is the acronym of Design Order Principles, and they are 12 in total as represented in figure 2. They are not just a list, more like a network of targets. Design Order Principles include a variety of interactions and all of them are related with each other. DOPs are correlated with the Sustainable Development Goals and especially 11th one (Sustainable Cities & Communities) is directly related with this field. All DOPs are related to the subject of this research with different degrees of relevance hierarchically. 7 DOPs have been selected to present as the most integrated ones.

**1. Balance the ground use:** Its aim is to prevent the land degradation. This DOP is correlated with the UN's SDG target 11.a and 11.b. SDG 11.a is Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city. SDG 11.b is Number of countries with national and local disaster risk reduction strategies. Land use, community design, and transportation systems substantially impact local air quality, water quality and supply, traffic safety, and physical activity (Fallon and Neistadt, 2006). Hence both targets have inevitable relationship to public health, a holistic urban plan have to be implemented in all cases. The land in the case of Farini area is currently occupied by disused railways. Main aim is to transform disused railway yard into commercial, business, cultural and residential areas with the integration of open public areas and corridors.

**2. Permeability to facilitate urban flow:** This DOP is correlated with SDG targets 11.7 that provide universal access to safe, inclusive, and accessible, green, and public spaces, particularly for women and children, older persons, and persons with disabilities. Accessibility to green and public spaces is beneficial for both mental and physical health (Velarde et al, 2007). Everyone in the area should be able to reach these areas without any obstacle. To make this access possible for both pedestrians and cyclers became more important since the transmission risk of contagious diseases by close contact might increase in indoor and crowded areas such as public transportation vehicles.

**3. Balance the distribution of type of uses and foster multifunctional spaces:** This DOP is correlated with the UN's SDG target 11.7 as previous. Balance of distribution of several activities is more than mixing them. A proper distribution should provide simultaneously with the need of mixing them quantitative property and to arrange them morphologically. As a quantitative property, this balance could create safety and livability, improve accessibility to work for employees and services for all the people in the area. Even if a dominant



function of a building is residential, it should include various functions at the ground floor level such as baker, market, or several shops. If this principle is implemented, to come together and form a crowd in closed areas, correspondingly close contact, would be prevented.

**4. Make biodiversity an important part of urban life:** The considerations are to develop urban green infrastructures as recreational opportunities and get benefits from them by enhancing biodiversity in terms of its environmental benefits such as cleaning water, air, and soil. In this case, five different classes of main green areas are proposed as represented in figure 3b: public green area to connect all existing and proposal green system; community garden to be managed by residents, botanic garden that includes a wetland zone, a buffer line with railways and the railway ecosystem itself. And each of these classes considered which species could be best solution for the environmental concerns. Besides environmental benefits, consideration of the arboreal properties, the species were chosen because of their longevity, the characteristics of flowers and fruits, the richness for the flora and for ecological and aesthetic characteristics to create colorscape to improve aesthetics and psychological impacts. During the pandemic, physical and even visual interaction with living plants is beneficial for mental health (Gola et al, 2021).

**5. Connected open space system, activate urban metabolism:** To create a strong connection between the intervention area and the surrounding in the city through green bridges that are also used for making accessibility easier for not only motorized vehicles but also bikes and pedestrians. To activate urban metabolism, existing green composition is defined, and they are tried to become a part of this green and open system at two different scales (figures 3a and 3b). However, it is possible to connect with some green corridors, as represented in figure 3a. The existing active railway yard is evaluated as railway ecosystem, since this land is a part of the urban ecological corridors that flank the infrastructures and an open system that promises rich urban biodiversity both for flora and fauna. This event creates a chain effect and improve air quality of the neighborhood as well due to the capability of decreasing pollution levels of plants (Lazzari et al, 2018). This

[Sch 5] Figure 3. (a) Open green corridors at intermediate scale and surrounding (b) Green network at local scale in relation to surrounding. Source: author elaboration

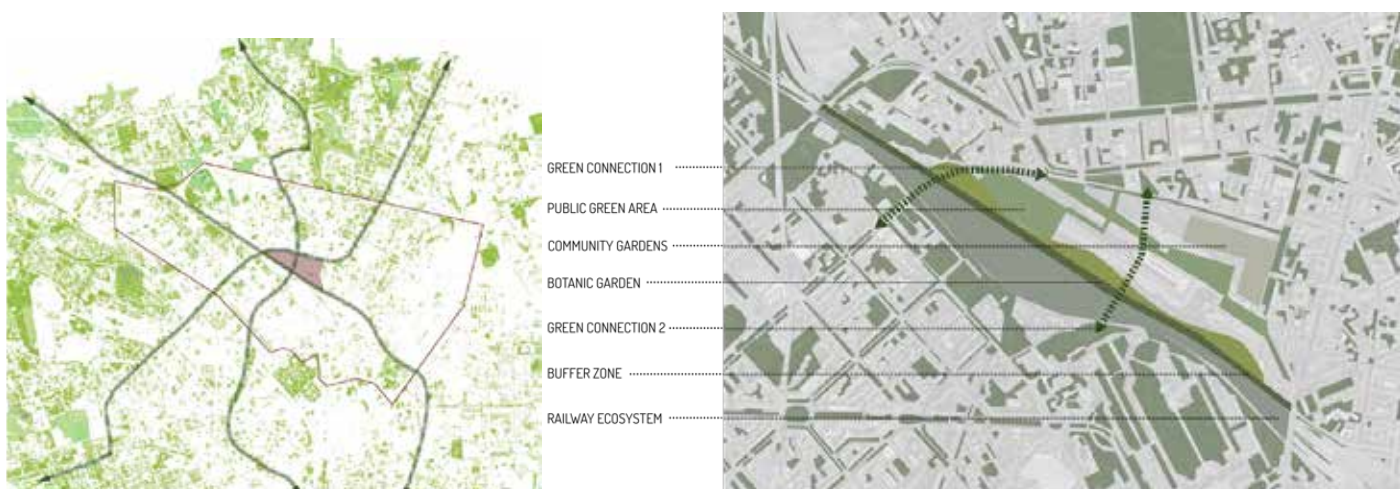
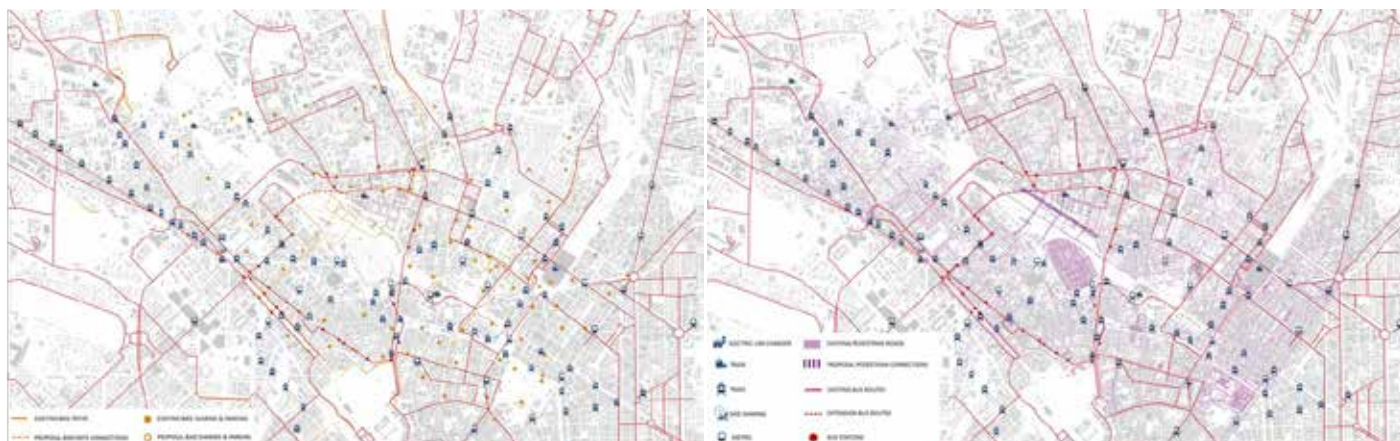


Figure 4. Intermediate scale (a) Cyclability proposal (b) Walkability proposal. Source: author elaboration



principle provides improvement in urban environmental quality.

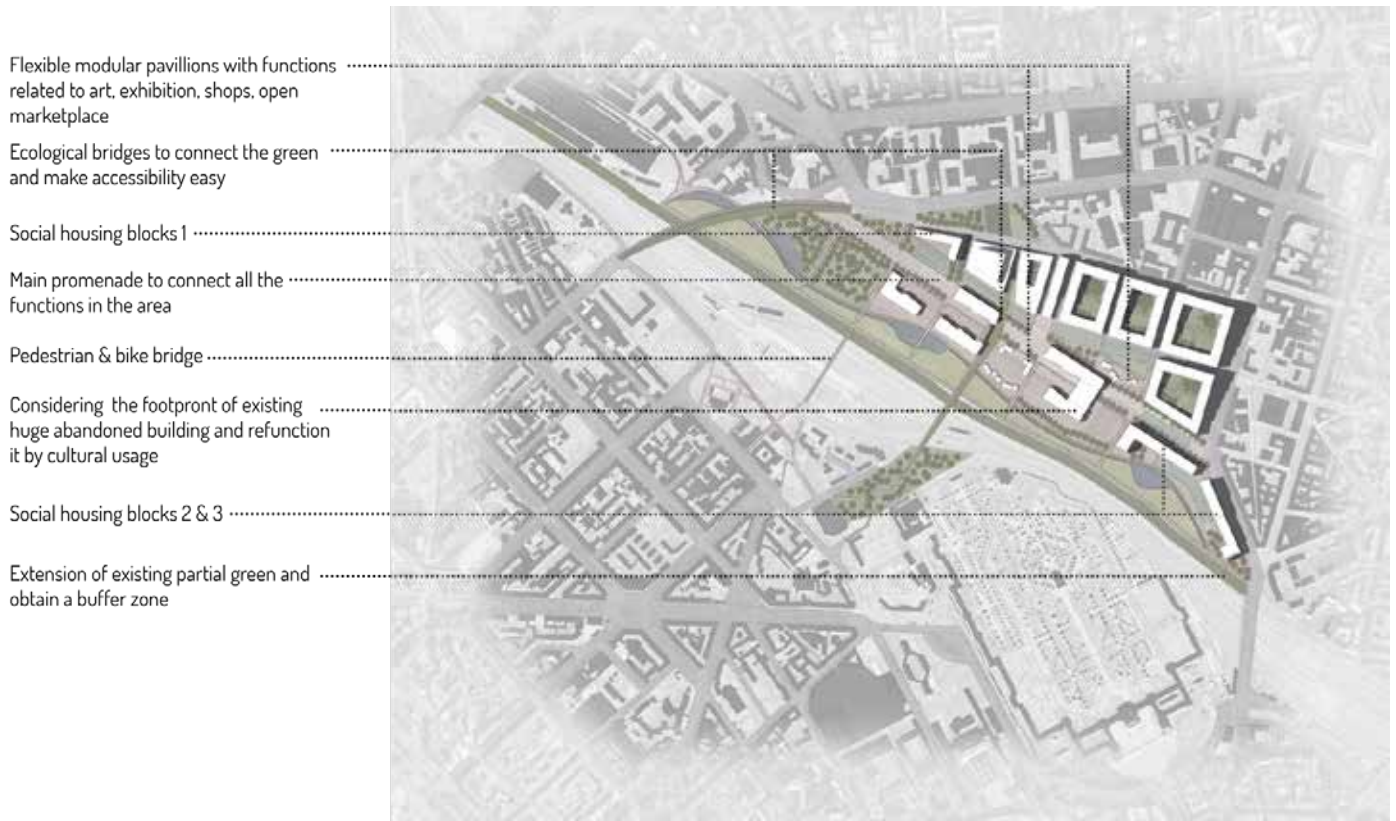
**6. Promote walkability, cycling and their integration with public transport:** This DOP is correlated with SDG target 11.2. Both walkability and cyclability could improve the energy efficiency in the area and correspondingly decrease air pollution. In addition, to encourage people to walk or cycle improve their physical and mental health. Main aim is to take advantage from the existing pedestrian and bike paths and make the area as a part of this network as it is shown in figures 4a and 4b. In this case, bike is proposed as the main transportation mode. Many bike sharing and bike park points are organized to improve the cyclability in the area and surrounding.

**10. City in a food producer:** The proposal buildings which has residential functions are located at the northeast part of the site. The shape of this volumes lets to have community garden inside. In total, there are four community gardens which could be managed by the residents who live in this area. All these gardens are connected to each other with internal pedestrian and bicycle paths. At a strategic point, that are reachable comfortably from all the residential blocks, an open marketplace is located with flexible outdoor pavilions. These pavilions let people to meet their need without getting in crowded outdoor spaces. In this open market, the residents could sell their crops from the community gardens and the people from surrounding in the city, could shop vegetable, fruits etc. Especially during the COVID-19 pandemic lockdown and self-isolation to consume healthy food and to grow it trustily became common concerns in order to reduce risk immunology system.

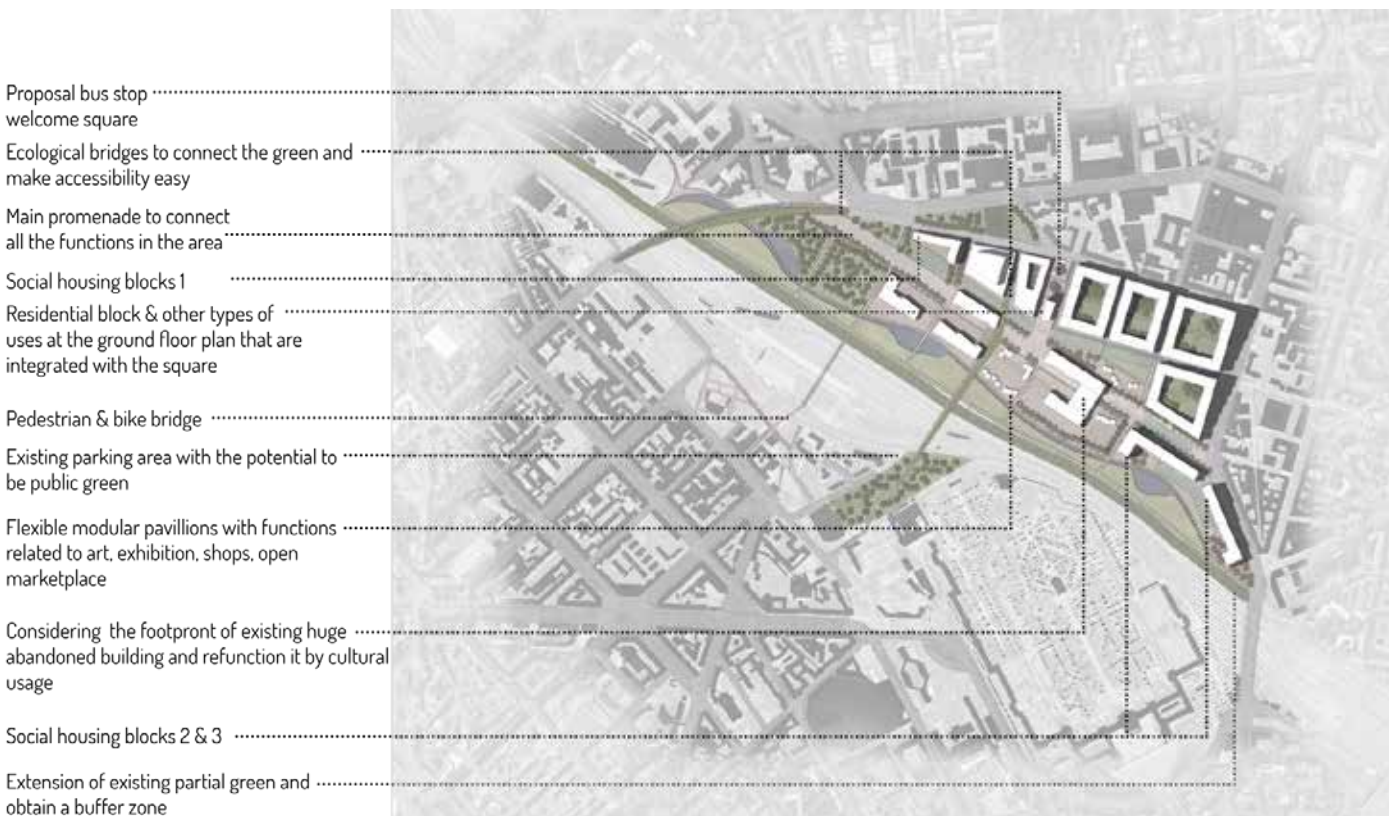
[Sch 5] Table 3. Assessment Metrics of existing situation.  
Source: author elaboration

	Key Category		Metric	Result
1	Porosity	1	Void Volume Ratio	0,910
		2	Net Floor Ratio	0,772
		3	Net Courts Area Ratio	0,093
2	Permeability	4	Directness	0,821
3	Accessibility	5	Number of Key Functions	0,441
		6	Network Measure	0,558
		7	Attractors	0,574
		8	Generators	0,179
4	Interface	9	Block Built Parameter	0,665
5	Proximity	10	Mixed-use Share	0,548
		11	Surface Share	0,144
		12	Simultaneous Proximity	0,962
		13	Street Discomfort Ratio	0,454
6	Effectiveness	14	Employees Density	0,799
		15	Volume Density	0,463
		16	Population Density	0,970
7	Diversity	17	Number of Types of Uses	0,313
		18	Diversity Index	0,446
		19	Coverage	0,203

[Sch 5] Figure 5. The initial masterplan – Masterplan I. Source: Ogut, 2020



[Sch 5] Figure 6. The final masterplan – Masterplan II. Source: Ogut, 2020



### 3. Findings

After obtaining the assessment metrics (Table 3) and performance indicators (Table 4) for investigating the existing situation of the area, the masterplan is improved by following the process of IMM methodology, that is illustrated as Masterplan I in figure 5. This masterplan is produced as a part of a master's thesis (Ogut, 2020) in collaboration with IMM Design Lab.

The aforementioned DOPs have been used as guideline in order to develop the masterplan I. This area is going to be a new part of the society and have to meet the requirements of sustainability from environmental, social, and economic aspects.

After the first masterplan, the diagnostic process has redone, and some parts detected as under-performed. Because of this reason, it is efficient to go back to the transformation phase and proposed some local interventions in the masterplan which is shown as Masterplan II in figure 6.

Both after producing masterplan I and II, the performance indicators have been recalculated to evident the improvement, as the result can be seen in Table 4. In case of opposite situation and/or less improvement than required, masterplan is partially edited.

[Sch 5] Table 4. Performance Indicators of existing situation and after two masterplans. Source: author elaboration

DOP	Indicators	Existing	After Masterplan I	Change I	After Masterplan II	Change II
1	1 SDG 11.3.1 Ratio of land consumption rate to population growth rate	32,33	29,24	3,09	29,24	3,09
	2 SDG 11.1.1 Proportion of urban population living in slums, informal settlements, or inadequate housing	17,27 (ISTAT, 2019)	17,1	0,17	17,1	0,17
	3 Number of buildings per hectare	11,1	11,58	0,48	11,56	0,46
	4 Urban Built density	2,29	2,33	0,04	2,33	0,04
	5 Block Density	0,51	0,52	0,01	0,52	0,01
2	6 Heatmap Street indicator	0,054	0,058	0,004	0,058	0,004
3	7 Ratio between numbers of residents and activities	139,77	138,88	-0,89	138,72	-1,05
	8 Housing diversity	0,115	0,117	0,002	0,117	0,002
4	9 Proportion of the resident living 300m of a park	63%	94%	31%	95%	32%
5	10 Extent and number of parks (%)	5,39%	7,30%	1,91%	7,30%	1,91%
	11 Lawn Cover Ratio (LCR) (%)	13,17%	17,30%	4,13%	17,31%	4,14%
	12 Percentage of Residents within Walking Distance of a Recreation Area %	79%	93%	14%	95%	16%
6	13 Length of biking roads	5,8 km	18,9	13,1	19,05	13,25
	14 Number of bike parking spots	13,78	16,26	2,48	17,14	3,36
	15 Bike Sharing	92	123	31	128	36
	16 Population with walkable access to bike trails	44%	70,39%	26,30%	70,39%	26,30%
	17 Number of key functions in a walking distance from residential buildings	247	254	7	254	7
	18 Car free or minimal car traffic streets	78,4 km	90,2	11,8	92,1	13,7
	19 Pedestrian street paths - walkways	35,70%	36,33%	0,63%	36,42%	0,72%
	20 Number of people that are within walking distance of frequent transit stops	45%	48%	3%	48,05%	3,05%
	21 Physically permeable frontage. Number of entrances per 100 meters of block frontage	23,21	23,27	0,06%	23,27	0,06%
	22 Sidewalks that are lined with continuous ground-floor activity	4,40%	4,70%	0,30%	4,82%	0,42%
10	23 Shade and shelter	4,36%	6,20%	1,90%	6,21%	1,91%
	24 PM10 Annual average concentration in Milan	40 µg/m3 (ISTAT, 2019)	20	-20	20	-20
	25 PM2.5 Annual average concentration in Milan	29 µg/m3 (ISTAT, 2019)	10	-19	10	-19
	26 NO2 Annual average concentration in case	58 µg/m3 (ARPA, 2020)	40	-18	40	-18
	27 Number of Urban farms within a given locale/ community	3	7	4	7	4
	28 Access to community gardens	5,07%	10,30%	5,23%	11,10%	6,03%

## 4. Discussion

The assessment metrics are feasible in any case in any city worldwide in case the dataset is available or possible to produce. To apply this kind of objective measurement before design benefits understanding the existing structure of parameters in the context of improving the cities' health and resilience with the lessons learned from the COVID-19 pandemic. There are different questions emerged since the beginning.

The main ones are how urban design is effective on public health and how to rethink how the urban areas are designed, built, maintained, and lived in to minimize the health risks for the long term.

Regarding the first question, it has been known that urban design and urban planning impact meteorological conditions such as temperature and wind conditions due to land use, allowed built volume amount. On a broader scale, wrong policies and implementation can accelerate the climate change effects, and correspondingly it causes an environment that endangers public health. Among the indicators from Table 2, the following ones offer the opportunity to measure these issues: Number of buildings per hectare, Urban Built density, Block Density, Heatmap Street indicator, Housing diversity, Shade, and shelter. Eventually, after the design, recalculating the same indicators shows the optimum option in order to mitigate or even prevent the possible risk factors caused by related urban parameters.

Air pollution is one of the main topics occurred as more noticeable with the COVID-19 pandemic. However, even before the COVID-19, it was evident that there is an undeniable link between human health and air pollution. Respiratory infections, cardiovascular, lung diseases, brain growth damage, the onset of diabetes, and premature mortality are some of the examples. There are three different determined association between air pollution and the spread of diseases: long-run exposure is linked to air pollution (Analitis et al, 2006; Chakrabarty et al, 2021), short-term exposure (Ciencewicki and Jaspers, 2007) and higher levels of air pollution increase the infection because the virus remains in the polluted air longer (Cui et al, 2003; Wu et al, 2020).

The following indicators helps to understand where the project area stands in terms of air quality: PM10 Annual average concentration, PM2.5 Annual average concentration and NO2 Annual average concentration. With proper implementations, the following indicators also help to mitigate this crucial problem: Length of biking roads, Number of bike parking spots, Bike Sharing and Car free or minimal car traffic streets, Pedestrian Street paths – walkways. These are useful to measure walkability and cyclability, which are healthier and more environment friendly options for urban areas than public transportation.

In addition to respiratory, cardiovascular, and many other acute and chronic diseases, physical and mental health could be threatened in urban areas. Accessibility to open green and public areas has a positive impact on the physical and mental health of the public as well as improving environmental quality by cleaning the air. The decentralized network of smaller green spaces will make it easier for residents to breathe nature that has important physical and mental health benefits (Velarde et al, 2007). Extent and number of parks (%), Lawn Cover Ratio (LCR) (%) are the indicators to represent these aspects.

Food is now produced through vast spanning networks that are vulnerable at many points and function as effective disease vectors (Matthew and McDonald, 2006). Besides, public have more awareness of the importance of immunology system, hence they are more conscious about what they eat, and tend to consume food from the sources they rely on or even they produced themselves. To measure access to community gardens, Number of Urban farms within a given locale/community are initiatives to include this issue to urban design and health relation from another perspective.

The Proportion of urban population living in slums, informal settlements or inadequate housing, Ratio between numbers of residents and activities, Percentage of Residents within Walking Distance of a Recreation Area %, Population with walkable access to bike trails are the indicators proposed to evaluate the effect of demographic factors on the contagion risks in an integrated way to urban related featured.

## 5. Conclusion

An urban area is like a living organism, in other words, it has a dynamic structure. 19 metrics among 42 and 28 performance indicators among 150 of IMM have been selected and applied to an urban area in Milan in order to assess the conditions created by urban morphology and affected the public health. 7 Design Ordering Principles among 12 of IMM, have been taken account as guidelines to improve these conditions in the transformation process of the case into more resilient and healthier area to live in. All the issues have an

interrelated effect sequence. Some of the DOPs has direct impact on health. 3 DOPs among the 7 selected ones have direct impact. Although keeping the social distance, wearing mask, and being vaccinated might be effective for protection from the COVID-19, this pandemic is not only a health problem. It is a wicked problem since the nature of transmission is not easily definable and the state continues to change over time.

Therefore, the city has to be considered from a holistic point of view. Urban morphology is not just transportation or energy performance from environmental point of view. Every aspect is related to each other as a ring of a chain. Besides environmental issues, economic and social perspectives have to be included in urban design, regulations, and planning. Sustainable Development Goals provide an effective framework to achieve this, however they have to be interpreted as a network.

As mentioned before, the goal 11 is Sustainable Cities and Communities, directly related to architecture and urbanism. Nevertheless the goals 2 (Food security and nutrition and sustainable agriculture), 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), and 13 (Climate Action) should not be forgotten in whole process of policy making, design, and application in all scales.

Despite growing research, there are still questions without certain answers about the spread of the virus. Due to the fact that the pandemic is still going on to be a threat, a new paradigm is necessary. This new paradigm is going to affect the way of design. For instance, the trends of transportation have been changing and the relevant Design Ordering Principles seems a few. However, this change has to be thought simultaneously by considering the other Design Ordering Principles that are focusing on different subjects but pertaining to each of them. During the pandemic, the role of green infrastructure in built environment is attracted more attention. Increasing the open green amount is crucial because of many benefits such as improving air quality, enhancing biodiversity, managing exceed stormwater, and supplying food.

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# KEYWORDS

URBAN REGENERATION, URBAN HEALTH, INTEGRATED MODIFICATION METHOD IMM, ROCINHA FAVELAS, RIO DE JANEIRO



*Photo Credit: IMM design LAB*

# [SCh 6] PolimiparaRocinha. Improving public health in Rocinha Favelas (Rio de Janeiro) through Integrated urban regeneration process

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## 1 The PoliparaRocinha project

The essay summarizes the PolimiparaRocinha project that is a research project founded by Polisocial that is the social responsibility program of Politecnico di Milano (Masera & Tadi, 2020). It is coordinated by four departments of Politecnico di Milano (Architecture, Built Environment and Construction Engineering – lead partner; Architecture and Urban Studies; Energy; Civil and Environmental Engineering) and the NGO “Il sorriso dei miei bimbi” that is an international association acting for 20 years in Rocinha. The partnership included, since the beginning, a large range of actors (different Italian associations as RESilienceLAB, Rotary, SMEs consortia etc.) and the Federal University of Rio and it was enriched during the project development engaging local and international actors able to support the whole process implementation, including institutional bodies (e.g. the Rio municipality, the Milano municipality), research centers (as the Fundação Getúlio Vargas) local social enterprises and/or other NGOs acting in Rocinha and international bodies (e.g. UN-Habitats, Rotary International).

The project aims to contribute to the improvement of health, livability, and inclusiveness of Rocinha community applying the Integrated Modification Methodology (IMM) multidisciplinary design methodology. The regeneration process integrates several thematic assets climate and energy, ecosystem services and food, waste management, water and mobility activating local circular cycles and virtuous synergies among different disciplinary and technical solutions. The essay focuses on the methodological innovation and highlights the integrated proposals addressing the local health improvement and food strategic asset proposals.

## 2 Challenges for health and sustainability in Rocinha Favela of Rio de Janeiro

### 2.1 Overview of the Rocinha Favela

The Favela da Rocinha is considered the most significant favela in Brazil, with an official population of 69,000 inhabitants and an unofficial estimation between 100,000 and 200,000 inhabitants

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## ABSTRACT

*Rocinha, the largest favela in Brazil with an unofficial population of 200,000 inhabitants, is an informal settlement with several interlinked problems requiring a systematic solution. The favela is disconnected socially and physically from the city. It lacks the infrastructure to implement safety and sanitation systems, waste collection, access to healthy food and clean water, or an efficient transport system. The paper will present the health challenges and the priorities characterizing the local context and the holistic approach to the regeneration developed by the PoliparaRocinha project. The PolimiparaRocinha project provided operative integrated strategies and design solutions (co-production /co-design) organized along identified Thematic Assets: morphological structure, Food & ecosystem services, Water management, Waste Management, and Energy. The paper focuses on the projects and strategic thematic assets strongly related to the urban health and communities' well-being, demonstrating the value of integrated methodology and the multiple benefits on the local complex urban context of Rocinha in activating synergies among sectors and components.*

living in 26 neighborhoods at a density of 45,000 inhabitants per square km (Rekow, 2016b). The favela is set in the South Zone of Rio de Janeiro, between two of the wealthiest neighborhoods of Rio, Gávea and São Conrado, on the side of the mountain Dois Irmãos.

Rocinha is a massive agglomerate of bricks, concrete and wooden buildings that occupy less than 2 km<sup>2</sup> of land (Tadi et al., 2017). Rocinha includes areas with different characteristics in social status, welfare, and service coverage of infrastructures. It is well known for its size, history, culture, activism, and identity. Rocinha is often also under media attention due to several critical phenomena due to an extensive range, complex and interconnected emergencies: Rocinha population and construction density, irregular supply of clean drinking water, un-management of rainwater and wastewater, irregular electricity supply, high level of impervious surface (ground surfaces that are almost entirely sealed), the limitation to the accessibility, and the presence of social and criminalities urgencies (Ceppi et al., 2020; Martins & Saavedra Farias, 2019; Oyuela et al., 2018; Tadi et al., 2018).

## 2.2 Health Challenges for Rocinha communities

Environmental, geographical/morphological and life-support services criticalities generate severe impacts on the citizens health of Rocinha. The Rocinha community has one of the highest rates of tuberculosis in the world: in Brazil, the rate of tuberculosis infection is 37.5 cases per 100,000 people, despite in Rocinha, the data soar to 380 per 100,000 people (Ceppi et al., 2020).

Environmental conditions refer to the high density that implies a lack of ventilation and the lack of lifelines and infrastructures. The under-management or lack of domestic water and sewage services creates a severe health hazard that makes the area prone to viral and bacterial diseases from mosquitoes and water contamination (Becciu & Mambretti, 2020; Kunz et al., 2016).

Territorial risks are related to geographical conditions, such as landslides, mudslides and flooding due to heavy rains that cause debris to fall from the Rocinha (Stålhammar & Brink, 2021). In the last years, there at least three significant events caused the infrastructure collapse and victims: in 1988, hundreds were killed because of the massive floods of the rainy season, while in 1996, many residents were victims of a deadly rockslide; the last disaster dates back to 2010 when a landslide occurred (Becciu & Mambretti, 2020).

Severe impacts on population health also derive from the critical situation of waste and water systems. Due to the discontinuous waste collection service, as reported in Rio Federal State official documents, Rocinha is characterized by the waste accumulation in open spaces and waste dispersion in the existing channel networks simultaneously for drainage, sewage and waste disposal (Becciu & Mambretti, 2020). In particular, the waste accumulation and the pollution of channels imply relevant impacts on possible disease diffusion increased during the flood events that often occur during rainy periods. PolimiparaRocinha (Mäser & Tadi, 2020) diagnostic phase confirmed these urgencies regarding waste and water management (flood events and sewage collapses).

Urgent interventions are needed on the infrastructural network, despite in recent years, different sectorial interventions failed, demonstrating the inefficacy of top-down and siloed approaches. Improving the culture of citizenship and engaging the local communities in the profound cultural and physical process of regeneration appears crucial. In recent years, “De Olho No Lixo” cooperative and “Secretaria do Meio Ambiente” of Rio de Janeiro launched a waste collection service mostly related to recyclable waste creating a micro-economy integrated with other educational and cultural initiatives on the (creative) reuse of materials and better familiar management of garbage.

In literature, researchers investigated the impact on health deriving from un-healthy diet behaviors of the population of the favelas in Rio de Janeiro (Ferreira & Magalhães, 2011; Gama et al., 2015; Rotenberg & De Vargas, 2004). Processed food and unhealthy diet based on meat and hyper-caloric food consumption are replacing the traditional Brazilian food based on healthy staple foodstuffs, particularly rice and beans (Colucci & Sganzzetta, 2021) producing impacts on health. In the Rio Favelas, it is possible to assist in the increase of obesity (and related diseases) and other health diseases due to unbalanced dietary (Kac et al., 2012). Processed products appear as individually cheap items but imply expensive direct and indirect costs for individual long-term budgets and collective sustainability, having impacts/costs in terms of environmental sustainability and waste management (Gama et al., 2015). The impacts on social and environmental aspects deriving from the current unsustainable food system (production, provisioning, and consumption) are recognizable in the whole Rio de Janeiro metropolitan area but more urgent in the favelas.

## 2.3 Existing policies and initiatives: barriers and opportunities for innovation

The comparison of principal slum-upgrading policies and programs in Rio shows recurring criticalities: policy fragmentation, the lack of appropriate participatory and systemic approaches, and a general weakness of implementation and management instruments adopted (Rekow, 2016b; Simon, 2021). In particular, the

conducted analysis of upgrading programs acting on Rocinha highlighted that the interventions have ever been developed considering the particularities and specific characteristics of the place, like the community-oriented and informal organic-like morphology (Ceppi et al., 2020). The critical analysis of the past slum-upgrading programs for the Rocinha favela, Favela-Bairro and PAC, emphasized the need for a shift in the methodologies and approaches adopted: aspects such as participatory procedures and decision-making, information and awareness of inhabitants, more robust synergic approach among economic, social and environmental challenges (Rekow, 2016a; Simon, 2021). The infrastructural adjustments have to pay particular attention to the new paradigms of environmental sustainability and de-carbonization, such as using renewable energies and green infrastructure models to mitigate climate change and urban resilience (Stålhammar & Brink, 2021). The traditional policies approach emerges as characterized by a “top-down” reductionist approach, simplifying the integrated nature of the local problems.

## **2.4 Food Policies and Practices: Emerging Opportunities**

Starting from the evidences and the serious implications deriving from a food system characterized by unsustainable dynamics both in the production and consumption steps, the city of Rio de Janeiro and the Rocinha area were protagonists of several investments and projects both from public and private sector aimed at the improvement of the sustainability of the food system (Rekow, 2016c; RIO FOOD VISION, 2014). Some of them were part of a huge investments program starting with the Olympic games, others were local initiatives from NGOs and community-based organizations focused on metropolitan scale with the participation of local networks of non-profit organizations aimed at sustainable project management in Rocinha. To understand the role of the public actor in the urban food regeneration process in Rio de Janeiro and in Rocinha, during the PoliparaRocinha an extensive investigation and comparison was conducted characterizing the food policies starting from the local food initiatives. The siloed approach emerges as one of main failure factor of slum upgrading policies and community-led interventions and initiatives (Colucci & Sganzzetta, 2021).

## **3 PoliparaRocinha: an integrated regeneration process**

### **3.1 Rocinha regeneration: innovating the process**

The slums regeneration requires an integrated approach (UN-Habitat, 2016) based on articulated interventions for the improvements of social, economic, physical, environmental and organizational components using local based resources (from social activation resources to ITC and Mobile potentialities). The PolimiparaRocinha process rooted in Integrated Modification Methodology – IMM (Masera & Tadi, 2020; Tadi et al., 2017), methodology, foster the interdependencies among urban components, topics and principles and it considers Rocinha as Complex Adaptive System characterized by unique values and local resources.

PolimiparaRocinha encompasses various dimensions: ecosystem services and food production, waste management, water management, energy, mobility, and information technology. The proposed projects connect the different thematic assets and provide multi-issues strategic actions: the single projects are at the same time modular (they can be independently implemented) and coherent with the whole vision of urban regeneration. PolimiparaRocinha project strategies activate the nexus among climate and energy, sustainable mobility, water, waste, ecosystem services and food developing synergic solutions. The strategies are coherent with the PolimiparaRocinha vision long-term generating a system of modular design solutions resulting from the co-production/co-design process coordinated by the Politecnico di Milano team and engaging a large partnership of technical, social, institutional, and economical actors involved. The flexibility and modularity in implementation phase are relevant aspects towards the achievement of large urban vision goals giving to local actors' possibilities to catch opportunities (e.g., financial support, call for urban regeneration....) and to adapt the proposed solutions to global and local new conditions.

The PolimiparaRocinha proposal offers a system of integrated projects aimed at simultaneously improving the environment through social involvement and improvement of the 'urban metabolism.' The project launched a systemic investigation and diagnostic of Rocinha's complex system; the malfunctioning subsystems and existing capacities were studied, revealing the potential of intrinsic relations to be activated to bring about the changes needed in different areas.

Considering the project's multidisciplinary approach, IMM has been integrated with the assessment of the ecosystem services to support decision-making processes to define strategies and design priorities for natural resources management to retrofit ecosystem services in a future scenario. The ecosystem services considered are habitat quality, carbon sequestration, nutrient retention, and sediment retention.

The investigation and exploration of practices and solutions were conducted on the policies, projects and interventions activated and active in Rocinha and on international best practices comparison. In particular, the local and international policies/cases investigations emerged as essential for food, waste, water, and energy

assets.

The waste topic focused on data collection to obtain a realistic picture of Rocinha (general context, waste quantification and characterization, and waste management systems). However, the analysis of the current practices highlighted the crucial role of social aspects and the identify the level of community engagement as a success factor for sustainable waste policies implementation.

In last decades, a large range of initiatives on food security and urban agriculture has been launched becoming a lever in urban regeneration process of favelas and slums: also the investments on these initiatives launched in the Rio' favelas (characterized by small economical budget) demonstrated how the "food" is a powerful lever for the implementation of actions aimed to life quality enhancement of favela inhabitants and an issue able to collect interests and then build multi-stakeholders alliances and social networking restoration.

The local policies/practices also permitted the partnership to engage institutional, economic, and civil society actors in the PoliparaRocinha process.

### 3.2 Food as lever for regeneration and synergies

Urban agriculture and food initiatives are promising levers for the implementation of innovative solutions activating synergies among water, energy, and waste sectors (Colucci et al., 2017; Scott et al., 2015). For instance, small water storage systems can reduce the pressure in water collection during stormwater events providing, at the same time, water for vegetable cultivation or the extension of "green surfaces" for urban agriculture (social farming or community small gardens) can improve the drainage capacity of urban systems and the water retention reducing the hydrogeological risk and improving microclimate comfort and urban landscape quality/livability of public open spaces.

The food asset emerged as a driver for the regeneration process activation for different reasons:

- the highlighted criticalities related to the population health connected to food issues.
- during the participative process with local stakeholders, food asset was identified as a successful lever for community engagement and empowerment.
- the food policies and interventions can activate synergic strategies towards a new circular metabolism of the favelas due to their strong correlations with water management (in particular, with the drainage problem) and waste management (re-use of organic waste) assets.
- food is one of the main project catalysts of IMM's DOP: "Convert the city into a food producer."

The food strategies of the PolimiparaRocinha project are based on three main principles: valorization of local opportunities and resources, knowledge and learning, and the legacy of the PolimiparaRocinha project.

A co-design/co-production process was activated to strengthen the actors' networking, to activate the synergies among all experiences on urban agriculture/food developed in Rio and Rocinha (including all social activation initiatives launched locally), and to valorize local opportunities and resources. All the Food strategies are central to the mutual learning and training aspects (lifelong learning) based on different training and learning approaches and solutions targeted to citizens, associations, social enterprises, and micro/small local enterprises. At the same time, all food strategies assign a central role to the design of the governance process (co-production and co-design) based on large partnerships.

The main aims of food asset strategies of the PolimiparaRocinha project are the improvement of citizen/local communities' awareness regarding healthy dietary behaviors (education and community engagement/empowerment), the improvement of environmental sustainability (activating circular synergies and nexus among food and waste: the collection of organic waste could be processed in local/small nodes able to provide biogas and compost giving energy and material for the fertilization of green areas and local urban farming) and the urban green improvement through productive landscape interventions.

The development of urban farming (community gardening of social farming) finds severe "morphological" barriers in Rocinha: the high density, the complete absence of empty soil, and the high steepness of the territory. To overcome existing obstacles, the PolimiparaRocinha project developed innovative solutions to integrate urban food production in/with existing buildings and/or existing facilities and services, like green roofs, vertical farming, and aquaponics. PolimiparaRocinha Food projects are structured on three main strategic assets: micro urban farming, modular food hub, and urban farming (aquaponic).

#### Micro urban farming

The PolimiparaRocinha regeneration project includes specific micro-interventions on existing urban morphology to improve the urban connectivity and the public spaces network: small and light modules for familiar food production was proposed developing/testing some technical solution that could be easily integrated into the interventions of buildings or public space refurbishment. PoliparaRocinha developed some

“toolkits” for the self-realization and management of micro aquaponic or vertical/rooftop garden systems collecting existing documentation transferable and applicable to the Rocinha project context). The “toolkits” based on an extensive comparison and evaluation of innovative/traditional solutions for urban agriculture include the selected different transferable tools related to materials (all selected materials are cheap and easy to find locally) and possible or suggested cultivar (concerning local climate and productivity/management). For instance, a particular “vegetable box system” was proposed using similar plastic tanks present on each roof in Rocinha to collect the rainwater that could be easily equipped with four wheels (to make this moveable) and a circular wooden panel to accommodate 40-50 cm of cultivable soil.

### **Community modular food hub**

The local food hub project aims to connect and enhance all activated social innovation nodes and all food initiatives in Rocinha. The food hub provides a functional interconnection and integration among all these practices through:

- a food educational and training center: the courses and events focused on healthy food behaviors (nutritional training, cooking courses, urban community farming) primarily targeted to children and women and involving school and other local public/social functions of NGOs; specific training activities could also be targeted to social enterprises, associations and micro/small enterprises (start-up) for transfer and exchange knowledge on food production, transformation, and catering.
- a market hub connecting local urban food productions with local needs/demand (market) and local canteens (the first target are the local school canteens and the canteen of NGOs) and at the same time connecting the metropolitan urban farming producers with Rocinha food initiatives.
- an experimental urban beehive to be located in the green areas on the boundaries of Favela not yet settled and to be preserved for hydrogeological reasons and ecological biodiversity improvement. The urban beehives could play a didactical role (ecosystem services, biodiversity/ecological values) and, in a long-term perspective, could also become a possible asset of local production (honey and all other products connected with the beehives) managed by social enterprises or NGOs.

During the PolimiparaRocinha project, a specific investigation on cultivation species was developed, providing inputs for the vegetables and fruits cultivar selections concerning seasonality and productivity (For instance, possible rotations/associations based on local traditional cultivations were proposed in order to improve the efficiency of micro urban farming).

### **The urban farming (Aquaponic)**

The food strategies of the PolimiparaRocinha project aim to contribute to activating micro/local (social) economies integrated along the food chain and integrated with the other thematic assets of the urban regeneration. Different urban farming systems were investigated: since the beginning, traditional soil-based farming emerged as a not feasible/transferable model in the Rocinha context. Due to this evidence, a specific research focus was dedicated to the aquaponic greenhouses modules (investigating the transferability from similar experiences launched in other favelas of Rio de Janeiro).

In the context of Rocinha, the aquaponic system shows several advantages: it permits the production of differentiated fresh food, including fruits/vegetables and fish, while also in the absence of soil, in water scarcity conditions and reducing/eliminating the pesticide and artificial nutrients supply.

A preliminary evaluation to understand the aquaponic system's transferability and feasibility was conducted using the parametric data of the UFBOX prototype (<https://www.swissnexbrazil.org/>) that is a modular, compact and movable unit using a container with a greenhouse placed on top developed by the Swiss company UrbanFarmers. Different simulations of the aquaponic module were developed to investigate and identify preferable associations of production and transferability intervention/solutions to optimize the feasibility and adaptability in the local context. The modular aquaponic system proposed permits an incremental development of urban farming strategies starting from a first pilot module (the most relevant cost of the aquaponic system is related to the initial investment for the infrastructure, including container, fish tank, the pump, grow-bed) with the possibility to incremental upscaling of urban aquaponic system with the installation of other modules.

## **4 PolimiparaRocinha project legacy and perspectives**

The PolimiparaRocinha project was rooted in a multi-stakeholders and participative process that has demonstrated to be able to activate synergies among local actors acting in Rocinha, metropolitan/regional actors (as Rio de Janeiro Municipality and Federal State) and international bodies (Oyuela et al., 2018). PolimiparaRocinha project has received different international awards that have contributed to providing

positive storytelling and recognizing the values and potential of Rocinha.

One aspect of the legacy provided by the PolimiparaRocinha project is the enhancement of local actors' capabilities to build up large partnerships and alliances and develop proposals for local/international calls for project implementation. The PolimiparaRocinha team, with a large partnership including institutional stakeholders (e.g., Milano and Rio municipalities), developed and submitted to an international call several proposals to receive the economic support for the launch and implementation of modular projects proposed. PolimiparaRocinha strategic assets provided several integrated solutions for local communities' health enhancement.

- Food asset. Several integrated actions address improving accessibility to fresh and healthy food and enhancing dietary approaches. In particular, the project aimed to activate local fresh food production (aquaponics production managed by local social enterprises, community gardens/urban agriculture, small rooftop food productions systems) and educational and training initiatives promoting healthier dietary behaviors that targeted children, youth and women and provided them with information on the health risks from consuming highly processed food and on the values of a healthy diet. The aquaponics project and urban food production can integrate the procurement of fresh food to public/private canteens of schools (and NGO centers for children and the young) to ensure a balanced and healthy diet (and sustainable costs).
- Water asset. The ecosystem mapping contributed to the sewerage system design and provided valuable information for preventing environmental hazards and managing runoff. The project provided solutions for the construction and proper maintenance of an adequate sewerage system that could positively impact public health.
- For the area of energy production, which relies on local sunlight, a smart grid with a flow management system has been proposed.
- Waste management strategies were developed with local actors and communities to provide adequate and feasible solutions reducing waste accumulation and the impacts on citizen health.

By activating a local initiative, the PolimiparaRocinha process has a tremendous capacity to improve environmental and social conditions at the city scale. A valuable lesson from this case study is the crucial relevance in recognizing the environmental and social potential of informal settlements. Rocinha, in terms of environmental performance, Rocinha could act as a vital organ for Rio de Janeiro.

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# [RCh 6] One-Health: a transformational concept to drive urban planning and resilience for the post-pandemic future

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*Since its early outbreak the COVID-19 health crisis has represented a disruptive element in the current structure of way we designed our societies. Notably, the COVID-19 health crisis has shown how ecological health and human health have different interconnections for various reasons and aspects. By this COVID-19 has represented more than just a health crisis, but represents a clear demonstration of an ecosystem crisis. It can be argued that the coronavirus pandemic has unveiled, more than any other disease, the deep meaning of the vision of "One Health".*

*Such a category has been defined as an approach that see health of humans strictly linked to the health of animals and ecosystems (One Health Commission 2020). The "One Health" concept has been introduced at the beginning of the 2000s to summarize the idea that human health and animal health are interlinked and bound to the health of ecosystems. On the same year the Paris Agreement has been signed the One Health concept has been recalled by the definition of Planetary health launched in 2015 by Rockefeller Foundation and The Lancet (Seltenrich 2018, 126) that refers to "the health of human civilization and the state of the natural systems on which it depends".*

*It aims to investigate the effects of environmental change on human health and study the political, economic, and social systems that govern those effects (Whitmee 2015, 1973-2028). There is significant overlap between planetary health and traditional environmental health; both examine the relationship between human health and conditions and exposures originating outside the body, be they extreme temperatures, chemicals and biological agents, vector-borne diseases, or any number of other potential factors.*

*However, the OneHealth concept integrates the interlinkages between human communities with the biosphere to pursuit a more holistic vision of wellbeing, it is also very well fitted to drive a more comprehensive driving framework to address environmental analysis, monitoring and protection. Especially, after the pandemic the OneHealth framework offers an exciting opportunity to find alternative solutions for a better and more resilient future. From a system point of view COVID-19 represent a s strong system stressor (Breitbur et. al 1998, 416-431). Especially COVID-19 has shown a peculiar spread and turned fast into a pandemic echoed by highly anthropized agglomerations and thanks to precedent and hyper-used world travel connection.*

*In other words, it expresses a special disruptive power representing a deep shock for the existent systemic models. From an epidemiologic point of view COVID-19 is classified as a zoonotic disease (Quammen 2021, 608): this type of disease passes from an animal or insect to a human and their spillover (Quammen 2021, 608) to human species is worsen by the destruction of ecosystem and loss of biodiversity (Schmeller 2020, 8).*

*Obviously COVID-19 is not the first example and epidemiologic science has observed the spread of many other viruses such as Zika, Sars, Mers, COVID-1 and H1N1 in recent years. Each of them has a common denominator with the recent COVID-19: they have been transmitted from animals to men (Cemma 2017). The zoonotic phenomena and the vector-borne disease are currently increasing due to another big systemic stressor that is climate change with the lens of One Health vision, it can be observed that beside the zoonotic phenomena of COVID-health crisis and the climate crisis have different interconnections, for different reasons and different aspects (Fuentes 2020, 8560, Newel 2020,1-5).*

*Surely both of them are connected to the interactions between human communities or anthroposphere (Kuhn 2010, 282-341) and what we can widely call biosphere, intended as composed of living organisms (biota) and the abiotic nonliving part in support of life (Hugget 1999, 425-431). Even with a more striking effect, the global pandemic unveiled the strong effect that the biosphere can have on anthroposphere:*

never before a biotic component (virus) has influenced and determined the state of the economic system so much (Vito 2019).

As we are experiencing with COVID-19, that pandemics are not just health issues but can turn into planetary socio-economic burdens, as assessed by the report "A World at Risk" released by the Global Preparedness Monitoring Board in September 2019, which estimates the economic costs of the widespread of disease produced by the possible % of GDP losses from 2018 values (Global Preparedness Monitoring Board 2019).

Besides the worsening of the climate crisis and its socioeconomic effects such as the impacts of extreme events on population and the increase of climate refugee phenomenon, this year COVID-19 outbreak has led to a health crisis, representing a even a deeper stressors for current socioeconomic models.

Even if they act of different scales, the pandemic and the climate change are more than just overlapping and reinforcing each other. Despite their catastrophic nature, the two crises pushed human activities to be redesigned in their structure, beyond just adaptation to changing conditions to pursuit stability, indeed requiring a deep transformation to continue and survive. COVID-19 and climate change can be defined in a way transformative crises that foster and enhance community resilience (Magis 2010,401-416).

Since the small things this pandemic has pushed us to rediscover our social, working and living urban spaces constraining us into a condition in which we must redesign how to strengthen ourselves, to work, to build relationships. The pandemic obliged us find new ways to work, to connect d live. In other words, as well climate change with different time scales is the pandemic has represented a transformative crisis (Brett 2010, 155-174).

The concept of transformative crisis as well the concept of resilience is taken originally by the field of psychology. Several authors like Laing (Laing 1967) Brett (Brett 2010, 155-174), and Grof (Grof 1989) argue that states of intense and prolonged psychological pain assumable to psychosis can be considered as transformative crises. Transformative crises are indeed the ones that lead to transformational change.

Transformative Change is a philosophical, practical, and strategic process to effect revolutionary change within an organization, i.e., culture transformation. In management and organization sciences, it approaches systems to a broad-based change to catalyze rapid shifts in the mental constructs inhibiting solutions to complex problems or in the organization's culture that prevent it from realizing its full potential (Transformative Change 2021).

Transformational changes alter what we do, not just how we do what we do. They are by nature risky and uncomfortable (In Business 2021). Crisis as a result of global environmental change, such as extreme floods, droughts, bush fires, and planetary health issues such as pandemic, can be considered at a macro-scale transformative crisis (Utter 2012, Novalia 2020, 361-370).

They are diminishing infrastructure integrity and undermining resilience across many urban areas pushing it to the limit by which merely maladaptation to the current conditions becomes a rigid scheme (Novalia 2020, 361-370).

The system theory literature conceptualize crisis in terms of a special event of exogenous or endogenous origin that influences system's evolutionary dynamics. they can be defined as system disruptor. In transformative crises, the system disruption push the system to thresholds where minor adaptations are not enough, and systemic transformations become mandatory and safe for the system itself to survive (Guderson and Holling 2002) . In such extreme cases the critical events create the opportunities for systems to develop structural processes, renewing them and creating conditions for their improvement (Greiner 1989, 373-387).

Regarding the current pandemic we can argue that COVID-19 has finally brought human community resilience to transformational levels, giving a unique evolutionary chance to our current models, not just limiting risk factors to survive, but developing the ability to transform to thrive in and through adversity with innovative strategies (Ahmed 2004, 386-40). This pandemic has constrained us into a condition in which we had to find new ways to strengthen ourselves, to work, to build relationships. The pandemic

*obliged us find new ways to work, to connect and live.*

*Social distancing, lockdown, mask has been in a way collective responses: facing a common threat, we have rediscovered our community resilience. Standing to Magis (Magis 2010,401–16) there are several definitions of community resilience in literature in relationship to the power of the system disruption and the activation of the community in response to the disruptor as well to the stability and resources of the communities themselves.*

*Moreover, community resilience goes beyond community stability, that is often addressed by the most of the health and social policies: it is more dynamic, changing with internal conditions, external forces, and by the community's ability to respond and develop (Holling and Gunderson 2002, 25-62). It has several contact points with community capacities (Holling and Gunderson 2002, 25-62). - like productivity, or safety - as both types consume community resources for the collective well-being: however, community resilience exclusively focus on community systems in the context of change. Community resilience by systems theory and socio-ecological studies, is indeed strictly connected to the concept of change and to the response measures to systemic disruptors.*

*In such responses community rely on community resilience itself and do not control all the conditions of the processes affect them, rather they foster the ability to respond to change itself (Koliou et. Al 2020, 131-151).*

*And this peculiar feature, can be observed both into the health crisis and climate crisis that are intertwining: COVID-19 and climate change together considered into a community resilience envisioning are shifting the attention from adaptation of presumably stable and controlled models to managing the capacity of dynamic communities to shape a transformational change toward completely new models (Magis 2010,401–16).*

*The current One-Health ecological crisis is providing us a unique evolutionary opportunity for a radical revision of economic and, social relations inside anthroposphere as well toward the biosphere. Such special punctuating episode in the history of human kind poses serious challenges for our collective ability to respond to change.*

*Any serious effort to address the current global crisis indeed need to pass to such crucial understanding: if we are to develop the capacity for leveraging the crisis, we have fundamentally to transform outdated and policies and practices and ideologies, that are no more able to product common good for the whole human community (Holling and Gunderson 2002, 25-62). In this scenario the concept of One-health can represent driving framework to address environmental analysis, monitoring and protection and a new vision to design our urban spaces.*

*One Health can elicit to find alternative solutions for a better and more resilient future. It aims to investigate the effects of environmental change on human health and study the political, economic, and social systems that govern those effects (Whitmee 2015, 1973-2028).*

*As One-health integrates the inter-linkages between human communities with the biosphere to pursuit a more holistic vision of well-being, it is also very well fitted to drive a more comprehensive driving framework to address environmental analysis, monitoring and protection. Particularly in relation of data, the One-health approach helps to think and design ways to explore the cross influence between health and environment. In particular this influence can be interestingly explored though data driven approach throughout a One-health vision that are increasingly a key pillar for EU implementation strategy, as now COVID-19 pandemic has influenced each sector of the society*

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*\*HEALTHY CITY  
WILL BE POSSIBLE  
THROUGH HEALTHY  
POLICY. PUBLIC  
HEALTH DESIGN  
STRATEGIES  
BECOME EFFECTIVE  
INTO CITIES' POLICY,  
ONLY IF AWARENESS  
ON THIS FIELD IS  
TRANSFERRED BOTH  
IN THE ACADEMIC  
SECTOR AND BY  
TRAINING PUBLIC  
ADMINISTRATIONS*

\* quotes/excerpts from the contributions shared by the participants of the UROH international conference and the co-production activities promoted by REsilienLAB



Photo Credit: Angela Colucci

# PART III. Reality Check



# [RCh 7] The Impacts of the COVID-19 Pandemic Emergency on two Italian Red Cross (IRC) Committees in the Southern Area of Milan

## THE COMMITTEE OF THE SOUTHERN MILANESE AREA AND THE COMMITTEE OF SAN DONATO MILANESE

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*Before probing into the Pandemic Emergency effects on the Italian Red Cross (IRC) activities of the two committees of the Southern Milanese Area and San Donato Milanese, it is crucial to shed the lights on the importance of the social welfare activities that have been already taking place within the respective suburban communities of Southern Milano and San Donato Milanese, way before the hit of COVID19.*

*Over the past decades, both two committees of the Italian Red Cross in South Milano and San Donato Milanese, have been deliberately developing several activities which have different social impacts on their local communities. The rescue missions have certainly remained the main focal activity of the IRC. Additionally, this has also been supplemented by various social and welfare initiatives. In the last five years, both IRC Committees have been sparing no effort in combating food poverty and reducing food waste. These two actions have given shape to a widespread workflow for recovering and redistribution of unsold food and necessities collected from small and large businesses in southern Milan in coordination and close cooperation with the local municipal administrations and several social services.*

*Furthermore, since 2001, both local units of the Italian Red Cross have been an integral core of services that supports homeless people in the Metropolitan city of Milan. COVID-19 has severely impacted the most vulnerable groups in the Southern part of the Metropolitan area of Milan.*

*Moreover, such drastic health and economic predicaments of the unexpected pandemic have significantly affected diverse groups that were already exposed to poverty; including families, poor individuals, homeless people, immigrants, and among others. In collaboration with local administrative authorities of Milan, both Committees have successfully been supporting people with no fixed abode and/or at risk of becoming homeless.*

*The collaboration between both IRC Committees demonstrated an integral perspective of assistance that is capable of providing essential support to a variety of vulnerable groups, and the wide range of implemented activities through local actions, and community-based services. This has been all guaranteed by the effective logistic system pivoted on committed IRC volunteers, specialized operators, and emergency vehicles.*

*The pandemic emergency has increased the number of rescues, and consequently the transversal efforts of*

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*The translation from Italian to English was done by Yahya Shaker and Sara De Bene*

both IRC Committees. In particular, there have been three main focuses: the complexity of the emergency medical services; the quantity of food and necessities collected, managed, and redistributed; the number of families and people assisted through the provision of food aid from the European Union.

The “unpredictable” pandemic emergency, has indeed left no room but for a sudden response with an enormous amount of work in terms of load and criticality. Without question, all members of the Italian Red Cross found themselves facing – in a very short time – a situation never been experienced before. The reality of the emergency response—during the pandemic peak period—could not be enough described even by all the stories and images disseminated by the media:

*“We witnessed hazardous times in the initial months; this has marked the actual disproportional gap between the needs and the available human and material resources”*

The basis of partnerships and collaborations has remarkably increased the interventions addressing food insecurities during the pandemic; more amount of food was collected and redistributed to the local communities. It should be noted that this increase was most significant in the first months of the emergency, as well as in the consecutive months of absolute lockdown.

That’s because large-scale retail chains, restaurants, catering, and entertainment facilities had to abruptly stop their commercial activities open to the public, and thus, there have been an abundance of perishable and non-perishable food and goods that could better be used for humanitarian aid in such emergency times. The amount of work required during the ongoing pandemic response is higher than that of “pre-pandemic” 2019. However, this is attributed to the accumulation of experiences, the development of formal and informal partnerships, as well as the increased endowments of means and personnel, which the two committees of the Italian Red Cross in South Milano and San Donato Milanese was able to consolidate during the two-year emergency period.

Considering the rapid increase in the numbers of vulnerable groups, food distribution by the IRC has been accompanied by The Fund for European Aid to the Most Deprived (FEAD) which has likewise seen the expansion of its target groups. Such aids offer as well more opportunities to address immediate needs such as food aid and material assistance. The overall picture outlined by this sudden drastic event has revealed a paradigm shift in the social fabric gravely impacted by the pandemic that has severely worsened the situation of already vulnerable individuals, families, and communities, and notably has dragged many others into the range of critical vulnerability. Where the two Committees of the Italian Red Cross have been operating in a context in which states of fragility regarding housing poverty were already existing, and which the public administration and the civil society have been committed on resolving this issue for a long period.

It is noteworthy that, all these critical events, lack of preparedness, material disadvantages, contingencies and sudden responses to emergencies added to the economic predicaments at the individual, the family, and city levels have not succeeded at forging a total societal breakdown of the local communities. These local communities are currently—and will certainly be—grappling with a long-term recovery phase aiming at dealing with the overall Metropolitan and suburban context of Milan and its multilayered complexities. Yet, these local communities have practically demonstrated a concrete level of resilience able to overcome the such a hazardous emergency.

*[Italian version - original chapter version]*

*L’Impatto dell’Emergenza Pandemica su due Soggetti del Terzo Settore in un’Area Suburbana Italiana – Croce Rossa Italiana (CRI) Comitati dell’Area Sud Milanese e di San Donato Milanese*

*Un rilievo importante prima di provare a delineare come l’emergenza pandemica abbia inciso sulle attività e sulla percezione che le due realtà socio-assistenziali hanno avuto delle rispettive comunità, riguarda tutto ciò che era in essere prima dell’arrivo di COVID19.*

Le due realtà avevano già sviluppato, nel corso dei decenni di attività sul territorio, diverse forme di impatto sulle proprie comunità. L'attività di soccorso urgente è rimasta sicuramente la prima nell'immaginario collettivo ma è accompagnata da diverse iniziative prettamente sociali e assistenziali. Un esempio sono gli sforzi messi in campo nell'ultimo quinquennio per il contrasto alla povertà alimentare, articolati in modo da seguire quelli volti alla riduzione dello spreco alimentare; queste due direttrici hanno dato forma a una diffusa opera di recupero di beni alimentari e di prima necessità invenduti dagli esercizi – piccoli e grandi – del territorio, e alla conseguente redistribuzione attraverso una stretta sinergia con le Amministrazioni comunali territoriali e i loro Servizi Sociali.

Dal 2001, inoltre, entrambe le unità locali della Croce Rossa Italiana, sono parti integranti del servizio che nell'area cittadina di Milano assiste le persone senza fissa dimora durante tutto l'anno con generi di conforto e attività assistenziale, anche di concerto con l'Amministrazione di Milano soprattutto nei mesi invernali. Tutto questo, insieme alle altre numerose attività, vengono garantite da un apparato logistico che conta automezzi e operatori specializzati. L'emergenza pandemica ha generalmente aumentato i numeri di soccorsi, di persone in stato di bisogno, e quindi gli sforzi, di entrambe le realtà trasversalmente. In particolare però sono stati tre i focus: il numero e la complessità dei servizi di soccorso sanitario; la quantità dei generi alimentari e di prima necessità ritirati, gestiti e redistribuiti; il numero di nuclei familiari e persone assistite attraverso l'erogazione degli aiuti alimentari dell'Unione Europea.

Nei riguardi degli interventi di soccorso sanitario e della loro complessità, non lascia spazio a particolari considerazioni l'esplosione di un volume di lavoro assolutamente senza precedenti per mole e criticità. Le donne e gli uomini dell'Associazione si sono infatti trovati ad affrontare in poco tempo una situazione mai sperimentata e del tutto identificabile con le storie e le immagini diffuse dai media nel corso del periodo di picco pandemico:

*“si è assistito a più riprese e specie nei mesi iniziali a una improvvisa e marcata disproporzione tra le necessità e le risorse disponibili, tanto in termini materiali quanto in termini umani e addestrativi”.*

I generi alimentari ritirati e redistribuiti sulla base di partnership e collaborazioni hanno parimenti visto un importante aumento quantitativo. Va segnalato come questo aumento è stato maggiormente rilevante nei primi mesi di emergenza, in corrispondenza dei periodi di lockdown assoluto ed è in parte considerevole da imputarsi alla disponibilità di ingenti quantitativi di beni alimentari deperibili e non, nelle disponibilità della grande distribuzione organizzata, delle catene di ristorazione e di quelle dell'intrattenimento, che hanno dovuto interrompere bruscamente le proprie attività commerciali aperte al pubblico.

Non rimane del tutto secondaria la considerazione per la quale i volumi di lavoro in questo senso siano tutt'ora superiori rispetto a quelle del 2019, questa evidenza è però imputabile all'esperienza e alle partnership – formali e informali – nonché alle aumentate dotazioni di mezzi e di personale, che le due realtà hanno avuto modo di far maturare molto rapidamente nel corso del biennio emergenziale.

Nel rendere il polso delle aumentate necessità della popolazione, a questa attività si è affiancata quella di consegna degli aiuti alimentari dell'Unione Europea, che ha allo stesso modo visto l'ampliamento della propria platea di fruitori finali.

Il quadro da tutto quanto ciò delineato ci ha rappresentato un tessuto sociale su cui l'emergenza pandemica ha indubbiamente impattato in misura importante, nello specifico peggiorando la situazione di individui e nuclei familiari già vulnerabili e trascinando in una fascia di vulnerabilità molti tra chi, in precedenza, ne viveva appena al di fuori. Questi fenomeni, nell'area di operazioni dei due Comuni della Croce Rossa Italiana, hanno agito in un contesto in cui già non erano assenti stati di fragilità, come ad esempio la povertà abitativa, che da tempo impegna le realtà del terzo settore e le amministrazioni pubbliche dell'area.

Va però detto che, l'insieme dei fattori sfavorevoli, delle contingenze e delle risposte messe in campo a tutti i livelli – come quelle descritte o come gli interventi di dilazione e di proroga di diverse incombenze materiali ed economiche in capo alle famiglie – non abbiano comunque generato un breakdown puntuale delle comunità.

Queste sono e saranno certamente alle prese con una ripresa non immediata e nemmeno semplice, da inquadrare nel complessivo contesto suburbano e nelle sue criticità, ma hanno dimostrato un livello di resilienza almeno sufficiente al superamento dell'emergenza stricto sensu.

# [RCh 8] How territories could face climate change from an urban and healthcare point of view

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*Besides the worsening of the climate crisis and its socio-economic effects such as the impacts of extreme events on population and the increase of climate refugee phenomenon, these years of COVID-19 outbreak has led to a health crisis, representing a deep shock for the existent systemic models. Even if they act of different scales, these two crises are more than just overlapping.*

*They both pertain to a dysfunctional relationship among human communities and environment, both regarding their origins (Fuentes 2020, 8560, Seltenrich 2018, 126) and impacts (Quammen 2021, 608). COVID-19 has given us a substantive proof of the interconnection between climate, environmental and health. COVID-19 and climate change pandemic responses show that they are very based on community resilience. And community resilience could be the same driver to rethink and re-capacitate post-pandemic and economies. Considering the application of the One-health concept by which biosphere and anthroposphere health and wealth are strictly interconnected, these crises are giving us a unique opportunity to pervasively find inter-twinned solution.*

*However, pandemics and epidemics are not the only way by which health and climate crises are related. The Lancet Countdown report (Romanello et. al 2021, 1619-1662) has defined climate change as “the greatest global health threat facing the world in the 21st century” but as well “the greatest opportunity to redefine the social and environmental determinants of health”.*

*The climate crisis is endangering decades of progress in global health. Rising temperatures, air pollution, which already causes approximately eight million deaths a year, diminishing supplies of clean water and rising food insecurity could create a perfect storm that rolls back advances in both health and development (Romanello et. al 2021, 1619-1662). As temperatures rise, the geographic range of vector-borne diseases will expand, and transmission seasons will grow longer. Recent studies assessed that more than two billion more people could be at risk for dengue fever in 2080. Heating is not only affecting land but also warming oceans are causing areas that were once too cold for certain bacteria to flourish, and to be more susceptible to outbreaks of diseases such as cholera.*

*The World Bank estimates that global warming of two to three degrees Celsius could increase the number of people at risk of malaria by up to five percent and diarrhea by up to 10 percent. And without concerted action, climate change could mean more than 100 million additional people living in poverty by 2030 (The Guardian, 2021). At the city level heat is the most direct impact of global heating: extreme heat in cities across the world has tripled in recent decades. Standing to The Lancet record temperatures in 2020 resulted in a new high of 3.1 billion more person-days of heatwave exposure among people older than 65 years and 626 million more person-days affecting children younger than 1 year, compared with the annual average for the 1986–2005 baseline (Romanello et. al 2021, 1619-1662). Another big thread at for urban communities and settlements are extreme weather, such as hurricanes and cyclones, can also have disastrous effects on health.*

*It's estimated that each year, 22.5 million people are displaced by climate or weather-related disasters, a figure that is expected to rise as these types of events become more common (The Guardian, 2021): such amount of people is going to constitute the mass of 'climate migrants' that actually are losing essential health services, leaving them more vulnerable to diseases. Moreover, as displaced individuals they can have strong consequences on both mental and physical health. It's important indeed to address climate action as an important health urgency. The climate action and health communities must find common cause.*

*Adaptation and mitigation policies need to be integrated with health policies to reach a new vision of “healthy cities” Such synergy is also suggested by the framework of Health in All Policies (HiAP) (Ramirez*

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Adaptation and mitigation policies need to be integrated with health policies to reach a new vision of “healthy cities” Such synergy is also suggested by the framework of Health in All Policies (HiAP) (Ramirez Rubio, 2019 1-21) HiAP has been defined by the World Health Organization (WHO) as “an approach to public policies across sectors that systematically takes into account the health implications of decisions,

seeks synergies, and avoids harmful health impacts in order to improve population health and health equity” (World Health Organization, 2019).

The HiAP strategy suggests a strong and effective “horizontal governance” (Kickbusch and Kevin 2010) to complex health problems that involves a multilevel stakeholder governance to lead effective priority setting, innovation in policy making and implementation of sustainable solutions. In 2015, countries committed to limit global warming to “well below 2°C” as part of the landmark Paris Agreement, and in particular this year at COP26 the topic of health has found its arguments (Paris Agreement 2015). COP26, has taken place in the international context of Covid-19 recovery efforts, and as presents an opportunity to pave the way the right to health, as enshrined in the Paris Agreement.

During the negotiations the health advocacy groups presented their position papers to promote ambitious greenhouse gas emissions reductions targets in countries NDCs, in order to promote long-term strategies, and climate policies that can provide high returns on investment, but samely can reduce climate impacts, promoting healthier populations (Salas et al 2021, 375). According to the Lancet Countdown research on Health and Climate Change, actions to reduce emissions in line with the Paris Agreement would save 1.18 million air pollution-related deaths, 5.86 million diet-related deaths, and 1.15 million deaths due to physical inactivity annually by 2040 in just nine countries (Hamilton 2021, e74-e83). Addressing climate change can indeed return in different co-benefits on health (Markandya 2018, e126-e133). Health co-benefits need to be maximized on the implementation of long-term strategies regarding climate policies and they need to become an integral part of the NDCs.

This includes accelerating the transition to clean, renewable energy, shifting to low-carbon transport systems with zero emissions vehicles and safe active travel, and transitioning to plant-rich diets. Such action will immediately improve health, save lives, increase work productivity, and school performance, and save money in avoided healthcare costs and premature deaths. Furthermore, net zero targets should be founded on real emissions reductions and mitigation.

Net-zero policies have several co-benefits for example on air quality and related health impacts. In relationship to COP26 a detailed description on the role of the net-zero policies on air quality is contained into the report “Effects of net-zero policies and climate change on air quality” (Lewis et al. 2021) report from the royal society. The report identifies possible mitigation measures that could be considered alongside net zero measures to limit negative effects on air quality, providing scientific evidence to support the design of policies that maximize the benefits for air quality at the same time as supporting progress towards net-zero greenhouse gas emissions by 2050.

*Net-Zero and One-Health: a unique opportunity for cities and regions*

Urban areas have the potential to be places of social innovation in our relationship with energy and materials use. Energy efficiency, generation from renewable sources and more recently energy flexibility, are key elements of present sustainability policies.

However, we are beginning to see a recognition of the need to couple technological solutions with lifestyle and behavioral changes, sometimes labeled under the term “sufficiency”. particularly relevant the role assigned to sufficiency in the recent scenarios by IEA and IPCC. Appropriate policies and design principles are necessary to enable sufficiency options, which in turn reveal that there is a bidirectional influence between the building and the district/city level. In this context, it is possible and important to analyse how city and building re-design should be implemented combining energy efficiency, flexibility, production from renewables and sufficiency options for achieving a positive energy balance at the district level even within the constraints of dense cities. Recent analysis concludes on the possibility to achieve, through deep and coordinated sufficiency, efficiency, and renewables a positive energy balance at yearly but also at seasonal (winter and summer) time scales.

The implication on land take of such a strategy is the possibility to generate the necessary renewable energy

on the footprint of the district/city. At the opposite, a conventional low efficiency district would need at least 6 times more land for the generation of renewable energy to achieve a zero-energy balance (Erba and Pagliano 2021, 4697). The concept of net-zero should be accurately reformulated in order to move from a formal virtual accounting to a real physical balance ensuring zero use of fossil and zero emissions.

Both at the district and building level a general critique holds with respect of an energy balance performed over a year when compensation is allowed between different time steps: it allows one to compensate for continued fossil use in some moments (e.g., winter) with overproduction of RES at other times (e.g., summer).

This obviously does not lead to zero emissions and requires potentially large inter-seasonal storage locally or somewhere in the network, with associated land occupation, energy losses and use of materials, embedded energy, and related costs. Additionally, the fact of choosing a long-time interval for the energy balance creates a conflict with other objectives, e.g., the self-consumption of renewables as already mentioned (Good et. al 2017,7-30). As for buildings, some MS such as Italy and Spain have opted for running the balance with only partial compensations, meaning that compensation happens within months but not between different months.

Additionally, in fact lower time periods for compensation might be chosen in case more detailed calculation methods (ISO, EN. "52016-1. 2017) would be adopted for the energy certification (e.g., when hourly calculation methods would be adopted) rather than the most current monthly calculation method. A similar method to limit the negative effects of the simplistic yearly balance should be adopted also in performing the energy balance of a district. The HiAP framework embraces and broadens all these elements adding the health implications, especially highlighting the role of subnational government bodies. After COP26, the Race to Zero initiative and the Glasgow Breakthroughs (Mountford et. al 2021) contribute to relevant steps toward the involvement of subnational levels.

In particular the Cities, Regions, and Built Environment Day (CRBE Day) brought together leaders from the private and public sectors to accelerate climate ambition for the built environment.

The event has been promoted by the "Build to COP" coalition that have assessed that:

By 2050, 1.6 billion city dwellers will be regularly exposed to extremely high temperatures

- Over 800 million people living in more than 570 cities will be vulnerable to sea level rise and coastal flooding
- By 2060, the world's housing stock will double and nearly 70% of the world's population is projected to live in urban areas
- Most countries that have submitted Nationally Determined Contributions (NDCs) to the UNFCCC do not include full building decarbonization goals and some areas such as building materials are not addressed

The "Building to COP" coalition has also called for global building project emissions to be halved by 2030 and to achieve net life-cycle emissions of zero for all buildings by 2050 at the latest.

The challenge requests:

- For all countries to include comprehensive construction decarbonization goals, concrete policies and measures and related implementation mechanisms in their NDCs.
- to have 1,000 cities and at least 20% of the largest companies in the built environment sector based on revenue committed to the UN race to zero.
- By 2030, 100% of new buildings must be carbon-neutral in operation and the embedded carbon must be reduced by at least 40%; and by 2050, all new and existing activities must be zero for their entire life cycle.

In conclusion even more after COP26, cities are called to mobilize multiple sectors, disciplines, and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change envisioning a One-health approach.

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# KEYWORDS

AIR POLLUTION, NITROGEN  
DIOXIDE, SULPHUR DIOXIDE, SMOKE,  
VARIATIONS, TRENDS, WHO, HARARE



Photo Credit: Angela Colucci

# [Sch 7] Spatial and temporal variability of air pollution in the city Harare

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## 1. Introduction

Air pollution is one of the major environmental challenges facing many urban environments. Atmospheric pollutants have direct and indirect effects on the Earth's climate and human health.

The pollutants, include: smoke emitted from fuel burning appliances, bonfires, vehicles, veld fires, burning of refuse thermal power stations and metallurgical plants; dust from thermal power stations, yard sweeping, cement works, stone quarries, milling and fibre glass works; fumes from galvanising, spray painting manufacturing of paint, food, battery, rubber and chemicals; and odours from abattoirs, municipal waste disposal sites, food and detergents manufacturing, foundries and tanneries (Zhakata et al., 1998).

Presence of air pollutants directly affect the radiation budget by scattering and absorption of incoming shortwave (solar) radiation, thereby changing the planetary albedo. Absorption of longwave (terrestrial) radiation by greenhouse gases enhances global warming.

The increase of ambient temperature affects the cloud formation processes, cloud lifetime and shifts rainfall patterns. The atmospheric constituents that act as cloud condensation nuclei can modify the cloud microphysics, radiative properties of clouds and can enhance or suppress precipitation.

The effects of atmospheric pollutants on human health and the environment vary in several ways. Studies have linked air pollution in cities to chronic health problems like cardiovascular and cardio-respiratory deaths in the population (Mujuru et al., 2012).

Fine particles less than 100 nm in diameter may adversely affect human health, especially with regard to cardio-vascular illnesses and reduce visibility by scattering and absorption of radiation. On the environment, atmospheric constituents can affect photosynthesis and C-uptake rates of ecosystems subjected to large pollutant loadings by perturbing leaf temperatures and the amount of photosynthetic active radiation available to green plants. Pollutants such as total suspended particulate matter (TSPM),

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## ABSTRACT

*Changes in the quality of atmospheric composition due to pollution affects many aspects of life. In many urban areas, population exposure to air pollution is one of the main environmental health hazards. Air quality deterioration affects the fundamental necessities of human existence; human health, food production, ecosystem health and water. Research on atmospheric pollution is therefore fundamental to give evidence-based direction for stakeholders to develop mitigation strategies and enhance environmental integrity.*

*This paper analyses the spatial and temporal variations of air pollutant in the city of Harare from 1988 to 2005. Monthly levels of sulphur dioxide (1989-2005), nitrogen dioxide (1994-2005) and total suspended particulate matter or smoke (1988-2005) measured at 8 sampling sites in the city were collected from the City Health Department.*

*Levels of air pollutants were compared with WHO standard guidelines. while nitrogen dioxide and total suspended particulate matter emissions show increasing trends. Based on the research findings, it is suggested that there is need to limit levels of pollution in the city to avoid adverse health implications.*

ozone (O<sub>3</sub>), oxides of nitrogen (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), carbon monoxide (CO) and lead (Pb) threatens socio-economic activities, public health, and biophysical environments by endangering animal and human lives, and contributing to changes in climate and sea levels (Mujuru, 2012).

Although pollution problems were previously considered to be confined to Europe and North America since the second half of the 20th Century, levels of some pollutants have declined in some developed countries as a result of tight emission standards and routine monitoring (Wong et al., 2002).

On the other hand, in many developing countries local and regional ambient air pollution levels are growing as a result of rapid growth in urban population, increasing industrialisation, rising demands for energy, motorisation, poor environmental regulation, less efficient technology of production, congested roads, economic development and age and poor maintenance of motor vehicles (Mishra, 2003; Bandaiko et al., 2018). However, pollutant levels vary from city to city due to the geography in which city is located, weather conditions, natural nitrogen cycle, overuse of fertilizer, combustion of fossil fuels in vehicles and factories.

Pollutants are chemically harmful on their own or indirectly by reacting with others to produce harmful substances. For example, pollutants like SO<sub>2</sub> have a 'cocktail effect,' hence become more harmful when particulate and other pollutant concentrations are high. Coal burning accounts for almost 50% of annual global sulphur dioxide (SO<sub>2</sub>) emissions, with oil burning accounting for a further 25-30% (Mabratu, 2004). Smog which is made up of mainly of dust, soot and sulphur dioxide is related to deaths and illnesses worldwide. For example, the London winter smog of December 1952 was responsible for up to 4,000 deaths.

Summer smog causes extreme breathing difficulties for asthmatics as well as adverse effects on plant life, often severely reducing numbers. At least half a million premature deaths were caused by air pollution worldwide and a significant 1.4% of these occurred in major cities (Bandaiko et al., 2018).

The 2002 World Health Report claimed that indoor air pollution accounted for 2.7% of the global disease burden and some 1.6 million premature deaths annually (Wong et al., 2002). Urban air pollution additionally causes 0.8% of the global disease burden. In poor developing countries, indoor smoke from solid fuels ranks fourth, behind only under-nutrition, unsafe sex, and unsafe water, sanitation and hygiene, accounting for an estimated 3.7% of the disease burden. Mishra, 2003).

The health impacts of air pollution depend on the pollutant type, its concentration in the air, length of exposure, other pollutants in the air, and individual susceptibility. Thus, poor, undernourished, young and old people with pre-existing respiratory disease and other ill health are at high risk. Also, exposure to air pollution increases chances of acute and chronic effects on human health, ranging from minor irritation of eyes and the upper respiratory system to chronic respiratory disease, heart disease, lung cancer, impaired mental function, visual motor performance and neurological damage and death (Mabratu, 2004).

It is important to monitor air pollution for environmental planning and decision making. This can be achieved if capacities to measure, reduce and assess impacts of air pollution are strengthened. However, an increasing number of Southern African countries still have NO<sub>x</sub>, SO<sub>2</sub>, TSPM and lead pollutant levels exceeding the WHO guidelines (Sithole et al., 1993; Chibanda, 2004). This study therefore, analyses the spatial and temporal variability of SO<sub>2</sub>, NO<sub>2</sub> and TSPM in Harare city. The three pollutants were selected in this study due to availability of data. They are also indicator pollutants or surrogates of levels of other hydrocarbons (HCs)

## 2. Materials and methods

### 2.1 Description of the study area

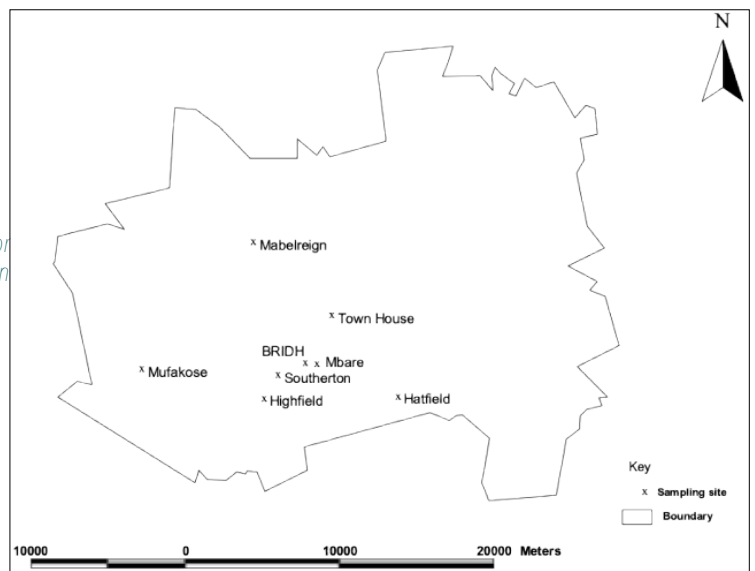
The city of Harare was established in 1890 and covers an area of 846 km<sup>2</sup> at a height of 1,492 m above sea level. Its population grew from 310,360 in 1961 to 1,542, 000 in 2021 (Zinyama et al., 1993; Chibanda, 2004). Vehicle population in the city increased from 168,119 in 1996 to 1,200, 000 in 2018 (Bandaiko et al., 2018). The mean annual temperature is 27 °C, while the maximum temperature is about 35 °C is experienced in October and an average minimum of 3 °C occurs in July. The general flow of air is from east to west.

### 2.2 Air pollutants in the city of Harare

Air quality in Harare, the capital of Zimbabwe, is a source of concern and is compromised by the presence of SO<sub>2</sub> NO<sub>2</sub> and TSPM among other pollutants (Mujuru et al., 2012). TSPM made up of visible particulates such as soot, smoke, metals, dust, and liquid droplets. The main sources of NO<sub>2</sub> are vehicular emissions, fuel combustion, aerobic decomposition, and manufacture of nitrogenous fertilizers. SO<sub>2</sub> from the combustion of fossil fuels in motor vehicles, boilers, stoves, coal burning, is emitted from combustion engines, manufacturing of fertilizers and sulphuric acid. The country's coal contains about 3% sulphur. The pollutants chiefly come from human activities and are transported by wind and affect places away from sources of pollution. The country's response to air pollution comprises pieces of legislations shown in Table 2.

Legislation	Description and comments
Atmospheric Pollution Control Act, 1971; Atmospheric Pollution Prevention Regulation (Smoke control and control of emissions) 1975; dust control areas notice 1981 and gas control and specified processes notice 1974.	Zones under the control of local authorities (municipalities) were declared to be 'gas, smoke or dust control areas' and subject to regulation by the Act. Outside these 'areas' there was minimal control of air pollution.  The Laws did not require vehicles to be fitted with emission control equipment. It also did not specify the maximum concentration levels of pollutants to be emitted into the atmosphere.
The Hazardous Substances and Articles Act and Public Health Act (1977)	The Minister of Health enforced these two Acts. The Acts did not specify the maximum levels of pollutants to be emitted into the atmosphere but allowed emitters to control.
The Environmental Management (EMA) Act December 2002	EMA repealed the Atmospheric Pollution Control and the Hazardous Substances and Articles Acts. It provides for the establishment of air quality standards including emission standards and air pollution control for both mobile and stationary sources. The Act also includes the polluter pays principle, licensing emissions and control of emissions by motor vehicles and other conveyances.  Enforcement of this regulation is weak due to socio-economic and political environment.

[SCh7] Figure 1. Location of air pollution monitoring sites. Source: author elaboration



[SCh7] Table 2. Air quality sampling sites. Source: Chibanda, 2004, p. 112

Site	Represent
Town House	City centre, CBD
Southernton polyclinic	Industry areas
Mbare (Edith Opperman clinic)	High density residential area, market place
Hatfield Polyclinic	Low density residential area
Mabelreign district office	Medium density residential area affected by pollutants from fertilizer company
Mufakose polyclinic	High density residential area affected by Sulphur dioxide from industries and thermal power station
Beatrice Road Infectious Disease Hospital (BRIDH)	Represent highways and industries
Highfield polyclinic	High density residential area, close to industries

Measurement of pollutants is done on a 48-hour sampling frequency is done during the week on Monday, Wednesday and Friday, and 72 hours during weekends.

SO<sub>2</sub> is measured using the daily volumetric samplers which are an active method for measuring net sulphur dioxide after reacting with ammonia.

TSPM are measured using filter papers. Their density is determined by the densitometer. NO<sub>2</sub> is measured using the Polish or badge sampling unit which uses the ultraviolet (U-V) spectrophotometer hence a passive method. In the laboratory it is analyzed using ion chromatography method.

Problems of air pollution monitoring include; breakdown of measuring equipment, severe transport shortages due to breakdown of municipal vehicles allocated to environmental monitoring and fuel shortage and shortage of personnel due to brain drain caused by harsh economic conditions in the country since 1998.

## 2.4 Source of data

Monthly data on pollutant levels of the period 1988 to 2005 were obtained from the Harare City Health Department's annual reports. Data for TSPM, SO<sub>2</sub> and NO<sub>2</sub> covered 18, 17 and 12 years respectively.

## 3. Results and discussion

### 3.1 Temporal variability of air pollutants over years

Figure 2 shows increasing trends of air pollutants over time. The decreasing SO<sub>2</sub> trend from 1991-1993 is due to harsh economic conditions, cut down on manufacturing concerns and low coal production in the country. This resulted in declining coal fuel consumption industries and other uses.

### 3.2 Spatial variability of air pollutants

Sulphur dioxide: Figure 3 shows that levels of SO<sub>2</sub> were below the WHO standards in Mbare and Town House. Whereas, at other 6 sites, SO<sub>2</sub> were exceeded the WHO guidelines. Highest SO<sub>2</sub> levels were recorded at Southerton while lowest SO<sub>2</sub> levels were observed at Mbare

Nitrogen dioxide: The levels of NO<sub>2</sub> were below the WHO guideline value of 40 µg/m<sup>3</sup> at the 6 monitoring sites which reported data (Figure 4).

SPM: Figure 4 shows the average levels of SPM measured over the 18-year period at the 8 monitoring sites. It is clear that only at BRIDH were SPM levels exceeded WHO standards. This is attributed to high volume of vehicles along the road to and from western suburbs, South Africa into the city centre. In addition, the monitoring site is close to heavy industries.

Findings from this study are relatively consistent with observations by Mujuru et al. (2012) who monitored SO<sub>2</sub>, NO<sub>2</sub>, and TSPM in the city for three months from July, to September.

During the sampling period, all these pollutants were found to be above the air quality guidelines provided by WHO, and of much concern were levels of SO<sub>2</sub> and TSPM, SO<sub>2</sub> was found to be higher during winter in July than in at beginning of summer in September.

The high ambient air concentrations of SO<sub>2</sub> and TSPM were mainly due to vehicles and industrial operations near the sampling sites. NO<sub>2</sub> pollution was found to be mainly from vehicles.

## 4. Conclusion

This study establishes the levels, trends, and spatial variations of air pollutants in Harare, the capital city of Zimbabwe. Data for SO<sub>2</sub>, NO<sub>2</sub> and from 8 monitoring sites were collected from the city records. The air quality monitoring stations are located along highways (BRIDH), in industrial areas (Southerton), in the city centre (Town House), low density (Hatfield), in medium density suburb (Mabelreign) and high-density residential areas (Mbare, Mufakose and Highfield).

The study revealed increasing trends for the 3 pollutants though significant for SO<sub>2</sub>. Highest levels of SO<sub>2</sub> were measured at Southerton, SPM at BRIDH and NO<sub>2</sub> at Town House (Figures 3, 4 and 5).

These results suggest that the city authorities should scale up efforts to reduce emission of air pollutants by formally adopting prioritised pollutant reduction plans.

Based on the research findings, it is recommended that policymakers in many developing countries need to design programs, set standards, and take action to mitigate adverse health effects of air pollution.

[SCh7] Figure 2. Mean annual levels of air pollutants. Source: author elaboration

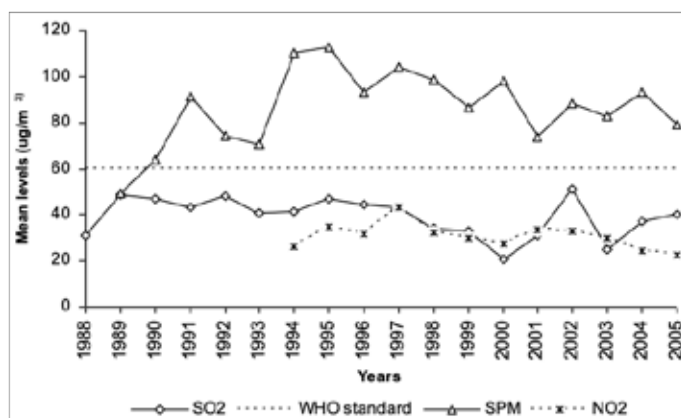
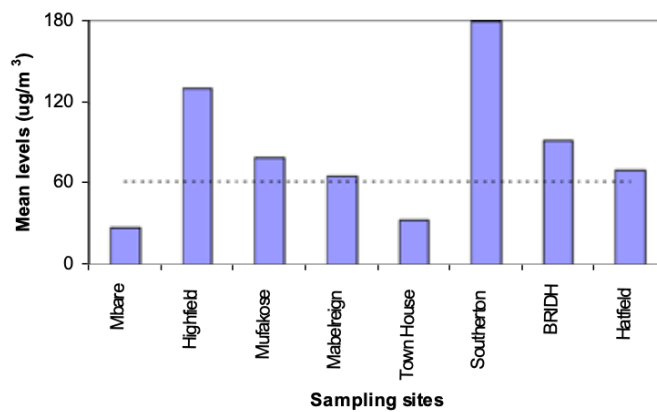


Figure SCh7.3 Mean levels of SO2



[SCh7] Figure 4. Levels of NO2. Source: author elaboration

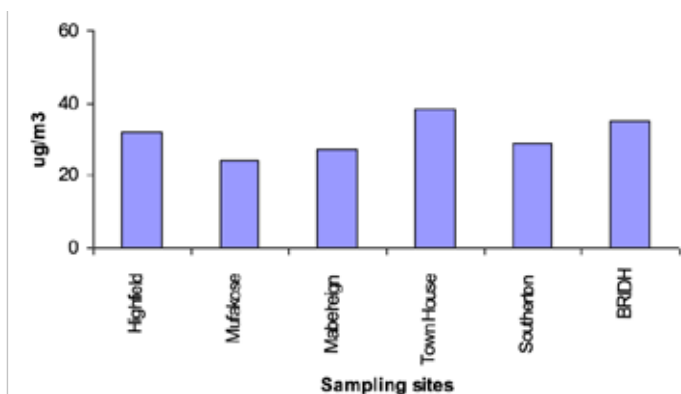
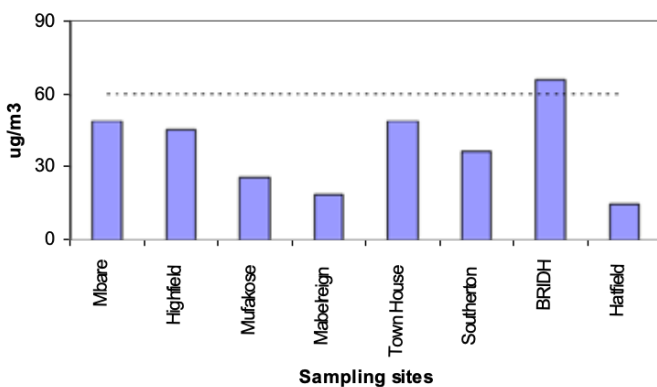


Figure SCh7.5 Mean levels of SPM

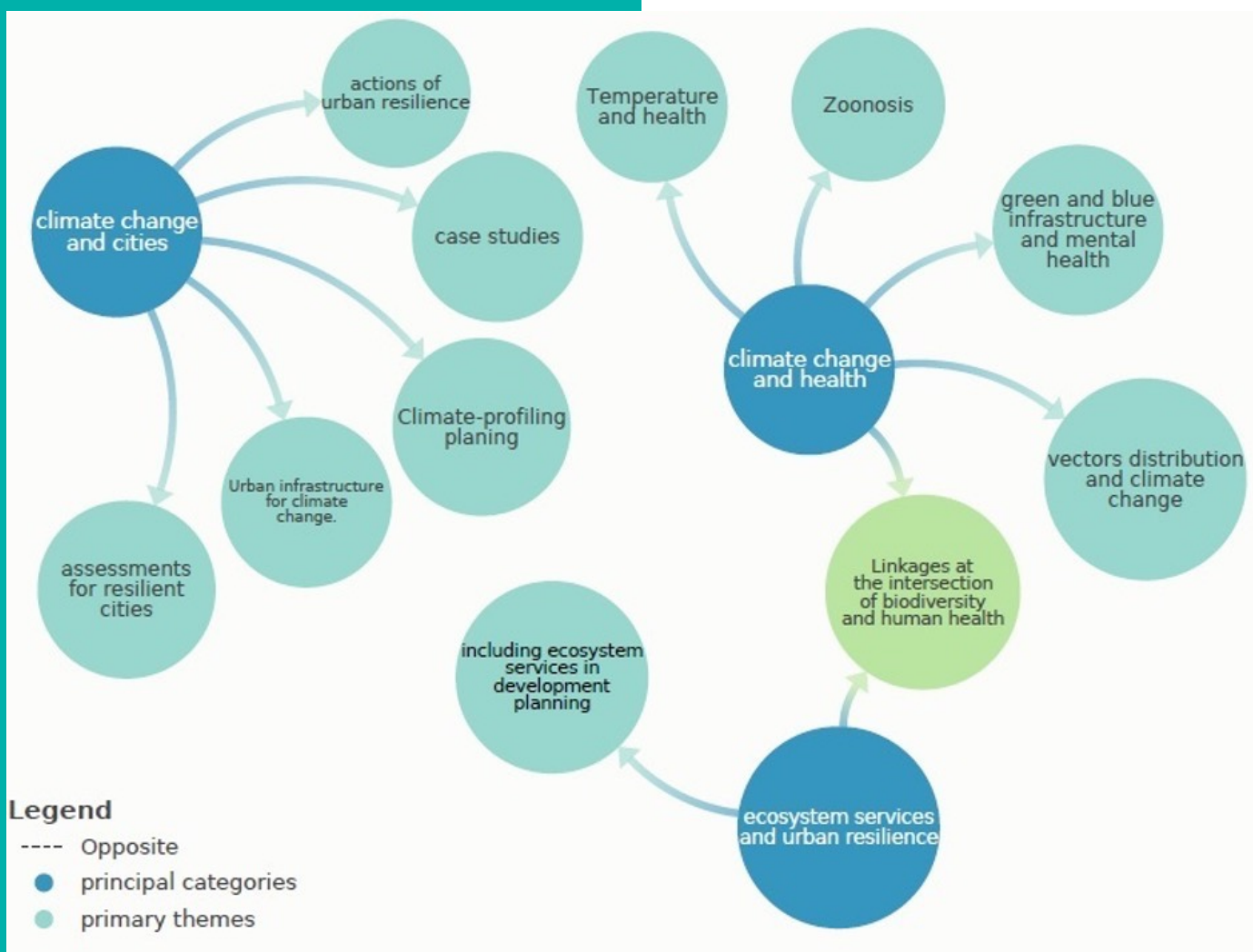


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# KEYWORDS

CLIMATE CHANGE; HUMAN HEALTH;  
CITY; PANDEMIC; URBAN RESILIENCE;  
DISASTER RISK REDUCTION



Principal themes from the main topics for the private and public organizations.  
Source: author elaboration

# [SCh 8] Climate change and health interlinkages for urban resilience: a gray literature review

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## 1. Introduction

Urban areas are increasingly vulnerable and exposed to the effects of climate change, from floods to heat waves, that have major impacts on human life and health, as well as on the social function of communities. The current system of production and consumption, based on the extensive use of fossil fuel, have a negative impact on climate due to the emission of greenhouse gases (GHG), that have also direct impact on human health, particularly in urban areas.

According to the World Health Organization (WHO) a significant number of countries, due to COVID 19 pandemic, understood the importance of strengthening public health systems to be prepared to future shocks, including climate change ones (WHO, 2021). In fact, the 2021 WHO Health and Climate Change Global Survey report highlighted that only 25% of the 95 reviewed countries had a national health and climate change plan or strategy in place and an additional 25% of countries have a plan or strategy under development (WHO, 2021).

The health of urban population is not only subject to the climate related risks but to a broader set of risks that requires to be understood systemically, as well. The Sendai Framework for Disaster Risk Reduction, through the Making City Resilience Campaigns, have been supporting governments in developing risk assessments, plans and policies to face disaster risk reduction systemically, specifically including components of human health and human well-being (UNDRR 2015a; 2015b).

Human health in cities is ultimately a fundamental component of sustainable development, particularly in a developing context, being closely related to eradicating poverty, food security and nutrition, as well as to water and sanitation and access to modern energy. Without any doubt, health is the most basic human right and one of the most important indicators of sustainable development (United Nations 1992; World Health Organization and Secretariat of the Convention on Biological Diversity 2015).

This article aims at understanding the human health interlinkages with climate change in cities, in the wider context of disaster risk reduction and sustainable development, by searching grey literature, namely produced by selected public and private international organizations, and analyzing specifically the policy recommendations, methodological frameworks and tools that can

## ABSTRACT

*The causes and effects of climate change are strongly interrelated with human health. As a result, public and private international organizations have been addressing the issue, especially in urban areas, studying the impacts generated by climate change and its consequences on human health.*

*This article reviews the grey literature published by public and private organizations working on climate change and health. Using the keywords climate change, health, ecosystem services, and urban resilience, 41 reports were selected to link climate change and cities, 30 for climate change and health, and 21 for ecosystem services and urban resilience. The selected documents were classified and analysed based on three categories related to conceptualizing the main topic and their contributions to the planning process of local governments.*

*The review identified some knowledge gaps related to the level of development of methodological and conceptual framework and guidelines for policies.*

*As a result, implementing actions from local governments that address the relationship of human health, urban resilience and ecosystem services in contexts of climate change in cities is still weak.*



facilitate local governments to implement measures that allow to enhance urban resilience. After reviewing 59 reports, it was found that the main knowledge gaps identified by the reports show that even when some planning tools for climate change are related to urban resilience, most do not include health variables.

Urban resilience is here defined as a dynamically adaptive process, that is going beyond climate adaptation and disaster risk reduction, tackling both causes and effects of mayor global challenges, starting from climate change that, apart from its direct impacts, have a multiplying effect on other major urban challenges as urban sprawl and sustainable development.

The following research questions guided the research:

1. How have public and private organizations studied the effects of climate change on health?
2. What relationships emerge between urban contexts and human health from the gray literature review?
3. Which are the principal policies and actions proposed by public and private organizations?
4. How are ecosystem services linked to human health and therefore to urban resilience?

The article is structured including a background to the current research, analyzing links between climate, urban, and health (Section 2), the description of the methodology used for the grey literature review, and for the analysis of results (Section 3), the key results obtained from our review (Section 4) and a last Section 5 for discussion and conclusions.

## 2. Background framework

### 2.1 Urban structure, climate change and health

The world has become predominantly urban, and cities are where the main challenges of sustainable development are being tackled. Cities occupy only 2% of the land, and are responsible for 70% of global GDP, greenhouse gas emissions (GHG), and global waste and over 60% of global energy consumption. (UN-Habitat 2019).

Likewise, the impacts caused by climate change increase the vulnerabilities inherent to the existing inequity due to factors such as poverty, placing a large part of the population at a disadvantage. That is why the concept of resilience has gained strength in the last ten years. It is evident from the commitment assumed by governments in the adoption of global agendas such as Agenda 2030 for Sustainable Development, Paris Agreement, Sendai Framework for Disaster Risk Reduction and New Urban Agenda (ICLEI 2019).

The concept of urban resilience that will be addressed in this article includes environmental complexity and the relationship of culture with this framework retrieved by Folke et al. (2011), where it is understood that people and societies are integrated parts of the biosphere. They depend on their functioning and vital support on ecosystems, generating socio-ecosystems. The problem is that culture seems to have disconnected from nature and has forgotten that economies and societies are fundamentally integrated with the planet, which has generated the increase of vulnerability worldwide. Therefore, urban resilience attempts to create a new understanding of how humans and nature interact, adapt, and impact each other amid change. That is why the need to reconnect to the biosphere is argued, that sphere that encompasses air, water, and land that sustains life (Folke et al. 2011).

In this way, it is necessary to make cities capable of managing all kinds of threats or risks, coming from natural, social, economic, or political origin, minimizing the negative impacts that may be generated. The key point is how urban societies can deal with their reorganization, returning to a state similar to the initial one or how new states can be created that allow it to continue fulfilling its vital functions.

Intergovernmental Panel on Climate Change (IPCC) and WHO have been making an effort to merge climate change effects on human health in cities. To analyze the impacts of climate change on human health, IPCC selected three categories: direct, indirect, and tertiary impacts. The direct impacts of climate change on human health are related to the direct effects of threats of hydrometeorological origin. For example:

- A risk of mortality and morbidity from an increase in the frequency or intensity of heatwaves, principally in older age groups and among the urban poor (direct)
- Increased risks of infectious disease, particularly in low-income countries following extreme weather patterns, flooding, and displacement (direct)

The indirect impacts arise due to the effects of climate change, such as effects on the agricultural system and change in vector-borne diseases distribution. Climate change directly contributes to damage of infrastructure and human settlements, resulting in human mortality and morbidity that includes survivors' mental health and

well-being. Some examples:

- An increase in vector-borne infections, particularly in populations at the margins of the current distribution of diseases (indirect)
- An increase in the number of undernourished people in low-income countries, following more vulnerable food supplies in drought or flooding conditions (indirect)
- Increases in morbidity and mortality following exposure to ozone and other air pollutants (indirect) (IPCC, 2014a; IPCC, 2014b; IPCC, 2014c).

The tertiary impacts have been included in the following agendas after COP 21, including the health impacts of large-scale famine, forced migration, and human conflict, which result from climate change's geophysical and ecological consequences, including the alteration of ecosystems, sea-level rise, and long-term disruptions in water supply and food production (World Health Organization and Secretariat of the Convention on Biological Diversity, 2015). For example, the impacts of climate change that may cause social disruption, economic decline and displacement of populations which in turn negatively affect population health (World Health Organization and Secretariat of the Convention on Biological Diversity, 2015, p. 225)

Since 1988, the IPCC was called on to assess "the scientific, technical and socioeconomic information relevant to understanding human-induced climate change risk." (World Health Organization and Secretariat of the Convention on Biological Diversity, 2015, p. 223). Today, the scientific community and the public health sector are widely attracted to this topic (World Health Organization 2015; United Nations 1992). Indeed, in the last UN Climate Change Conference in Glasgow (COP26), "50 countries have committed to take concrete steps towards creating climate-resilient health systems" as part of the COP26 health program (Wyns and Johnson 2021).

Each time is more visible for local governments, the relevance of having quality information for decision-making in urban planning, specially adding climate change scenarios from identifying weather patterns, variability and anomalies, and meteorological information and identifying systemic relationships that allow strategies to increase urban resilience.

The development of the subject by the public sector and the scientific community has led to an increasing awareness that good health depends on "the ecological, physical and socioeconomic systems of the biosphere remain stable and incorrect operation." (WHO, 2003, p.5)

## 2.2 Climate change in urban areas and pandemic

Pandemics such as COVID-19 or outbreaks of influenza A (H1N1), dengue, MERS, SARS, among others, show that health crises generate significant economic losses with serious social impact. On the other hand, inequalities in access to quality health services are a central link in reproducing poverty since they reduce capacities and economic opportunities (Comisión económica para América Latina y el Caribe (CEPAL), 2020, p. 41).

These vulnerabilities are exacerbated in developing countries, where poverty reduction goals are far from being achieved, and inequities are due to the fragmentation of health, education, and culture but also to the negative effect on ecosystems.

However, considering that health systems are highly vulnerable, evidenced in the current health emergency caused by COVID 19, it is important to incorporate their resilience within the adaptation and mitigation framework to climate change by being among the first responders to crises. It is not only necessary to improve the facilities of health centers, adapting them to new climatic conditions, but also empowering leaders and organizations, preparing staff to respond to catastrophic events. (ARUP 2020).

COVID 19 can be used in fact as a great opportunity to initiate the structural changes required by the current development model in search of climate-resilient cities based on sustainable and respectful relationships with the natural environment and humanity itself.

The clear link between deforestation and virus emergence suggests that a significant effort to retain intact forest cover would have a large return on investment even if the only benefit were to reduce virus emergence events. At the same time, it is crucial to stop wildlife trade and keep them out of markets (Dobson et al., 2020). Prevention actions concerning pandemics are much more cost-effective in the long term, when "the underlying causes of pandemics are the same global environmental changes that drive biodiversity loss and climate change" (IPBES Bureau and Multidisciplinary Expert Panel, 2020, p. 2). Following Dobson et al. (2020), who explored eight alternative scenarios with varied assumptions drawn from the highest and lowest values of prevention costs and pandemic damages, the present value of prevention costs for ten years was only about 2% of the costs of the COVID-19 pandemic.

Thus, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) Bureau and Multidisciplinary Expert Panel (MEP) authorized a workshop on biodiversity and pandemics that was held

virtually on 27-31 July 2020. The workshop brought together 22 experts from all regions of the world, to discuss 1) how pandemics emerge from the microbial diversity found in nature; 2) the role of land-use changes and climate change in driving pandemics; 3) the role of wildlife trade in driving pandemics; 4) learning from nature to better control pandemics; and 5) preventing pandemics based on a “one health” approach” (IPBES Bureau and Multidisciplinary Expert Panel 2020, p.1). Main conclusions were that among main drivers for the current Pandemic Era are the continued rise in human population density, consumption, encroachment into wildlife habitat, degradation of ecosystems, industrialization of the wildlife trade, climate change and intensification of agricultural production. The experts agreed that the only way to change this situation is to initiate new global policies for prevention, after which it becomes extremely difficult to mitigate (IPBES Bureau and Multidisciplinary Expert Panel 2020).

Finally, the United Nations (UN), through the UN Environment Programme (UNEP) and global leaders, have been working in developing a new and ambitious post-2020 global biodiversity framework to bring emerging issues to the attention of decision-makers. (UNEP 2020).

### 3. Methodology

The grey literature search was performed from January 2021 to June 2021. First, a long list of leading international private and public organizations working on climate and health issues at urban level was elaborated, including: UN system organizations (e.g. UN-Habitat and UNDRR); bi-lateral and multi-lateral organizations donors (e.g. GIZ and WBG); other multi-lateral organizations (e.g. ICLEI and UCLG); and private sector organizations, for profit and non-profit (e.g. ARUP and EcoHealth Alliance).

The official organizations' websites were consulted to check the availability of an open access publications databases, and the possibility to perform simple key word or Boolean searches. The organizations lacking a searchable database of publications were excluded. A list of the organizations following these criteria are below:

1. United Nations Human Settlements Programme (UN-HABITAT)
2. World Health Organization (WHO)
3. United Nations Development Programme (UNDP)
4. Intergovernmental Panel on Climate Change (IPCC)
5. Economic Commission for Latin America and the Caribbean (ECLAC)
6. World Meteorological Organization (WMO)
7. United Nations Office for Disaster Risk Reduction (UNDRR)
8. Local Governments for Sustainability (ICLEI)
9. The World Bank Group (WBG)
10. U.S. Agency for International Development (USAID)
11. ARUP
12. EcoHealth Alliance
13. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
14. Agence Française de Développement (AFD)
15. Foreign, Commonwealth & Development Office (FCDO)
16. Inter-American Development Bank (IADB)
17. United Cities and Local Governments (UCLG)
18. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)

The search was limited to reports, notices, or book chapters published in English and Spanish, executing combination of Boolean or simple consecutive searches depending on the functionality of the database, and included the following key words: climate change, cambio climatico, urban resilience, resiliencia urbana, health, salud, ecosystem services and servicios ecosistemicos.

The search on 18 organizations' database gave 3.085 results, listed in Figure 1 and Appendix 1. The publications were screened looking at the title and abstract or executive resume to select the most relevant. Additional exclusion criteria were established to guide the selection process, as following:

- Healthcare profession and facilities
- Financial and economic evaluation of health impact
- In-door health and air quality
- Non-urban context, rural areas, forestry.

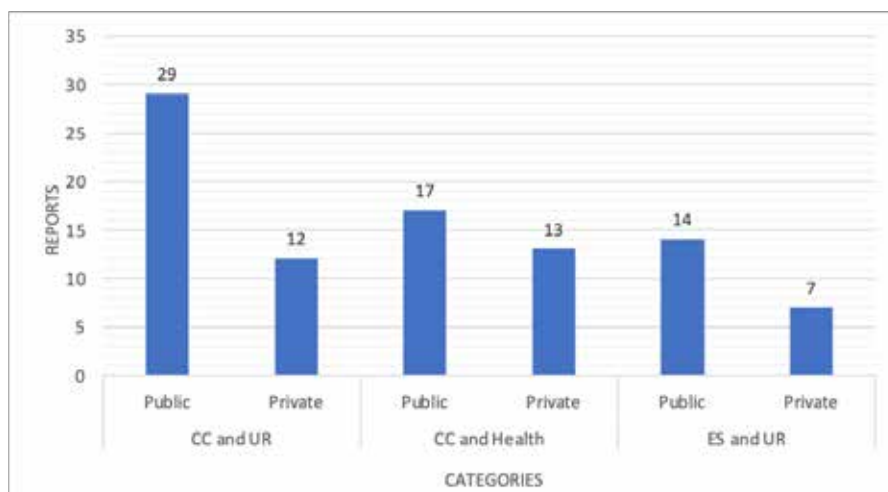
[SCh8] Table 1. Selection of reports from the grey literature review. Source: author elaboration

ORGANIZATIONS DATABASES SELECTED BY KEYWORDS	TITLES AND ABSTRACTS SCREENED	READ ABSTRACTS AND SOME CHAPTERS FROM THE REPORTS
UN-HABITAT	120	8
WHO	33	2
UNDP	133	2
IPCC	0	0
ECLAC	298	7
WMO	216	0
UNDRR	40	3
ICLEI	22	5
WBG	298	3
USAID	2	1
ARUP	269	9
EcoHealth Alliance	150	6
GIZ	94	3
AFD	21	0
FCDO	1158	0
IADB	23	5
UCLG	180	3
IPBES	1	1
<b>TOTAL: 18</b>	<b>3058</b>	<b>59</b>

A total of 59 reports were selected (full listed in Appendix 1) and were read and reviewed in full to respond to the aforementioned research questions. The graphical analysis of collected data was conducted using R-studio software to understand the number of publications on the different topics and subject areas. In addition, the principal authors and countries of publication, the time of publication and tools were graphically represented using Kumu and Goconqr software.

#### 4. Analysis of the results

The analysis of the selected reports focused on three central themes: climate change (CC) and health; climate change (CC) and urban resilience (UR); and ecosystem services (ES) and urban resilience (UR), as reported in Figure 2, looking at the distribution of selected report between private and public organizations. The topic with the largest number of publications by public organizations was “climate change and urban resilience” with 29 publications. The category “climate change and health” is represented by 17 reports, marking a difference with the category mentioned above. Finally, there is a lower number of reports for ecosystem services and urban resilience. However, it does not differ much from the last category, with 14 publications.



[SCh8] Figure 2. Main topics for the private and public organizations. Source: author elaboration, 2021

In the private sector, the distribution of publications corresponding to “climate change and urban resilience” and “climate change and health” present a relatively similar number, 12 and 13 publications, respectively. Finally, the category “ecosystem services and urban resilience” is the category with the fewest publications in this sector, represented by 7 related reports. It should be noted that some reports are part of two or all three categories.

A more detailed analysis to review the main topics included in the reports was carried out, as shown in Figure 3. For the “climate change and cities” category, five (5) principal topics related to case studies were discussed in most reports, including proposed actions for urban resilience, urban infrastructures such as green and blue spaces, climate profiling planning, and assessments for resilient cities.

There were five (5) main topics for the climate change and health category, including in most reports’ zoonosis, the relationship between temperature increases and human health, the relationship between vectors distribution and climate change, the relationship between green and blue infrastructure and mental health and climate profiling.

One topic shares the category “climate change and health” with “ecosystem services and climate change,” which is “Linkages at the intersection of biodiversity and human health.”

Most reports included information about ecosystem services in development planning for the “ecosystem services and climate change” category. The reports were reviewed including the following three subcategories for the analysis: policy guidelines, conceptual frameworks, and implementation tools.

As shown in Figure 4, the reports from public agencies show a high tendency to generate information to develop the conceptual framework, followed by policy guidelines, with 25 publications.

Finally, only 18 reports include tools for climate change and health in the framework of urban resilience. It should be noted that some reports are part of two or all three categories.

For the private sector, the categories “policy guidelines” and “conceptual framework” showed a similar number of reports, the former with 14 and the latter with 15. In the “implementation tools” category, the number of publications is reduced to 7, which shows that this is a topic on which information is still incipient and requires further research.

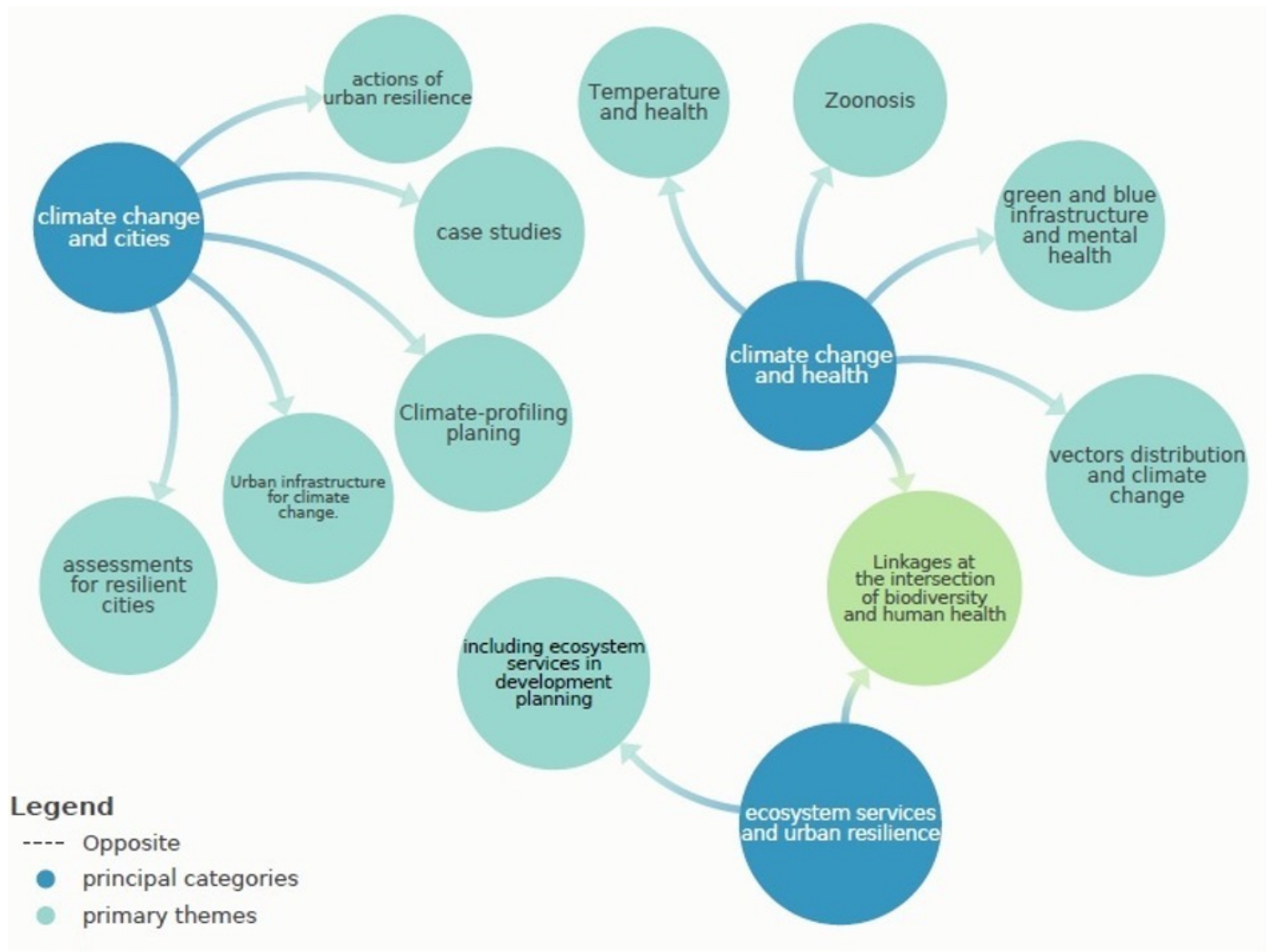
## 5. Discussion

Both organizations, IPCC and WHO, tackled the relationship between health and climate change from the publication on 1990 of the report “Potential health effects of climate change”, adding an express call on decision-makers to incorporate the issue into planning and seek to reduce impacts. (WHO 1990). It is clear from our review, that most reports included content on conceptual framework on climate change and cities, evidencing that it is a subject that is widely studied. It also presents a broad contribution in terms of guidelines for designing public policies, addressing case studies and tools that contribute to urban planning from resilience to climate change. However, this relationship with human health is still not very evident or direct (UNDRR 2012; GIZ 2017a; GIZ 2017b; UN-Habitat 2019; ECLAC 2020). For climate change and health, the climate change impact on the distribution and development of vectors, the zoonosis issues and the relationship between temperature and human health are the most addressed issues. Most of the reports directly and significantly contribute to the conceptual framework and in the promotion of public policies.

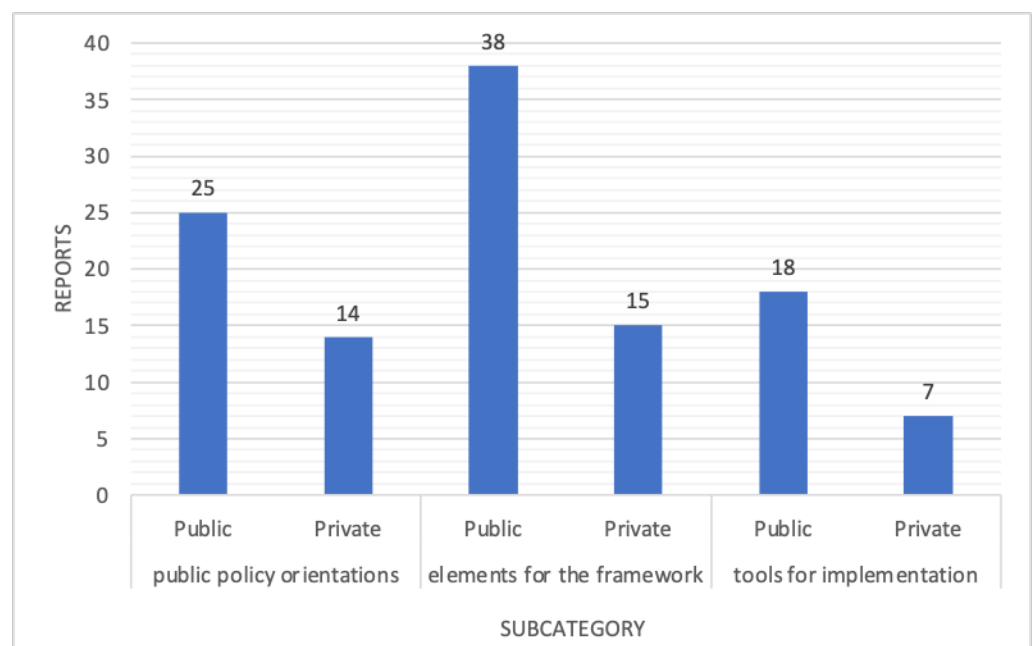
The close relationship between climate change and health is evidenced for ecosystem services and urban resilience. The relationship between biodiversity and human health is visibly addressed, primarily contributing to developing the theoretical framework, followed by providing guidelines for formulating public policies. In fact, the United Nations proposes to face climate and health crises systemically, increasing alternative energies to reduce greenhouse gas emissions, improving air quality, and preserving the main ecological structure and using nature-based solutions to generate resilient cities (UN, 2020). However, only one report from ARUP provides tools for implementation focused on how to incorporate ecosystem services and healthcare in project formulation (GIZ 2012; ICLEI 2019; World Health Organization and Secretariat of the Convention on Biological Diversity 2015; IPBES Bureau and Multidisciplinary Expert Panel 2020; ARUP 2020). On the other hand, the review has shown a lack of modeling systems related to climate change impacting human health to incorporate environmental determinants of health. Although the topic of pandemics leads to a high generation of information, there is little evidence of specific information on its relationship with climate change.

However, two reports talk about how pandemics bring catastrophic global impacts with high costs, not just economics, and recommend that the only way to reduce the impacts is to get into a preventing culture, and this

[SCh8] Figure 3. Principal themes from the main topics for the private and public organizations. Source: author elaboration



proposes a structural change in how humans live together with other animals due to most of the pandemics had an origin related to zoonosis (IPBES Bureau and Multidisciplinary Expert Panel 2020; Ecohealth alliance 2020). Figure 5 shows the main gaps identified from the grey literature review to analyze the link between climate change and health in the framework of urban resilience.



[SCh8] Figure 4. Main subject areas for the private and public organizations. Source: own elaboration. 2021

## 6. Conclusion

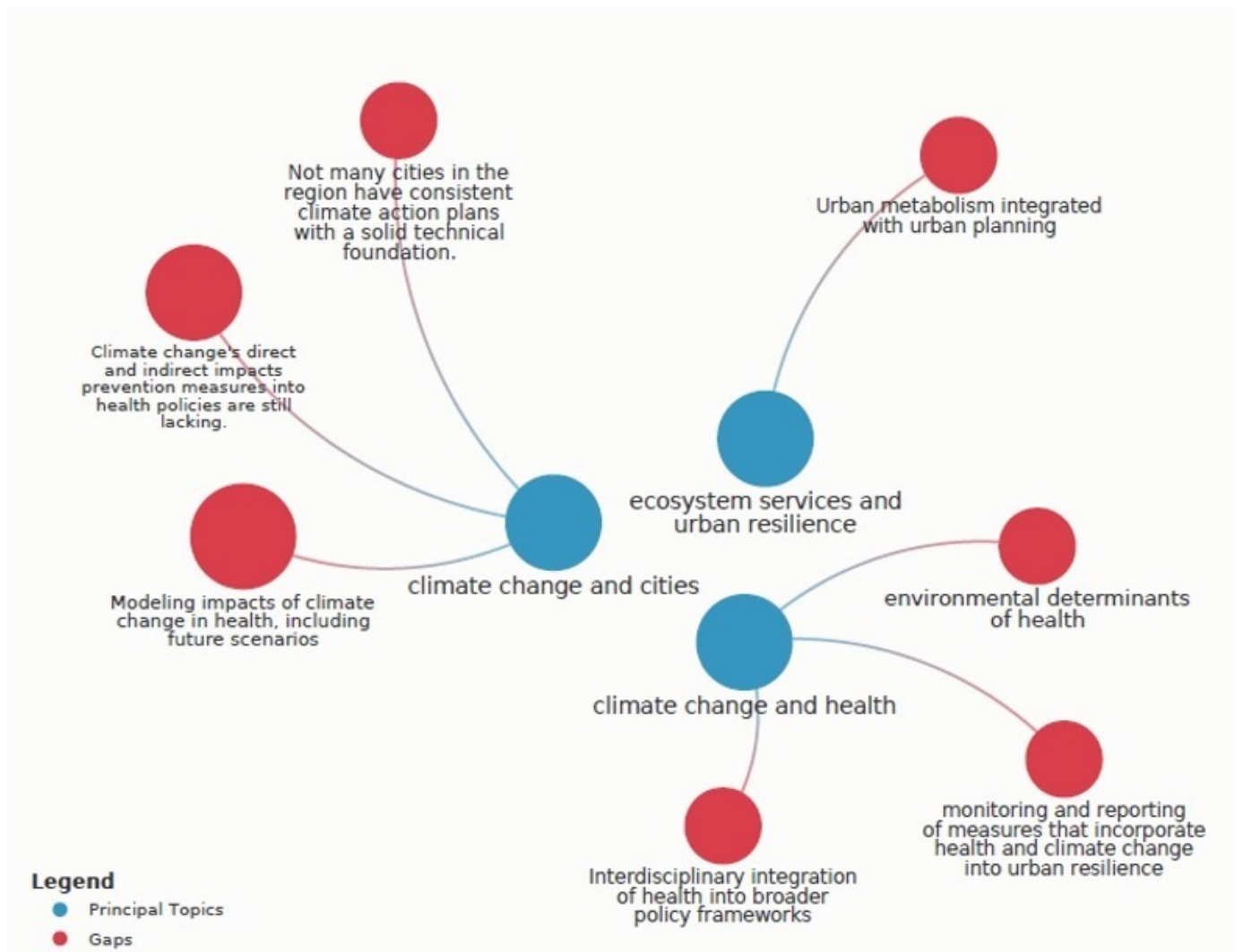
It can be observed that most of the reports made contributions to the impacts generated by climate change on the human health framework. To a lesser extent, efforts have been made to generate guidelines and tools to incorporate the topic into city assessments and planning.

Climate change and human health issues such as zoonoses and vector distribution were addressed on several reports. In addition, some reports evidenced the relationship between the generation of green and blue spaces in urban infrastructure and the improvement of mental illnesses and, generally, the health of children and the elderly. Research about climate change impacts on human health related to urban resilience should continue, emphasizing reducing vulnerabilities from local communities in developing countries and improving health services to increase climate-related stresses and shocks knowledge, as well as developing methods for assessing the effectiveness of policies and programs. (World Health Organization 2021)

Most of the climate change and urban resilience reports are focused on quantifying, modeling, or including case studies. However, some main knowledge gaps in the definition of direct and indirect impacts of climate change related to the vulnerabilities present in urban spaces have been identified. On the other hand, the link between urban resilience and ecosystem services were also approached on some reports. However, there is no more information on how to improve conditions of vulnerability, and human health is a clear determinant of increasing urban resilience and influencing community livelihoods.

Increasing studies related to the adaptation and mitigation of climate change emphasize human health. Furthermore, it is considered to develop vulnerability assessments that contribute to the construction of plans for adapting the health sector to the impacts of climate change. Also, it is noted that it is necessary that urban resilience assessments integrally show urban metabolism due to understanding the ecosystem services available.

[SCh8] Figure 5. Main gaps from the review of the grey literature for private and public organizations. Source: author elaboration.



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# ANNEX

Publication	Author	Organization	Type	Year	subject area			topic			Country	Selected abstract	Selected document
					orientations for public policy	elements for the framework	tools for implementation	CC and UR	CC and health	ES and UR			
Estrategias de desarrollo bajo en carbono en megaciudades de América Latina	Samaniego, Jose Luis Jordán, Ricardo Ruiz-Tejada, María Teresa	CEPAL	public	2013	Y	Y	N	Y	N	Y	Chile	x	Y
Respuestas urbanas al cambio climático en América Latina	Sánchez Rodríguez, Roberto	CEPAL	public	2013	Y	Y	Y	Y	Y	N	Chile	x	Y
Vulnerabilidad y adaptación de las ciudades de América Latina al cambio climático	Margulis, Sergio	CEPAL	public	2017	Y	Y	N	Y	Y	Y	Chile	x	Y
La economía del cambio climático en Bolivia. Impactos en salud	Oscar Molina Tejerina y Paolo De Ferrari Patton	CEPAL	public	2014	Y	Y	Y	Y	Y	N	USA	x	Y
Potenciar la resiliencia de las ciudades y sus territorios de pertenencia en el marco de los acuerdos sobre cambio climático y de la Nueva Agenda Urbana	Yosu Rodríguez Aldabe	CEPAL	public	2018	Y	Y	Y	Y	N	Y	Chile	x	Y
Efecto del cambio climático en el costo de los eventos de interés en salud pública en Colombia: estudio de caso sobre malaria y dengue	CEPAL	CEPAL	public	2013	Y	Y	N	Y	Y	N	Chile	x	Y
La Agenda 2030 para el Desarrollo Sostenible en el nuevo contexto mundial y regional. Escenarios y proyecciones en la presente crisis	CEPAL	CEPAL	public	2020	N	Y	N	Y	Y	N	Chile	x	Y
Global Disease outbreaks Associated with the 2015–2016 El Niño event	Anyamba, Asaf Chretien, Jean-Paul Botch et al.	ecoHealth Alliance	private	2019	N	Y	N	N	Y	N	USA	x	Y
Measuring the health-related Sustainable Development Goals in 188 countries: a baseline analysis from the Global Burden of Disease Study 2015	GBD 2015 SDG Collaborators	ecoHealth Alliance	private	2016	N	Y	Y	N	Y	N	USA	x	Y
An ecosystem risk assessment of temperate and tropical forests of the Americas with an outlook on future conservation strategies	Ferrer Paris, José Rafael et al.	ecoHealth Alliance	private	2019	Y	N	Y	N	N	Y		x	Y
Building resilience to biothreats: an assessment of unmet core global health security needs	Carlin, EP; Machalaba, C; Berthe, FCJ; Long, KC; Kares, WB	ecoHealth Alliance	private	2019	N	Y	N	N	Y	N	USA	x	Y
Avoiding catastrophes: seeking synergies among the public health, environmental protection, and human security sectors	Stoett, Peter; et al	ecoHealth Alliance	private	2016	N	Y	N	N	Y	N	Canada	x	Y
Connecting Global Priorities: Biodiversity and Human Health A State of Knowledge Review, chapter 13: Climate change, biodiversity and human health lead	Cristina Romanelli, Anthony Capon, Marina Maiers, Djamil Carabelli-Lensdram	WHO	public	2015	Y	Y	Y	Y	Y	Y	NA	x	Y
Ecology and economics for pandemic prevention	Dobson, Andrew P Pimm, Stuart L Hannah et al.	ecoHealth Alliance	private	2020	Y	Y	N	N	Y	N	USA	x	Y
Resilient Cities, Thriving Cities : the Evolution of urban resilience	ICLEI	ICLEI	public	2019	Y	Y	N	Y	N	Y	Germany	x	Y
interact-bio	ICLEI	ICLEI	public	2021	N	N	Y	Y	N	Y		x	Y
New Report Shows Extreme Biodiversity Loss Globally, Demonstrates Urgent Need for Urban Action on Nature	ICLEI	ICLEI	public	2019	N	Y	Y	Y	N	Y		x	Y
IPBES Workshop on Biodiversity and Pandemics	IPBES Bureau and Multidisciplinary Expert Panel	IPBES	public	2020	Y	Y	N	N	Y	Y	NA	x	Y

Publication	Author	Organization	Type	Year	subject area			topic			Country	Selected abstract	Selected document
					orientations for public policy	elements for the framework	tools for implementation	CC and UR	CC and health	ES and UR			
The Adaptation Gap Report 2018.	Gerardo Sanchez Martinez, Peter Berry	UNEP	public	2018	Y	Y	N	N	Y	N	Kenya	x	Y
Frontiers 2018/19 Nuevos temas de interés ambiental (Evitar la inadaptación en un futuro limitado por los 1,5 °C)	ONU	PNUMA	public	2019	N	Y	N	N	N	Y	Kenya	x	Y
CITY RESILIENCE PROGRAM	The World Bank	The World Bank	private	2018	Y	N	Y	Y	N	N	NA	x	Y
Climate Smart Healthcare. Low Carbon and Resilience Strategies for the Health Sector	The World Bank	The World Bank	private	2017	Y	Y	Y	Y	Y	N	USA	x	Y
One Health - Operational framework for strengthening human, animal, and environmental public health systems at their interface	The World Bank / EcoHealth Alliance	The World Bank	private	2018	Y	Y	Y	Y	Y	Y	USA	x	Y
Health Emergency and Disaster Risk Management overview	World Health Organization; Public Health England and partners	UNISDR	public	2017	Y	Y	N	N	Y	N	England	x	Y
Making Cities Resilient Report 2012. My city is getting ready! A global snapshot of how local governments reduce disaster risk	Sophie Blackburn, Cassidy Johnson	UNISDR	public	2012	Y	Y	Y	Y	N	N	NA	x	Y
Cómo desarrollar ciudades más resilientes. Un Manual para líderes de los gobiernos locales	UNISDR	UNISDR	public	2012	Y	Y	Y	Y	N	N	Suiza	x	Y
THE ROLE OF ENVIRONMENT IN ONE HEALTH AND NATIONAL HEALTH SECURITY	USAID	USAID	public	2015	N	Y	N	N	Y	N	USA	x	Y
WHO UNFCCC Climate and Health Country Profiles - Reference Document	WHO	WHO	public	2015	N	Y	N	N	Y	N		x	Y
PLANNING FOR CLIMATE CHANGE: A STRATEGIC, VALUES-BASED APPROACH FOR URBAN PLANNERS - TOOLKIT	UN Habitat	UN Habitat	public	2014	Y	N	Y	Y	N	N	Kenya	x	Y
2020 CATALOGUE OF SERVICES	UN Habitat	UN Habitat	public	2020	Y	Y	Y	Y	N	N	Kenya	x	Y
City Resilience Profiling Programme - Climate Action Enhancer	UN Habitat	UN Habitat	public	2018	Y	Y	Y	Y	N	N	Spain	x	Y
Climate Change Vulnerability and Risk - A Guide for Community Assessments, Action Planning and Implementation	UN Habitat	UN Habitat	public	2020	Y	Y	Y	Y	N	N	Kenya	x	Y
Data speak louder than words: Findings from an initial stocktake of climate change adaptation and urban resilience efforts.	ICLEI, C40, 100 RESILIENCE CITIES, UN HABITAT	ICLEI	public	2018	N	Y	N	Y	N	N	Germany	x	Y
Trends in urban resilience	UN Habitat	UN Habitat	public	2017	N	Y	N	Y	N	N	Kenya	x	Y
City Resilience Profiling Tool - Resource Efficiency Enhancer	UN Habitat	UN Habitat	public	2019	N	Y	Y	Y	N	Y	Spain	x	Y
City Resilience Profiling Tool (CRPT): Guide	UN Habitat	UN Habitat	public	2018	Y	Y	Y	Y	N	Y	NA	x	Y
World Cities Report 2020: The Value of Sustainable Urbanization	UN Habitat	UN Habitat	public	2020	Y	Y	N	Y	N	Y	Kenya	x	Y
Resilient Cities Report 2018: Tracking local progress on the resilience targets of SDG 11	ICLEI	ICLEI	public	2018	Y	Y	Y	Y	N	N	Germany	x	Y
Future of Healthcare Ecosystems	ARUP	ARUP	private	2020	Y	N	N	Y	Y	N		X	Y
Urban climate change resilience is vital	ARUP	ARUP	private	2020	Y	Y	N	Y	N	N	NA	x	Y
Cities Alive: 100 issues shaping future cities	ARUP	ARUP	private	2017	Y	Y	N	Y	N	Y	NA	x	Y
Arup in Cities	ARUP	ARUP	private	2015	Y	Y	Y	Y	Y	Y	NA	x	Y
Deadline 2020 How cities will get the job done	ARUP	ARUP	private	2016	Y	Y	N	Y	Y	N	NA	x	Y
Visions of a resilient city	ARUP & Engineers Without Borders UK	ARUP	private	2012	Y	Y	N	Y	Y	Y	England	X	Y
Smart City Strategies A Global Review	ARUP	ARUP	private	2017	Y	Y	Y	Y	Y	N	NA	x	Y
10 Priorities for Health and wellbeing	ARUP	ARUP	private	2018	Y	Y	N	Y	Y	Y	England	x	Y
THE CITY WATER RESILIENCE APPROACH: City Characterisation Report, Mexico City	ARUP	ARUP	private	2019	Y	Y	N	Y	N	Y	Mexico	x	Y
Climate Change and Migration: A CCE Analysis for Two Large Urban Regions of Latin America	Omar O. Chisari Sebastián Miller	IDB	public	2016	N	Y	N	Y	Y	N		x	Y
Long Term Effect of Climate Change on Health: Evidence from Heat Waves in Mexico	Agüero, Jorge M.	IDB	public	2014	N	Y	N	N	Y	N		x	Y
Ideas for Development in the Americas (IDEA). Climate change and health	IDB	IDB	public	2015	N	Y	N	N	Y	N		x	Y
PROMOVER CIUDADES SOSTENIBLES PERSPECTIVAS REGIONALES	IDB	IDB	public	2019	N	Y	N	Y	N	N		x	Y
Impacts of Climate Change on Dengue Risk in Brazil	Pereda, Paula C.; de Menezes, Tatiane A.; Alves, Denisard	IDB	public	2014	Y	Y	N	N	Y	N		x	Y
Why our future depends on cities	Robert Muggah	CGLU	public	2016	N	Y	Y	Y	N	N		x	Y
Urban Health	CGLU	CGLU	public	2021	N	Y	Y	Y	N	N		x	Y
Cumbre de las Naciones Unidas sobre la Diversidad Biológica	CGLU	CGLU	public	2020	Y	Y	N	N	N	Y		x	Y
Integrating Ecosystem Services into Development Planning. A stepwise approach for practitioners based on the TEED approach	Marina Kosmus, Isabel Reiner, Silvia Ulrich Main	GIZ	public	2012	Y	Y	Y	N	Y	Y		x	Y
How to Improve Integration of Climate Change Aspects into Urban Development Instruments, Strategies and Initiatives. International Dialogue Forum on Climate Proof Urban Development	GIZ	GIZ	public	2017	Y	Y	N	Y	N	N		X	Y
Protecting Health from Heat Stress in Informal Settlements of the Greater Cairo Region. A qualitative vulnerability and adaptation assessment among pregnant women and mothers of children under five.	Dr phil. Julia Katzan, Consultant Dr Sophia Owsianowski, MD, DTMPI	GIZ	public	2017	Y	Y	N	Y	Y	N		X	Y

# KEYWORDS

EARTH; HEMP; PAPERCRETE; CORK;  
STONE; STRAW BALE; SHEEP WOOL;  
INSULATION; STRENGTH



## NOMENCLATURE

$\rho$ : density in g/cm<sup>3</sup>.

W.A.: Water Absorption in %.

C.S.: Compressive strength in MPa.

$\delta$ : elastic modulus in MPa.

$\lambda$ : Thermal conductivity in W/m.K.

R<sub>w</sub>: Sound reduction index in dB.

E.E.: Embodied Energy is the energy required to extract, process and transport a material to the point of use or application in Mj/kg.

E.C.: Embodied carbon (EC) is the amount of CO<sub>2</sub> released to the environment, associated to the E.E., in Kg CO<sub>2</sub>/t.

*Construction of the vault. Photo credit: AVN /  
<https://www.lavoutenubienne.org/>.*

# [SCh 9] Traditional and Modern Building Materials and Practices Adapted to Natural Resources. A way to meet the resilience approach

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## 1. Introduction

The invasion of cement-based products in building sector has become very apparent and its effect on the environment is delicate. 38% of total global energy-related CO<sub>2</sub> emissions in 2020 is generated from building activities (Programme and Construction 2020). Alternative materials and techniques which were outmoded are retaking their places into the market. Used to build vernacular constructions, these materials whose originally from bio or geo sources are offering more energy saving and thermal comfort compared to conventional materials (Zhang and Gao 2013; Widera 2015). Using ecofriendly local materials, encouraging circular economy practices and passive building techniques are strategies currently in progress to resolve the problem (Cintura et al. 2021).

The evaluation of ecofriendly bioclimatic materials needs to be carried out with a detailed perspective. With this purpose, best practices for the application of bioclimatic design and case studies of use of local materials should be selected from the existing literature, analyzed, and capitalized. This paper reviews, in a narrative summarized method, the main physical, mechanical and thermal properties, most used in materials' international standards, reported in the literature of:

- Earth based materials and techniques, including adobe, bricks with additives, rammed earth, and earth-bag constructions.
- Cork based blocks, Hempcrete and Paper based blocks as eco-friendly building elements;
- Stone construction since it is one of the most abundant and used material to reach natural comfort;
- Straw bale construction with existing building styles;
- Sheep wool as natural insulation material;

## Acknowledgments

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## ABSTRACT

*In the aim of achieving comfortable living conditions natural conditioning design offers a very serious alternative to overcome the current challenges in building sector and meet the resilience concept to urban environments.*

*This paper reviews and compare the main technological properties of traditional and modern materials and designs adapted especially to arid climate and natural resources available in Europe and north-west Africa.*

*Discussed materials are earth-based materials, hempcrete, cork and paper-based, stone, straw bale construction and sheep wool insulation panels. Earth can be utilized in various applications such as clay bricks, rammed earth constructions, earthbags. It was concluded that selected earth building materials are practically similar. Sheep wool offers the best insulation performance comparing to the discussed materials.*

*Organic matters-based building materials are new penetrating building materials that offer good physicochemical and thermal properties as well. Ecological construction techniques are reviewed too, including: post and beam and load-bearing styles in straw bale construction, adobe, rammed earth, earth bag construction and stone construction.*

*As outcome, this paper reenforces the culture of utilization of ecological building materials and encompass their technological properties. As recommendation, need of establishment of guidelines and standards for the utilization of these sustainable materials and practices is crucial.*

Searches of computerized databases, hand searches, and authoritative texts are utilized to retrieve data. As added value achieved from this work, researchers might be now familiar with the capability of such materials to comply minimum mechanical and thermal criteria for ecological buildings. Despite urban resilience concept covers few topics, in the context of climate change and urbanization, energy saving, material and waste greatly become crucial elements (Chen et al. 2022).

## 2. Overview of properties of selected ecological bioclimatic materials

The use of bio-based materials generally decreases the emission of GHG gases, has lower carbon foot print and contribute on the preservation of natural resources (Weiss et al. 2012). This is why it is currently encouraged by the public authorities during the construction or renovation of buildings.

One of the most influencing parameters of a building material is the bulk density which may lead to important saves in energy and low CO<sub>2</sub> emissions (Limami et al. 2021b). However, the dependance between the density and the mechanical aspect should be always taken into consideration. The compressive strength is a very crucial characteristic that define the quality of building element, since it and its capacity to support load-bearing structure (Quagliarini, D'Orazio, and Lenci 2015). On the other hand, studies are focusing the most on the thermal conductivity in the field of buildings heat transport for the steady state without evaluating the other properties (Hung Anh and Pásztor 2021), and that is in order to evaluate the efficiency of thermal insulation.

### 2.1. Earth based materials

Earth constructions are variety of techniques that use soil as basic material. The technological properties of all earth techniques are practically similar. In this section, the two most popular ecofriendly techniques; unfired clay bricks and rammed earth are covered. In addition, an innovative method is described: earthbag constructions, also known as earth filled in, is a construction method where dry soil is poured into long synthetic tubes stacked upon each other to form the building structure ("Auroville Earth Institute" n.d.). Table 1 resumes some literature findings.

In their simplest form, basic mud bricks are made by mixing earth with water, placing the mixture into molds, and drying the bricks in the open air. Their embodied energy is the lowest of all building materials but the use of chemical additives such as cement, excessive transport and the use of firing process can increase the actual embodied energy of all earth construction (Dabaieh et al. 2020).

The type of used clay is crucial in the quality of brick and rammed earth wall. Illitic clay, also called red clay was proven to be the most convenient one in the manufacturing of brick (Muheise-Araalia and Pavia 2021). Common values of compressive strength are not much satisfactory. However, by use of red clay, optimum amount of water and selection of method of drying, brick can reach values up to 20 MPa in their compressive strengths.

Adding to Table 1, current researches are investigating the incorporation of various additives in unfired clay bricks in order to enhance their quality. These additives are especially wastes from agriculture activities, industrial activities or they are just from natural non transformed origins. Large variation is observed in the properties depending on the additive, its proportion on the mixture and the method of preparation. Best performances – that satisfy international standards such as BS 3921 and ASTM 62-17 – are reported:

- for agro-additives with Rice husk, Date palm fiber, Palm bark fiber, Oil palm fruit bunch, Straw (Wheat, Barley), Pineapple leaf fiber and nut shells (Jannat et al. 2020; 2021).
- for industrial additives with Fly ash, Bottom ash, Molybdenum tailing, Waterworks sludge, Ceramic waste and Steel slag (Al-Fakih et al. 2019; Jannat et al. 2020)
- for natural additives with Typha (Limami et al. 2021a).

The insulation properties of rammed earth as well as other earthen techniques are not much interesting either: ranging generally between 0.5 to 1.4 W/mK for thermal conductivity and 57 [dB] to 58 [dB] for the sound reduction index. Similar characteristics are offered by traditional ceramic brick. For this reason, the walls are built with excessive thicknesses.

### 2.2. Organic residues-based bricks and blocks

Hempcrete or hemp-lime is a new developed material, rapidly expanding across Europe, made from a mixture of hemp hurds with lime and water and is more lightweight than regular concrete. Compared to manufactured

[SCh9] Table 1. Overview of research on properties of ecological unfired earth-based building materials. Source: author elaboration.

References	Material	Comments	$\rho$	C.S.	$\lambda$	$R_w$
(Miccoli, Müller, and Fontana 2014; Riza and Rahman 2015; Fabbri and Morel 2020; Vijayan et al. 2021; Pacheco-Torgal and Jalali 2012)	<b>Unfired pure clay bricks</b>	When a high pressure is applied during the manufacturing of bricks, they are called Compressed Earth Bricks/Blocks (CEB). The addition of a chemical binder makes them stabilized.	1.50 to 2.00	0.35 to 7	0.21 to 0.5	–
(Jiménez Delgado and Guerrero 2007; Ávila, Puertas, and Gallego 2021)	<b>Unstabilized Rammed Earth</b>	The composition is about: 5% - 40% clay 15% - 40% silt 25% - 70% sand and fine gravel 25% - 46% liquid limits	1.79 to 2.19	0.81 to 2.46	0.6 to 1.6	57 to 58
(Rincón et al. 2019)	<b>Earth Bags</b>	0.28 m thick roof system 0.35 m thick wall system	2.19	–	2.18	–

[SCh9] Table 2. Overview of research on properties of cork, hemp and paper-based concretes. Source: author elaboration.

Reference	Material	Comm.	$\rho$	C.S.	$\lambda$
(Merabti et al. 2021)	<b>Cork</b>	50% cement, 50% cork	0.77	2.65	0.29
		25% cement, 75% cork	0.61	1.72	0.19
(Jami, Karade, and Singh 2019; Elfordy et al. 2008)	<b>Hempcrete</b>	–	0.291 to 0.920	0.18 to 4.0	0.179 to 0.542
(Shermale and Varma 2017; Zaki, Salih, and Gorgis 2017)	<b>Papercrete</b>	Composition: Paper/ Cement/Sand $\lambda$ and C.S. decrease with increase of paper content	0.4 to 1	1.6 to 5	0.79 to 1.21

insulating products or ordinary blocks, hempcrete performance details are difficult to generalize due to the range in formulations and additives. The industrialization of the manufacturing process is getting more and more interest at the international scale. It is considered to be carbon negative thanks to the high amount of hemp in the mixture which allows carbonation during the use phase of the blocks and photosynthesis during plant growth (Arrigoni et al. 2017).

Cork-cement composite is a material studied by Merabti et al. with the objective of improving thermal properties. Conducted experiments showed promising results. While different conducted researches on papercrete, by varying the proportions of contents, proved its aptitude as possible building material. Table 2 presents results from literature showing the main properties of these three ecofriendly materials.

#### 2.4. Straw bale construction

Historical uses of straw include thatching roofs, linings for internal plasters and reinforcement for traditional earthen building techniques, including adobe and cob (Pete Walker, Thomson, and Maskell 2020).

A new construction technique using straw has been developed during the 19th century in Nebraska, individual bales are laid in courses to form walls of buildings without a binder, then coated (King 2006).

Straw can be baled into a variety of standard sizes, with the most common size used in construction being the two-string bale that measures approximately 1000 mm × 450 mm × 350 mm (Pete Walker, Thomson, and Maskell 2020).

Straw bale buildings have significantly lower embodied energy and embodied carbon than conventional materials (Yin et al. 2018). The walls can provide high-quality physical properties including sound insulation, seismic stability of structure, low heating energy load and cooling energy load (Yin et al. 2018):

Straw is a hygroscopic material, which means that it will adsorb water vapor from the air and absorb liquid water when exposed to a suitable source.

The moisture content of straw bales has been found being in the range of 10% to 12% at 23 °C and 80% humidity. The mechanical behavior of straw bale is non-linear, orthotropic, and visco-inelastic (Pete Walker, Thomson, and Maskell 2020; Marques et al. 2020).

## 2.5. Sheep wool insulation

Sheep wool is considered the insulation material that emits less greenhouse gases. Literature describes sheep wool as a sustainable material. The production of wool fibers concerning release of carbon dioxide is estimated around 1.7 kg CO<sub>2</sub> to 36.2 kg CO<sub>2</sub> /kg fibers (Rubino et al. 2021). It is an excellent insulation material with a thermal conductivity of about 0.034 W/m.K (Dénes, Florea, and Manea 2019; Ahmed, Qayoum, and Mir 2019). Not just that, but it is also a non-toxic insulation material. It can be merited for being environmentally friendly, health conscious, renewable, and absorbs pollutants in the atmosphere such as Sulphur dioxide and nitrogen dioxide through a process known as chemisorption.

Additionally, sheep wool is naturally fire resistant without any flame retardants. In terms of moisture, sheep wool can absorb up to 35% of water during humid weather, then ejecting it back into the indoor environment during dry times without damaging its insulating ability ("The Advantages of Sheep Wool Insulation" 2017). Sheep wool has a high sound absorption coefficient compared to glass wool and polystyrene foam, which offers sheep wool the ability to reduce noise.

## 3. Discussions

### 3.1. Mechanical properties

Clay bricks are considered one of the most popular construction materials thanks to their good physico-mechanical and mechanical properties (Giroudon et al. 2019). The adobe does not reach mechanical strength as high as concrete or fired brick. However, it is enough for a specific type of one to two story building. Some studies observed that the adobe is strong enough, ductile, and resistant against earthquakes (Quagliarini, D'Orazio, and Lenci 2015). The most common values of compressive strength being between 0.8 and 3.5 MPa. The bulk density is about 1.87 g/cm<sup>3</sup> (Miccoli, Müller, and Fontana 2014). High values can be reached using appropriate soil with optimum water.

Merabti et al (Merabti et al. 2021) assessed the thermo-mechanical and physical properties of granular cork compositive with slag cement. Obtained results reflected that higher cork content produced lightweight building materials with lower mechanical resistance properties, reflected in the decrease in measured compressive and flexural strengths. Large variations in densities are available in hempcrete because the

[SCh9] Table3. Overview of research on properties of rocks building material. Source: author elaboration.

Reference	Experimental findings / Properties discussed				
		$\rho$	W.A.	$\lambda$	C.S.
(Siegesmund and Sneathlage 2011; Klemm and Wiggins 2016)	Sandstone	2.00 to 2.53	0.04 to 10.6	0.65 to 1.69	25 to 100
	Limestone	1.63 to 2.70	–	0.76 to 2.04	25 to 165
	Granite	2.60 to 2.67	0.05 to 21.9	1.34 to 3.69	130 to 300
	Basalt	2.68 to 2.71	0.05 to 0.38	0.51 to 2.03	115 to 200
	Marble	2.65 to 2.7	0.01 to 0.38	1.59 to 4.00	75 to 135
	Slate	2.7 to 3.1	0.01 to 0.57	–	90 to 220

Table SCh9.4 Overview of research on properties of straw bale. Source: author elaboration.

References	Comm.	$\rho$	$\delta$	$\lambda$	$R_w$
(Pete Walker, Thomson, and Maskell 2020; Lecompte and Le Duigou 2017; Maraldi et al. 2017; Sabapathy and Gedupudi 2019; Ashour 1993; Yin et al. 2018; D'Alessandro et al. 2017)	Type of application (load-bearing or not) and the orientation of bale are highly affecting those properties. A load-bearing application requires a density not less than 130 Kg/m <sup>3</sup> , but as a second application, no restrictions are dictated.	0.06 to 0.18	0.05 to 0.9	0.03 to 0.194	42 to 55

mass of the product depends highly on the mass composition of composite. This affects directly the other properties such as mechanical and thermal behavior.

Moving to masonry structures with stone, the identification of mechanical parameters is complex. In fact, strengths and stiffness of masonries depend on many factors, such as strengths of component blocks and mortar, blocks shape, volumetric ratio between components, and wall texture. A fair assessment can be made only by in situ test (Binda, Saisi, and Tiraboschi 2000) on the basis of a qualitative criteria evaluation. Norri et al. (Borri et al. 2015) a method called the Masonry Quality Index (MQI). It consists of the evaluation of the presence, the partial presence, or the absence of certain parameters that define the “rule of the art,” namely a set of construction techniques that, if executed during the construction of a wall, provide a good mechanical behavior, and ensure the compactness and monolithic nature of the structure. A synthetic evaluation of the wall quality is obtained through three overall scores, the MQIs, that define the quality of masonry in relation to three actions: vertical actions, out-of-plane actions, and in-plane actions. An estimation of the mechanical parameters (compressive strength, shear strength, and Young’s modulus of masonry can be obtained through correlation curves, obtained from experimental data.

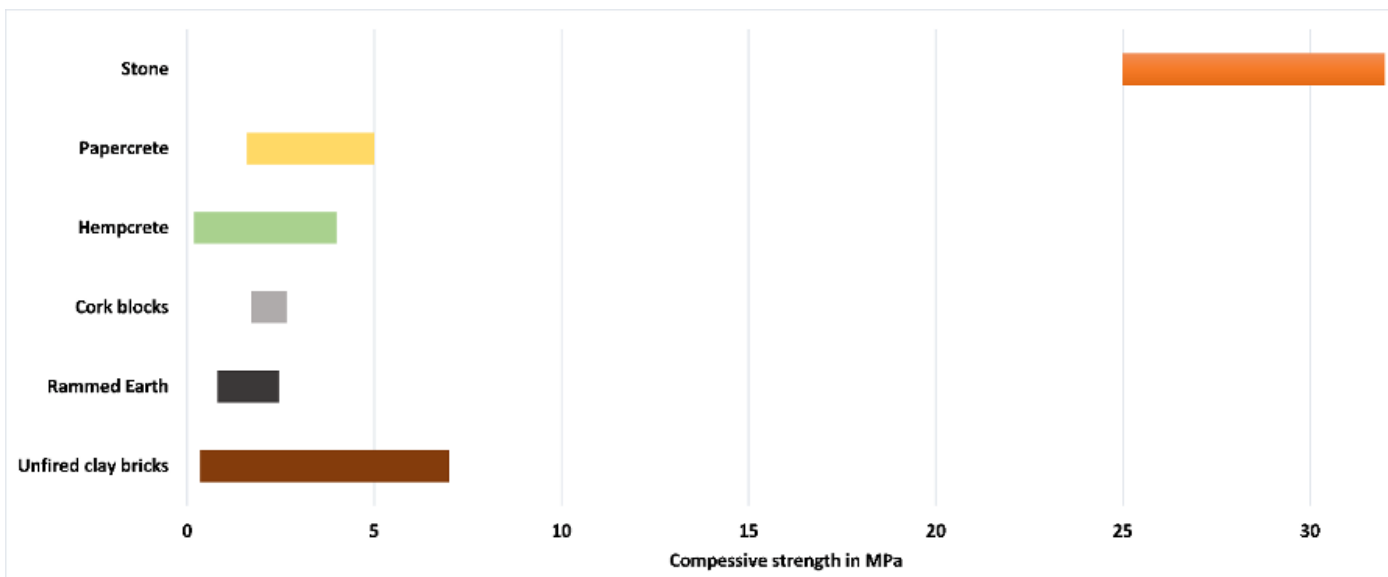
Unplastered straw bale walls exhibit an orthotropic, visco-inelastic behavior with an elastic modulus ranging between 0.05 and 0.9 MPa as mentioned in Table 4. Correlations models are proposed; Maraldi et al. suggest that  $E = a \cdot \rho^2$  between Young’s modulus  $E$  and density  $\rho$ , with “a” a coefficient that depends on the orientation (laid flat bales on edge) and type of straw bales (wheat; hard wheat; rice; oat; barley; corn; sorghum; and millet) (Maraldi et al. 2017).

Figure 1 presents a comparison between these materials in terms of compressive strength. As shown, stones are the strongest with very large interval because of the various types of rocks. Meanwhile the other materials have practically the same compressive strength, hempcrete is the weakest but in other hand its thermal properties are much more convincing.

### 3.2. Insulation properties

Earth could store heat absorbed during the day, keeping the interior relatively cool, because of its high specific heat capacity. When the outside temperature drops at night, the energy stored during the day in the walls would be emitted inside of the building. Which makes earth efficient to reach thermal comfort. However, according to some research conducted in cold and rigid weather climate conditions during cold seasons, clay constructions do not provide the thermal comfort to accommodate standard living conditions as (Laborel-Préneron, Magniont, and Aubert 2018). One of the suggested approaches to solve this issue is using environmentally friendly and ecological additives materials to produce clay-based materials with enhanced physicochemical, mechanical, and thermal performances. The insulation properties of rammed earth as well as other earthen techniques are not much interesting: ranging generally between 1.0 to 1.4 W/mK for thermal conductivity and 57 [dB] to 58 [dB] for the sound reduction index. Similar characteristics are offered by traditional ceramic brick.

[SCh9] Figure 1. Comparison between compressive strengths of selected material. Source: author elaboration.





In their assessment of granular cork composite with slag cement, Merabti et al noted a decrease in the thermal conductivity with higher cork content, reflecting the specimens improved thermal insulation properties in the 48%-22% range (Merabti et al. 2021). As for hemp concrete, with very low thermal conductivity which offers good insulation, it is considered to be a green building material not only because of its low embodied carbon but also because of its ability to regulate heat, moisture, and relative humidity (Jami, Karade, and Singh 2019).

Stone as a building material has high-density, low water absorption, high-thermal capacity but low thermal resistivity: It is generally a poor insulator unless used in extensive thicknesses, as has historically been adopted. Stone can be used as thermal mass for space heating and cooling. Some stones also have good solar reflectance (Ehrlich 2013). It was, also concluded that natural stone exhibits a low environmental footprint when compared with other typical building materials (less than 100 KgCO<sub>2</sub>/t of EC) (Klemm and Wiggins 2016).

Thermal performances of straw bales are the most important advantage in their use. By having a good combination of temperature, packing density, moisture content and orientations of the fibers, thermal conductivity can reach 0.03 W/mK as mentioned, which is a very exploitable as an insulator. Common straw bale walls are not good enough to be sound insulating structures. Even if walls are commonly 50 cm thick, the low density of bales limits their efficiency, especially at low frequencies.

Figure 2 presents a comparison between these materials in terms of thermal conductivity. As shown, sheep wool offers the best insulation among the compared materials; straw bale can reach very satisfying values depending on the density and type of application. Hemp and cork-based block may be considered good for insulation. Earth and stone have high thermal conductivities which make them poor insulator comparing to other materials.

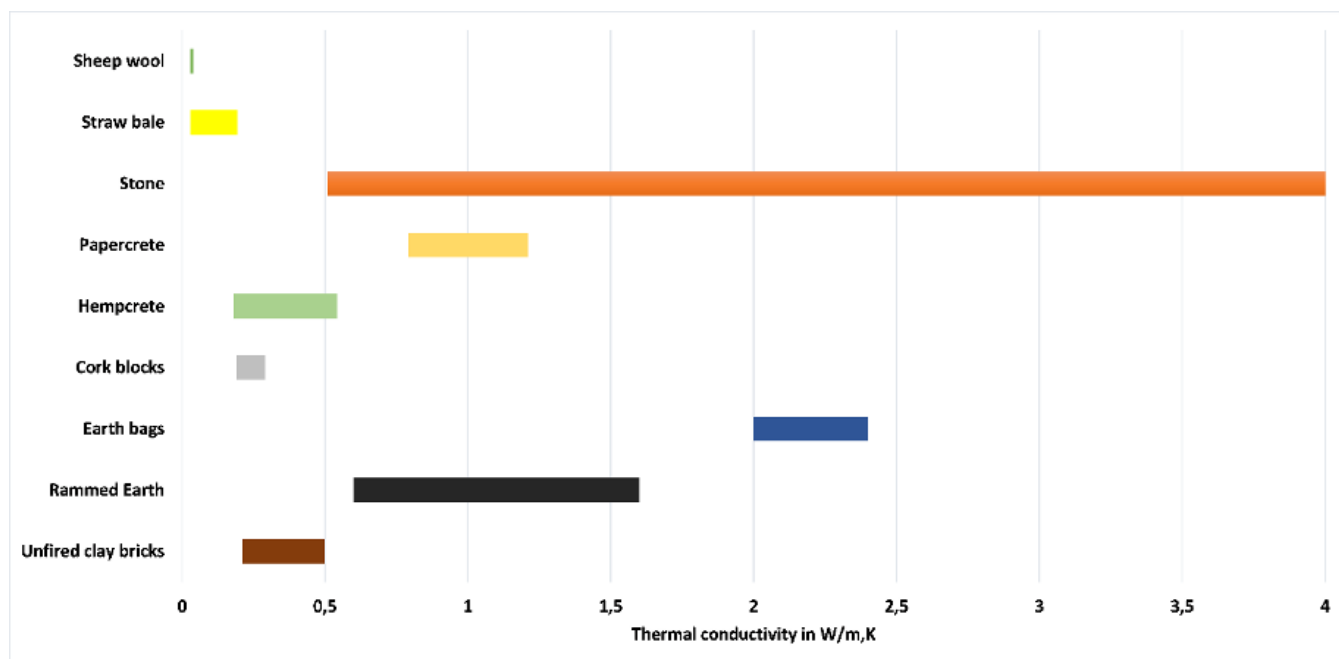
#### 4. Overview of used ecological bioclimatic techniques for construction

Each of discussed materials is applied using a specific technique which developed over the years and need to be resilient to the location (geology, weather, and availability of materials). In North Africa as an example, the dominant construction practices are based on earth and stone due to the absence of other sources like wood. Bricks and block with earth, hemp and paper are often used as elementary material, generally by applying mortar, to construct non-load bearing structures infill walls. Some of other techniques are shown in this section.

##### 4.1. Nubian Vault

The Nubian Vault is one of the penetrating techniques most common in Africa. It consists on self-supporting arched form, does not require the use of increasingly rare timber beams or

[SCh9] Figure 2. Comparison between thermal conductivities of selected material. Source: author elaboration.





expensive and inconvenient imported metal roofing sheets (Figure 3). It is classified as durable, comfortable, ecologically sustainable, affordable, and vernacular (The Nubian Vault Association n.d.). The Nubian Vault technique is described briefly following the steps below (Granier et al. 2006; The Nubian Vault Association 2018):

- Preparation of elements of construction: building site, orientation, materials and equipment.
- Foundations: the depth is ranging from 30 to 80 cm depending on the wall type and the geology.
- Walls and Openings: Load-bearing walls, Gable walls, doors, windows, cupboards, alcoves, and shelving. In a load-bearing wall, each course is made up of a row of bricks laid lengthwise alongside a row laid width wise, using an earth mortar. Gable walls are built in courses of bricks simply laid lengthwise.
- Constructing arches and the vault: The bricks are laid at a 60-degree angle, so the first brick is placed on the gable wall, and successive bricks are placed on the front bricks. The central axis of the vault is defined by a guiding cable, which is utilized to ensure a constant radius during construction. The best form isn't always an excellent semicircle however as a substitute barely elliptical on the top, as this form is towards the perfect catenary curve wherein all forces are in compression and the ensuing vault is as sturdy as it is able to be.
- Roof construction: the roof is water-proofed, using plastic sheeting locally produced, then covered with a rendering.
- Interior of NV: Plaster is applied using finer clay particles and lime.

## 4.2. Rammed earth

The earth mixture is rammed manually between temporary formwork panels and compressed. Modern technology replaces the pole with a mechanical ram. The formworks are removed immediately after completing the wall. The detailed construction process is presented below (Peter Walker et al., n.d.):

- Analyzing the soil: range of tests are carried out to determine if the native soil is inadequate for building, it can be blended with or replaced by soil from another source.
- Preparing the site: cleaning the site, stake out the outline of the building, the soil then is excavated to a depth that guarantees a level surface.
- Laying the foundation: the concrete strip foundation is the most common for the establishment of foundation, which is very similar to that for low rise buildings. Footing size is determined by the type of supported structure as well as the soil bearing capability underneath the foundation.
- Framing the walls: traditionally, wood forms were used. After the mold was filled with fully compacted soil, framework would be removed and reset to form the next section of wall. More efficient methods now allow forms to be constructed for the entire section of the wall.
- Tamping the soil: 10-15 cm layer of moistened soil is placed inside the form, and a worker drops the tamper made of a heavy wooden block from a height of 30-46 cm. Pneumatic tampers are now employed facilitating the majority of work. A layer was considered to be properly rammed when the noise made by the impacting tamper changes from a dull thud to a ringing sound after many repetitions over the entire surface of the layer. At this point, the soil has been compacted to about half of its original volume. Another layer then is added, and the tamping process is repeated. The forms are removed after the tamping is completed.
- Finishing the walls: Rammed earth walls may not be plastered. Instead, the surface is wiped with a moist towel immediately after removing the formwork. Interior faces of walls are often finished with plaster.

## 4.3. Earth bags construction

The method to build an earthbag construction is explained (“A Step-by-Step Guide to Earthbag Building - Walden Labs” n.d.):

- Tools and materials preparation: Woven polypropylene bags and earth and cement construction materials
- Filling the bags: Filling 90% of the bags capacities to leave enough space to sew the bags closed and ensuring the same size to keep walls level.
- Sew/stitch the bags from the top: Fold the bags from the top and use a wire to sew them closed.
- Gravel bags and add barbed wire: Align earthbags against each other and attach them with a barbed wire to avoid spillage.
- Place additional courses with sheetmetal slider: Use a sheetmetal slider to place additional courses so bags do not snag on the barbed wire.
- Repeat: Repeat the same process using earthbags until the opted level is reached.
- Tamping: Tamp earthbags after each course is complete.

## 4.4. Stone construction

Natural stone is suitable for working to diverse applications (Klemm and Wiggins 2016): aggregates, cladding/ façade masonry, conservation of existing structures, flooring, garden landscaping, internal fixtures, kerbing and paving, roofing, structural masonry. For walls masonry, depending on the shape of the stone elements and their assembly, different methods of construction can be distinguished (Dipasquale, Rovero, and Fratini 2020):

- Dry stone walls: blocks of stones that are laid down without any mortar to bind them together. The structural integrity of dry-stone walls arises from compression forces and the interlocking of the stones.
- Rubble masonry: blocks of undressed or rough stones placed with mortar.
- Ashlar masonry: regularly shaped stone blocks, with a dressed exposed face, which may feature a variety of treatments: tooled, smoothly polished, or rendered with another material for decorative effect.
- Masonry with wood reinforcing: very common in seismic-prone areas. The tensile strength of wood offers reinforcement against horizontal loads and enables the dissipation of substantial amounts of energy in the case of earthquakes. Two main categories of wood reinforcement can be identified: the hooping and frame systems. This system can be found in seismic regions of the Mediterranean from the Balkans to Turkey,

Maghreb, Greece, and Italy.

- Stone is reinforced with concrete: walls are made by two stone exterior layers used as formwork for the subsequent casting of reinforced concrete.
- Gabion walls: This technique consists of cages - generally made of galvanized steel wire or mesh-filled with rocks without mortar.

#### 4.5. Straw constructions

Two typical techniques of construction are mostly common with straw bale:

- **Post and Beam style:** A framing style, that uses a structural framework to hold roof loads, and the straw bales are either wrapped outside the framework or in filled between the framing members (Ashour and Wu 2011). Therefore, prefabrication off site may be enabled, which leads to a panelized construction methodology and architecture (Pete Walker, Thomson, and Maskell 2020).
- **Load bearing style:** Called also Nebraska style, Load bearing construction consists on using the straw bale themselves as the structural elements. Thus, they are in charge of sustaining the roof.

“Bales are laid horizontally to form a wall measuring around 500mm wide once plastered. Timber stakes, such as hazel or in some cases broom handles, are used to secure the base of the wall to the footing and pin the bales together. Once the bales have been stacked to storey height (around seven or eight courses high), the wall plate is placed on top, and then the wall is compressed (prestressed), typically using external strapping wrapped around the wall, such as fencing wire or packaging tape, which greatly improves the robustness of the wall. Thereafter, the internal plaster and external render coats of between 20- and 80-mm thick when complete are applied directly onto the straw in two or three coats” (Pete Walker, Thomson, and Maskell 2020).

[SCh9] Figure 4: Straw bale house in Rome, Italy. Photo Credit: esbg2015 by Herbert Gruber



For roof construction, thatching is a very popular style. It uses dry vegetation which are laid into layers and bundles, constructing a beautiful and warming roof ("An Overview of Thatched Roof Construction - AJ Scutching & Son" 2020). This technique is very affordable and commonly available in Europe. The three main thatching materials in use today are water reed, longstraw and combed wheat reed (straw). Sedge, a grass-like plant which grows in wetland areas, is also used extensively in ridging ("Thatched Roofs: An Introduction" 2019). Water reed requires a complete roof strip back to timber when it is renewed, whereas combed wheat straw (reed) and long straw can be partially stripped and re-thatched (Malone 2016). In some other regions in the world, palm is used to as a thatching material.

Before the material can be used for thatching it needs to be made into yealms. A yealm can be described as a tight, compact layer of straw, which has been 'tidied' and is level at both ends. Yealming is a lengthy procedure which takes place on the ground and is basically carried out in order to straighten the straw and prepare it into manageable amounts for use on the roof.

When re-thatching with longstraw, it is not usually necessary for all of the old material be removed from a roof. The thatcher will normally only remove existing material back to a base coat and the new straw is then fix to this with hazel spars.

## 5. Conclusion

This paper aims to make a state of the art and analysis of bio-climatic materials and eco-friendly construction practices and evaluate their quality in terms of performance. In the current context, materials adapted to local conditions from geological, vegetal, and animal origins, that reach the green and bioclimatic concept, are presented. Innovative techniques such as hempcrete, straw bales or earthbag construction, as well as ancient materials and techniques such as stone and adobe are providing satisfying quality. Stone and earth building techniques are showing high mechanical properties. Meanwhile thermal insulation is poor. Contrariwise, sheep wool, straw bale, hempcrete and cork blocks are all ecological materials that proved a low thermal conductivity and low mechanical strength. The introduction of innovative methodologies for the preparation of these materials and construction with, has offered the possibility to reach the exact same or better performance comparing to conventional ones.

Organizations have been working on preparing necessary regulation to standardize the practices of construction. The example of the "Association La Voûte Nubienne, which is trying to normalize the Nubian Vault method all over Africa. For this purpose, it is recommended from governments and organizations to make much more efforts in order to generalize regulations for all types of ecological bioclimatic materials and practices. It is important as well to extend this approach to different climates stressing and find potential correlations between climate variables and materials properties. The impact of climate change threats increasingly the balance established by nature between humans, animals, and the environment. A comprehensive and total perspective of Resilience and One-Health approaches needs to consider an urban ecosystem in which ecological buildings have a significant role.

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# KEYWORDS

HORTICULTURAL THERAPY,  
HEALTHCARE, HEALING GARDENS,  
NATURE



Photo Credit: Angela Colucci

# [SCh10] Horticultural Therapy and Mental Health Recovery Post Covid Outbreak.

From scientific evidence-based data to the need for a professional approach to care with nature

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## 1. Background

As stated by the American Horticultural Therapy Association (AHTA) "Horticultural therapy (HT) is "a time-proven practice. The therapeutic benefits of garden environments have been documented since ancient times. In the 19th century, Dr. Benjamin Rush, a signer of the Declaration of Independence and recognized as the "Father of American Psychiatry," was first to document the positive effect working in the garden had on individuals with mental illness. No longer limited to treating mental illness, HT practice gained in credibility and was embraced for a much wider range of diagnoses and therapeutic options. Today, HT is accepted as a beneficial and effective therapeutic modality. It is widely used within a broad range of rehabilitative, vocational, and community settings. HT techniques are employed to assist participants to learn new skills or regain those that are lost. HT helps improve memory, cognitive abilities, task initiation, language skills, and socialization. In physical rehabilitation, HT can help strengthen muscles and improve coordination, balance, and endurance. In vocational HT settings, people learn to work independently, problem solve, and follow directions. Horticultural therapists are professionals with specific training and credentials in the use of horticultural for therapy and rehabilitation. In recent years we have seen a significant upswing of interest in therapeutic gardens. These gardens are specifically designed to address a variety of applications within healthcare, rehabilitative and other therapeutic settings. In fact, the American Society of Landscape Architects maintains a professional practice network of consultants who specialize in designing therapeutic gardens. A therapeutic garden is a plant-dominated environment purposefully designed to facilitate interaction with the healing elements of nature interactions can be passive or active depending on the garden design and users' needs. There are many sub-types of therapeutic gardens including healing gardens, enabling gardens, rehabilitation gardens, and restorative gardens. What makes a garden therapeutic? The basic features of a therapeutic garden can include wide and gently graded accessible entrances and paths, raised planting beds and containers, and a sensory-oriented plant selection focused on color, texture, and fragrance" (<https://www.ahta.org/horticultural-therapy>).

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## ABSTRACT

Several studies and reviews are focused on general benefits of horticultural therapy (HT) for general healthcare facilities to improve health, wellness and mental health of different age groups. People's interactions with plants, through individualized goal-orientated horticultural activities in the form of active gardening, as well as the passive appreciation of nature, could be therapeutic to people with mental disorders reducing stress, reducing negative symptoms in schizophrenia, stabilizing mood, reduce anxiety, fatigue and restore attention and cognitive ability. HT increases self-efficacy, self-esteem, and quality of life; furthermore horticultural therapy, often carried out in group setting, could develop group cohesiveness and a sense of belonging; it could motivate and help people to engage in meaningful activities and develop a sense of accomplishment and productivity. Last, people with disabilities could develop sustainable vocational skills and productivity in horticulture. The implications of its use during the ongoing Coronavirus 2019 (COVID-19) crisis, social isolation and consequent psychosocial aftermath are also discussed. Finally as the last topic of this paper the needs to have trained therapist in HT and not improvised staff on personal aptitude.

## 2. Nature and horticultural activities benefits

The healing power of nature has always been known. The ancients spoke of *vis medicatrix naturae*. Since the late '90s several controlled clinical studies and trials related to the healing power of nature were published (Ulrich et al 1999, Pretty et al 2005, Soga et al 2017, Spano et al 2020): they confirmed how beneficial nature can be both as a direct use with rehabilitation techniques (motor and psychosocial) applied in green contexts and as an indirect use such as in green spaces or even better in the healing gardens where staying in properly designed green spaces allows you to experience a health benefit in itself (Hartig et al 1991; Kaplan 1993).

Healing means rebalancing the person, intervening not only on the physical illness, but also on the discomfort of the mind. It means having control over the disease even when it is objectively chronic or incurable and creates disabilities; it means knowing how to manage stress so that it doesn't become a normal way of life. Nature and the garden help to heal. This was discovered in the United States at the end of the last century by landscape architects, environmental sociologists, psychologists, doctors, and administrators. The term healing gardens was coined precisely to define therapeutic gardens within treatment facilities (Cooper et al 1999).

The adjective healing means precisely: something that heals, that heals wounds, that heals by rebalancing body and mind. Numerous studies have shown that a garden that is beautiful, well-designed, easy to read and simple to explore is able to contain stress, distract the patient from the thought of their current and future condition, helping them to regain control over their state of health and on their own life. Greenery, especially in health care areas, reduces the stress of both the sick and the operators helping not to completely delegate their health to others: the personal responsibility and control that follow are the first step towards recovery. In the medical literature throughout 2021 there are more than 350 studies that have highlighted the beneficial effects of nature and horticulture therapy on health:

- a) HT improves cognitive functions specifically increases attention, concentration, and memory, increases self-perception and self-validation, confidence in one's own abilities (Kaplan et al 1989, Cimprich et al 1993, Namazi et al 1994, Herzog et al 1997, Hartig et al 1991, Ulrich et al 1999, Makizako et al 2015, Chan et al 2017, Park et al 2019, Tu Hung Ming et al 2020).
- b) HT improves the emotional and psychological structure: it improves mood, reduces anxiety, improves quality of life, increases the sense of control and the state of psychological well-being in general (Ulrich et al 1991, Elings et al 2006, Joyce et al 2016, Soga et al 2017, Grahn et al 2017, Hall et al 2018, Grahn et al 2017, Howarth et al 2020, Spano et al 2020).
- c) HT has a positive effect on physical functioning: it improves motor skills, reduces blood pressure and heart rate, has a positive action on the pituitary-hypothalamus adrenal axis and on the immune response and stress (Davis et al 1995, Cimprich et al 2003, Pretty et al 2005, Wichrowski et al 2005, Grahn et al 2017, Chan et al 2017, Andersen et al 2021).
- d) HT improves social functioning. Horticulture therapy techniques are almost always carried out in groups and therefore socialization is stimulated through adaptive behaviors, an adequate communication style and more functional methods of interaction (Davis et al 1998, Elings et al 2006, Howarth et al 2020).

In general, well-coded HT activities carried out in groups and in adequately structured and certified environments (Spring 2016) show an effect of strengthening well-being in a broad sense (Joyce et al 2016).

## 3. Horticultural therapy – evidence-based effectiveness and interventions target

Most of the studies and meta-analyses concern studies on the efficacy of HT and gardening in elderly people and in patients with degenerative neurological diseases (Alzheimer's) in which it acts both as a protective intervention in the early stages and as an intervention aimed at reducing accidents and episodes of violence in structures but also to reduce memory deficit (Mooney et al 1992, Fabrigoule et al 1995, Ottosson et al 2005, Luk et al 2011, Chan et al 2017, Makizako et al 2015, Hall Jodi et al 2018).

HT is also used in childhood, for pre-school socialization (Predny et al 2000, Chiumento et al 2018) for individuals with intellectual disabilities (Castellani 2011), learning difficulties, behavioral disorders (McGinnis 1989). With a preventive purpose it is also indicated for some groups of fragile subjects including adolescents "at risk" for untimely beginnings with the aim of promoting adequate social interactions and reducing antisocial behaviors (McGinnis 1989; Nixon et al 1998) and always in the elderly, but not with neurological pathology, to

improve spatial orientation, increase attention, interactions with others and memorization (Monney et al., 1994, Benotti et al 2012).

#### 4. Horticultural therapy in psychiatric rehabilitation

In psychiatry, horticultural therapy is having a period of “renewed” fame even if it is necessary to define its methodological boundaries. Horticulture-therapy is not just gardening, having your own vegetables garden or dignified occupational activities with socializing purposes. The most serious consequence of mental illness, especially psychosis, is the loss of the ability to communicate in a harmonious way with the environment and the capability to successfully satisfy one's own needs, as well as to respond to the requests and needs of others. These inabilities expose the person to a series of failures that isolate them increasingly, both for the frustrating experience that reinforces feelings of lack of esteem and inadequacy, and for the marginalizing tendencies that are created in the context in which the subject lives.

Chronicity and impoverishment are not necessarily intrinsic to the disease but depend on a constellation of variables on which one can intervene to modify them, such as dysfunctional situations in the family, inadequate therapeutic interventions, adverse reactions from the external environment. Endogenous factors that determine a particular vulnerability certainly contribute to chronicity, but also and above all environmental factors referring to both the family system and the social system in its organizational, welfare, economic and cultural aspects.

In recent decades, the concept of rehabilitation in psychiatry has led to reconsidering the concept of illness and treatment: the goal of rehabilitation is in fact no longer in the strict sense of recovering from illness but rather healing, an untranslatable term in Italian, with many meanings including “social healing” or the achievement of a balance and new adaptation that allow the person to achieve a harmonious and acceptable integration in the social sphere of belonging. The concept of treatment expands beyond that of medical “tout court” therapy, solver of symptoms, to become “taking care”, thus far from the categories of the curability or incurability of the disease, in view of a process in which the intention to “make it grow” favors the evolution and change.

The rehabilitative action considers the patient as a participant and present subject in his own care in which the attention is focused on the resources even before the disease, on the healthy parts of the person, in order to contain and reduce the non-functioning ones (disabilities) and it implements it through a set of codified techniques and therapeutic tools (Ba G. 2003) organized in a planning and evolutionary sense, in a treatment path that can develop through different spaces and different times. The tools and techniques that rehabilitation uses are many, but they can never be improvised, applied without a goal and without monitoring, not supported by adequate professional preparation or training in the empathic relationship with the patient.

The rehabilitation project is built “with - and - for” the patient, based on objectives that emerge from a careful evaluation phase carried out by different team figures; it is composed of a careful integration of interventions aimed at “knowing how to do in everyday life” (from taking care of oneself and one's environment, to taking care of one's health, to the development of social skills, to job placement where indicated) and interventions aimed at “bringing out” a better ability to relate with oneself and with others (expressive techniques such as art therapies, psychotherapies), as well as interventions aimed at recovering cognitive abilities if compromised by the disease itself. In this introduction to the altered dimensions of mental illness which become the focus of rehabilitative action, horticulture as a technique is inserted thanks to the properties of nature to “create” relationships, create well-being, restore dignity to a natural time. In this sense, it is the task of rehabilitation technician to ensure that the intervention is structured in an adequate and personalized way, monitored over time, just as for the task of the therapeutic horticulture expert to prepare a protected and welcoming setting where the meeting of the healthy parts of the patient with nature can be encouraged. It is no coincidence that the natural, normalizing space can become a fundamental element that materially allows “being together” and which for this reason assumes relational qualities.

In general, the places of rehabilitation should not be “container”, static places, made of rules that mark time, regulate space and distance relationships, but places redesigned on the basis of the emotional and cultural characteristics of those who live there, which guarantee from the flattening out and from that type of negative habit. Attention to the place is useful for patients, but also for the operator to renew himself, so as not to lose motivation, interest, stimulus to do, so as not to fall back into a type of “poor” habit that would

reactivate custodial-assistance requests in which it activates and strengthens not only the chronicity of the patient but also the chronicity of the treating system. Many of the published studies on the therapeutic effect of HT concern patients with major psychiatric diseases: from depression to psychosis, from PTSD to anxiety and eating disorders (Spurgeon et al 1979, Nixon et al 1998, Gonzales et al 2011, Liu et al 2014, Makizako et al 2015, Kim Kyung Hee et al 2018, Kim Kyung Hee et al 2018, Oh Yun Ah et al 2018, Corazon et al 2018, Siu Ae Park 2019, Siu AHM et al 2020).

A recent meta-analysis of 2021 carried out on controlled studies concerning the use of HT in schizophrenic patients confirms the effectiveness of this technique if used in an integrated way with classic therapies both in inpatients services and in residential settings (rehabilitative residential centers). This study provided evidence supporting the positive effect of horticultural therapy. This review demonstrated that non-hospital environments have a better therapeutic effect on all indicators than hospital environments. The results also demonstrated the effectiveness of horticultural therapy on symptoms, rehabilitation outcomes, quality of life, and social functioning in patients in hospital and non-hospital environments, providing further evidence-based support for landscape design (Mo S. et al 2021). As highlighted by Patrick Grahn and Anna Maria Palsdottir and colleagues (2017), in major depression the impact of the disease is evident not only in the severity of the symptoms but also in the repercussions on social and work functioning, with long periods of absence from work. The authors in an RCT highlighted how applying an integrated model of therapy, pharmacology, psychotherapy, and Horticultural Therapy in an environment adequately designed with a healing garden would allow a faster recovery of global functioning compared to the usual treatment. More recent studies on the use of horticultural therapy in settings for acute patients in which attention to the subjective experience of the patient and the goal of recovery-oriented interventions are becoming recommended practice (De Seixas et al 2017).

## **5. Horticultural therapy, Mental health, and Pandemic SarsCov2 Outbreak**

Regarding the specific use of therapeutic horticultural techniques during the pandemic, no RCT efficacy studies are available in medical literature, but many experiences, mainly in Asian countries, have promoted the use of gardening (and not HT) to maintain a state of well-being in the population in lockdown, and many studies are in the process of being published. There is a 2020 study by Indian authors published open access in *Frontiers in Public Health* (Chaudhury et al 2020) in which the beneficial role of nature is highlighted and an “eco-therapy” approach is theorized; in the mentioned approach they use psychotherapeutic techniques mediated by interventions in the nature and among these the authors expressly cite HT techniques. Specifically, they recognize HT as improving mood and heart rate, emotional recovery reduction of stress, reduction of the impact of stress on cardiac functioning (hypertension, tachycardia), increase self-esteem, improvement of sleep and cognitive functions reduction of loneliness and reduction of burn out in health workers. These evidences matured over the years allowed the authors to see the potential in HT in this phase of the pandemic crisis to reduce the direct negative effects of COVID and the indirect negative effects of the pandemic related to isolation from quarantine, lockdown, smart working.

A recent Italian publication confirms how the use of gardening activities can help to hinder the stress of the pandemic (Theodorou et al 2021). In Italy social distancing and home confinement during the first wave of Covid-19 have been essential to help governments to flatten the infection curve but raised concerns on possible negative consequences such as prolonged isolation or sedentary lifestyles. In this scenario, gardening activities have been identified as a plausible tool to buffer the mental health consequences of forced home confinement.

An online survey was administered through sharing using social media to N = 303 participants during March-May 2020 lockdown in Italy, measuring Covid-19 related distress, psychopathological distress, engagement in gardening activities plus a series of socio-demographic and residential covariates). Gardening activities are defined as a range of active interactions with nature that an individual may implement (Spano et al., 2020). These activities may include indoor and outdoor plant care and the collection of natural elements and their use (e.g., cooking). In the literature, it is well-known that individuals who engage in gardening activities report greater psychophysical and psychosocial health (Soga et al., 2017; Spano et al., 2020).

Taking care of plants is a low expensive activity that can be easily implemented at home by a wide range of individuals, without particular expertise and tools. These important features become particularly relevant during quarantines and lockdowns. In this regard, different sources indicated that during the national lockdown in Italy, the selling of gardening supplies grew by 44%, ranking as the third product category to experience

substantial growth in the global sales (<http://sellics.com>). Estimates even report that three million Italians began to devote themselves to gardening precisely during the lockdown ([www.nomisma.it](http://www.nomisma.it), Osservatorio The world after lockdown Nomisma, Focus Gardening, 2020). As expected, a mediation model tested using a bootstrapping procedure showed that gardening is related to lower psychopathological distress through decreased Covid-19 related distress. Interestingly, results showed that psychopathological distress was higher for women and unmarried respondents, and negatively associated with age and square meters per person at home. Theodorou et al 2021).

In another experience conducted in a metropolitan rehabilitative service in Milan throughout the first lockdown of 2020 and then during that of 2021, gardening activities but also the HT ones were very appreciated and sought after by patients (mostly psychotic and severe personality disorders) because they were carried out outdoors and therefore fewer limitations compared to the group rehabilitation activities (Vanzetto S. et al 2020) carried out indoors with all the limitations imposed by the emergency and by the contagion prevention regulations. Also, in a previous study (Bassi et al 2012) conducted on the perception of subjective well-being and the optimal experience in the same center, a particular preference emerged for the perceived "normalizing" rehabilitation activities such as HT, singing, theater and psychoeducational groups promoting well-being and proper nutrition.

## 6. Final reflection

Final reflections are necessary about two most relevant topics: features of therapeutic gardens, their validation and dissemination in the cities and specific training necessary for the operators (health workers).

### 6.1 Features of Therapeutic gardens

Therapeutic gardens are designed, built, and arranged according to the users. They are very variable in features, and gardens can also be aimed at the production of food (vegetables) contributing to the city food security, improving food system sustainability, reducing food miles and post-harvest handling (Orsini et al., 2014, Orsini et al., 2020).

Therapeutic gardens can include traditional on soil or innovative cultivation systems carried out in containers or on raised beds/benches designed for the specific needs of users. For example, the realization of a garden aimed at neurorehabilitation must address the needs of neurological patients who may have different levels of motor and cognitive disability. Therefore, the garden must be wheelchair accessible, as well as safe for people walking with some kind of support; workstations must be adequate in height and design, and suitable for patients who need to recover from, for example, post-stroke depression or to test themselves before discharge from the hospital. Furthermore, the garden should create a unique sensory environment for patients with severe brain injury who, in the absence of functional mobility, can benefit from colors, scents and tactile experiences (Righetto et al. 2016 and 2016a). A well-designed and managed therapeutic garden, as well as patients regularly engaged in activities carried out by a trained Horticultural Therapist, can benefit relatives and caregivers both working and strolling in the garden (Gianquinto et al., 2021).

Therapeutic gardens must be managed with an agroecological approach to cultivation and should provide organic crops with high biodiversity, to offer suitable habitats and encourage the spread of useful fauna, and avoid any use of agrochemicals and pesticides. The size of the gardens may vary from a few tens to thousands of square meters and are completely integrated into the urban fabric. They become part of green infrastructures and ecological corridor network and, like other urban gardens, they provide various regulating and habitat ecosystem services. They promote biodiversity preservation, by cultivating a rich abundance of flowering plants, which can support urban pollinators and many other beneficial insects, agents of natural pest control (Bazzocchi et al., 2017; Bazzocchi, 2020). They contribute to: landscape management, increasing the livability and improving the value of nearby buildings; resource use efficiency, by using rainwater or regenerated greywater for irrigation and composted urban organic waste; climatic resilience and global change mitigation, by reducing flood risk, heat waves and by improving air quality (Orsini et al., 2020).

### 6.2 Horticultural therapist training needs

HT therapist needs a specific multidimensional training in order not to fall into the confusing error that HT is an exclusive socializing occupational activity. As the AHTA mentions, the skills of the Horticultural Therapist are very complex: "Being competent in horticultural therapy requires a horticultural therapist to

function as both a horticulturalist and a therapist. For a horticultural therapist, competencies are defined as the measurable or observable knowledge, skills and abilities, and behaviors necessary to ensure effective therapeutic relationships and successful job performance.

This definition can be broken down into three areas of competence:

- a) knowledge competencies - practical or theoretical understanding of subjects;
- b) skill and ability Competencies - natural or learned capacities to perform acts;
- c) behavioral competencies - patterns of action or conduct.

The basis for skill and ability, and behavioral competencies is the knowledge competencies. The American Horticultural Therapy Association (AHTA) requires educational competence in plant science, human science, and horticultural therapy. With specific core coursework, horticultural therapists develop knowledge competencies in the same content areas". In Italy, the figure of the Horticultural therapist is not recognized or certified yet, although for several years these figures, trained in specific courses in some Italian situations, have been operating in various fields, from education to health. In line with the international guidelines, AsslOrt (Associazione Italiana di Ortoterapia - Italian association of therapeutic horticulture) has proposed recommendations on the core training curriculum that can be summarized below.

The professional in horticultural therapy and therapeutic horticulture must have a sufficient theoretical basis to know the theories supporting the psychological, physiological, and sociological effects of the relationship with nature, and in particular with plant organisms, by people. They must know and keep updated on the research that supports the efficacy and use of therapeutic horticulture, horticultural therapy, and therapeutic gardens and, more generally, on the practices adopted in different contexts, have knowledge of principles of botany and plant physiology, basic concepts, theories, and principles relating to horticulture and horticulture and agro-ecological cultivation techniques, as well as knowing the ecosystem services provided by horticulture.

The professional must know the educational programs and indoor activities declined and adapted according to the needs of the different types of users, have the elements to design therapeutic, safe, sustainable, and accessible green spaces. Having notions of dynamics of group processes and management styles would be an added value. Finally, they must have the skills to design and carry out and evaluate a therapeutic rehabilitation program in collaboration with the treating team if they are psychiatric / neurological users in charge of the services (extracted from the working document of the AsslOrt 2021 Scientific Commission).

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# KEYWORDS

PUBLIC PARKS, PUBLIC SPACE,  
RESILIENCE, PANDEMIC, JAKARTA



*Re-opening of Taman Cattleya in November 2020. Source: Diana Zerlina, 2020*

# [SCh 11] Reconceptualize Jakarta's Public Parks Adaptability for the Post-Pandemic Future

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## 1. Introduction: COVID-19 Pandemic and Public Parks

The COVID-19 outbreak brought extensive disruptions in the cities' life globally. According to World Health Organization (WHO), the risk of COVID-19 disease transmission is higher in crowded spaces, where infected people spend long periods together in proximity. The SARS-CoV-2 virus, the cause of COVID-19 disease, is indicated to spread primarily by close contact within a 1-meter distance through liquid particles from someone's mouth or nose, ranging from larger "respiratory droplets" to smaller "aerosols", when someone coughs, sneezes, sings, breathes or talks (WHO 2021). In response to the nature of this virus conveyance, precautions were made in the form of physical/ social distancing, instruction to wear masks and appliances of basic hygiene protocols. People are forced and suggested to maintain distance one to another at minimum 1 m to decrease the risk of infection, especially in the public places. Health policies and protocols are strictly made by countries to protect and secure their citizens, following the WHO standards suggestions as the basic measure.

Globally, the COVID-19 pandemic is currently the most challenging crisis the world has ever faced, although human history had experienced other pandemics more than 100 years ago. Since being announced as a pandemic by WHO on 11th March 2021, a near-global lockdown was applied, which was followed by health control policies of quarantine, masks, case tracking, and tracing (Patterson, McIntyre, Clough et al. 2021, 2). However, as discussed by Patterson et al., culture and society's collective memory affect the response to pandemics and identify the essential values for making the right decisions to adapt to the pandemic and post-pandemic situation. Thus, each country and city should be mindful in administering the pandemic cases in their region distinctly according to the local situations and phenomena. The public response to the pandemic disease is also played differently in different contexts and environments.

As public gathering is highly restricted, public spaces are generally temporarily closed during the pandemic. Public spaces are believed as dangerous places to be and should be avoided to slow down the COVID-19 transmission. Public spaces as the city's hub for many societal activities were shut down temporarily and emptied to contain the virus. The restriction upon public space uses in many cities bring impacts on people's living quality, mentally and physically. Many studies describe the pandemic situation might

## ABSTRACT

*The COVID-19 outbreak brought transformation to people's relationship with public parks. In Jakarta, the uncertain restrictions reconcile people's behaviours in appropriating public space. This study aims to rethink and reconceptualize Jakarta's green infrastructure adaptability in the post-COVID time.*

fundamentally change our relationships with public spaces (Honey-Rosés et al. 2020, UN-Habitat 2020), which in this paper will be focusing on the form of public parks. Public parks in our cities essentially play as public spaces, providing places for people to recreate, exercise, relax, learn, and socialize with communities or other city residents. It radiance public life and the city's exclusion, while at the same time holding other multitudes of services in diverse aspects.

Public parks in a holistic view contribute benefits in bringing environmental, social, and economic values, as contended in many studies. Environmental values are associated with the ecological function, where public parks provide natural space, invite biodiversity, improve air quality, moderate urban temperature, mitigate flood as a natural drainage with its permeable surface, and help to mitigate climate change in the urban environment (WHO 2017, LEAF 2015, Saraev 2012). The social value is the second most benefit of public parks. As public spaces, parks are known for fostering social cohesion and interaction, improving public health and people's wellbeing, and providing cultural services such as tourism, leisure, and education (Kazmierczak 2007, Jansson 2014, LEAF 2015). As contended by Jane Jacobs, Parks are volatile spaces since every park has its own case in receiving their context value. However, they could be generalized by their basic function as public yards, regardless of their locality (Jacobs 1961, 91). Parks also have economic value, which lies in their significant impact on raising land and property prices (LEAF 2015, 15). Indirectly, this economic value tends to be higher as a reflection of the environmental and social services a park could give to the city.

This small study will be focusing more on the social value review of public parks in Jakarta in relation to their adaptability during the COVID-19 pandemic time. The essential capacity of public parks as green infrastructure for public life in Jakarta is severe and emerged during the pandemic time as the city grew with a short number of public parks. As raised globally, public parks are being questioned whether it is a safe place to be during the pandemic crisis. The pandemic has certainly brought a great impact to the city and its citizens to adapt with the uncertain 'new normal' condition with contextuality in mind. In Jakarta, the great question would be how to mitigate the relationship between people and public parks. To what extent the restriction and health protocols could change people's relationship with public parks? With the public high dependency on public parks as a social arena, to what extent has this crisis led us to rethink and reconceptualize the public park resilience and adaptability? This paper tries to analyse the current phenomenon of what is happening with Jakarta's public parks as an initial foresight to encounter the post-pandemic future. The research was conducted with a qualitative approach through investigation and comparative analysis of three prominent public parks in Jakarta: Taman Menteng, Taman Catteleya, and Taman Lapangan Banteng. The three case studies were considered able to show some variables and represent the basic typology of Jakarta's public parks' configurations and uses.

## **2. Jakarta's Public Park Development prior to the COVID-19 Pandemic**

Jakarta, the current capital of Indonesia, grows as the most populous city in Southeast Asia with more than 10 million population (The ASEAN 2021, 27) resides in total area of 664.01 sq.km (BPS-Statistics of DKI Jakarta Province. 2021, 1). The city has been developed rapidly as a megacity with intensive urban development, which caused it to keep losing its green open spaces. Jakarta's landscape has been changed drastically since the 1990s, when the city conversed public parks to other uses, such as schools, parking lots, and commercials, and led to the loss of about 246 of 412 public parks in the city (Silver 2008, 198-199). This reduction of green open space number could not be separated from the socio-political background of Jakarta at those moments, where the capital was strategized as the key component to lift up the nation's status as an under-developed nation through economic reinforcement (Silver 2008, 11). Jakarta's Masterplan figures from 1965 until 2030 show the massive depression of Jakarta's green open space numbers during sixty years' time. According to Rustam H. Manan, the targeted green open space ratio in Jakarta's Masterplan was decreasing through the years respectively from 37.2% in Masterplan 1965-1985, 25.85% in Masterplan 1985-2005, and 13.94% in Masterplan 2005-2010 (Manan 2016, 241). The green open space ratio target was increased to 30% in the published Jakarta's Spatial Planning for 2030, whilst the existing condition until December 2020 was only securing 9.98% green open space area (Haryanti 2020) or called RTH/ Ruang Terbuka Hijau in the local term.

The concern towards RTH's provision in Jakarta began to rise in the early 2000s and more gain highlights in early 2014 when the former Jakarta's Deputy Governor Basuki Tjahaja Purnama was targeting to add about 40-100 ha area in Jakarta for RTH (Detiknews 2014). The plan was continued further, some manoeuvres occurred in adding and improving the quality of the public parks. There are many RTH redevelopment projects that were done in the early 2000s in parallel with the land re-acquirements of some petrol stations and from the eviction of informal settlements, which found on the state's lands. Some of the public parks resulted from the

above programs are Taman Menteng (2007), Taman Ayodya (2009), Taman Suropati (2009), Taman Tebet (2010), Taman Waduk Pluit (2013), Taman Cattleya (2013), RTH & RPTRA Kalijodo (2017) and Taman Lapangan Banteng (2018). The redevelopment projects were continuously taking place prior to the pandemic time, although the programs occurred with different names under the leadership of current Governor Anies Baswedan.

In Jakarta, the public park is counted as the main spacious public place that the citizen could have. The shortage number of public spaces in the city, made Jakarta's citizens rely on the formal public parks as their open yard to experience free public life. In the 1990s, Jakarta's society has been imposed by 'shopping malls' culture since the parks are rarely found (Priatmodjo 1997). Shopping malls have been an instant public space, especially for the middle-class society, which provides a convenient place to be within an indoor space equipped with air-conditioning and protection from sun and rain. However, these shopping malls could not reach all the urban society and their existence has reached its saturation points (Nabila 2019). The public park improvement programs by the city government have been an oasis for Jakarta's citizens to have their right back in having a better quality of the urban environment and free social space for public interactions and participation. It restores the green infrastructure's role in social value, as well their environmental and economic value for the city. Many public parks revived from their deserted condition and become public highlighted spots for various functions and activities.

### 3. Jakarta during the COVID-19 Pandemic Situation

#### 3.1 COVID-19 Pandemic Trajectories in Jakarta

The first confirmed cases of COVID-19 disease in Indonesia occurred in Jakarta on the 2nd of March 2020, with two positive cases in Indonesian citizens (Wijaya 2020, Gorbiano 2020). According to Jakarta's official data, the case numbers increased gradually significantly in about a month to 909 cases on 2nd April 2020 and reached 183,735 cases at the end of 2020. In the last three months of the year 2020, Jakarta's monthly COVID-19 positivity rate was at the average of 9%, which is 4% higher than the safe standard from WHO (Hamdi 2020). Furthermore, the disease transmission continued in 2021 and attained its highest daily rate of infections in

[SCh11] Figure 1. Taman Waduk Pluit, North Jakarta. Source: Diana Zerlina, 2016

[SCh11] Figure 2 Taman Ayodya, South Jakarta. Source: Diana Zerlina, 2017



[SCh11] Figure 3. RTH Kalijodo, North Jakarta. Source: Diana Zerlina, 2019

[SCh11] Figure 4. Taman Menteng, Central Jakarta. Source: Diana Zerlina, 2021



July 2021, which is considered the second wave peak following the intrusion of highly contagious Delta variant virus transmission. As announced by Indonesia's Health Minister, Budi Gunadi Sadikin, the immense surge number of cases was identified roughly a week after the festive holidays of Eid al-Fitr 2021 in May (Jamaluddin, Shubert and Hollingsworth 2021), where most of the Moslems in Indonesia did the traditional exodus or known as "mudik" by went back to their hometown to visit extended family and celebrate the festive season. The high mobility across provinces during the season was believed to cause the spike in Covid-19 cases nationally, including in the capital city. Jakarta's official data reported 14,619 unprecedented daily positive cases on 12th July 2021 (DISKOMINFOTIK Provinsi DKI Jakarta 2021). After all, this number gently decreased in about six days to 5,000 daily positive cases on July 19th, 2021. The virus transmission cases appear to have been contained and decreasing since July 25th, 2021.

By the end of July 2021, Jakarta's total active cases have been continued drop to 19,654 cases compared to its peak number on the 16th of July 2021 which reached 113,138 cases. The acceleration of the vaccination program by the Indonesian Government was claimed as the key factor in declining the COVID-19 infections. The vaccination program in Indonesia began on 13th January 2021 and was previously planned to be given in priority batches. However, the implementation was dynamically changed after the country was hit by the Delta variant virus and led to the second wave transmission. On 10th June 2021, Jakarta's City Government was permitted by the National Government to open the Vaccination Program for citizens who are above 18 years old (Wiryo 2021), who are the most population. This acceleration program was held due to the risen of COVID-19 infection cases in Jakarta and the consideration of Jakarta's status as the capital city, the government centre, and the centre of the nation's economic growth. By the time this paper was written in early September, Jakarta has gained approximately 109.8% of the total first dose vaccination rate and 67.4% of the total second dose vaccination rate (DISKOMINFOTIK Provinsi DKI Jakarta 2021).

Like in other countries, the COVID-19 pandemic brought adjustment to the usual way of living in Indonesia. Since the first two cases were announced by President Joko Widodo, the national government was said to have set up mitigations for disease-spreading preventions. In March 2020, Jakarta's City Government immediately formed Jakarta's COVID-19 Response Team through the assignment of Jakarta's Department of Health, reevaluated the crowd gathering permit, set up an official website at [corona.jakarta.go.id](https://corona.jakarta.go.id) as an information platform for Jakarta's citizens, temporarily closed public parks and Car Free Day program, closing schools, modified main transportation services with limitation on routes and passenger numbers, restrict religious activities' in worship places, and termination of office and tourism industry activities by issuing Governor Call No.6/ 2020. (Hanggara 2020). Nonetheless, the basic standards of COVID-19 health protocols are still applied, as suggested by WHO, such as enforcing social distancing, wearing a mask, and washing hands to keep frequent hand hygiene.

### **3.2 Reflecting on the Societal Aspects of Jakarta and Indonesian Society**

The story of the COVID-19 pandemic in Indonesia could not be separated from the social, cultural, and economic conditions of Indonesian society. These reasons were also the main factors, which invoked President Joko Widodo withdrawal lockdown policy from the very beginning. Despite having "lockdown" terminology, some new terms are applied. The first policy was made on 31st March 2020 concerning the Large-Scale Social Restriction (PSBB) which allowed provinces, cities, and regencies to propose limitations on people's mobility if there are a high significant number of active cases and/ or mortality numbers happened in their region. Each region should follow this policy instead of applying a "local quarantine" (Ihsanuddin 2020). Jakarta was the first province who applied the PSBB policy, which started on 10th of April 2020. The policy is applied respectively every two weeks with evaluations. The application keeps being extended and adjusted following the fluctuation condition of the COVID-19 pandemic in Jakarta until the National Government changed the policy to another new term of Community Activity Restriction (PPKM) in January 2021 in regard to the high corona virus transmission in Java and Bali, which majorly caused by the contagion of Delta variant.

As contemplated by Kurniadi, the implementation of social restrictions in Indonesia went through many obstacles. By seeing from the Socio-Ecological Framework principles' perspective, the main obstacles are caused by the individual factor, which is shown by the less understanding of Indonesian society towards the COVID-19 disease; the interpersonal factors, where the religious gathering activities still carried out; community factors, which reflects on the usual Indonesian cultural values of "gotong royong" (mutual assistance) and close social relations; and structural factors, which demonstrated by the low law enforcement and PSBB policy (Kurniadi 2020, 37-40). In like manner to PSBB, the first PPKM was applied as an anticipation restriction after the festive holidays of Christmas and New Year. It regulated more strict measurements with

several terms and levels in conjunction with the pandemic dynamics. Many substitutions upon COVID-19 policies in Jakarta and Indonesia, along with its less law enforcement for those who omit the policies, are considered could not contain the corona virus transmission effectively.

Moreover, Jakarta has heavy challenges in facing the pandemic situation with its great number of population and a huge gap in socio-economic conditions among its stratified societies. As the capital city, Jakarta is filled with diverse socio-economic and cultural groups who are always attached to their specific community. As argued by Santoso, the nature of urban lives in traditional Indonesian cities was associated with the alliance between the socio-cultural groups and socio-religious groups which all manifested in the spatial hierarchy (Santoso 2006, 83). This condition is still carried out until today, where Indonesian society always has social meeting spaces as a reflection of the communal cultural value. This inherited collectivism principle of Indonesian society is one of the big obstacles to imposing the social distancing policies rightfully. As recorded in many transmission cases, many COVID-19 clusters occurred during the gathering events. Thus, the public activities' restrictions were made by closing public facilities and formal public spaces such as public parks, playgrounds, leisure, and recreational parks in the city to restrain the virus conveyance. In its application, the temporary shutdowns of public parks are entangled with the PSBB and PPKM restriction policies. However, on the other sides, this closure has not given any solution to replace and contain the social function of public parks nor introduce an anticipation plan from the perspective of the socio-cultural aspect.

This condition indirectly has led a disproportionate shift in urban behavior. One of the examples is the booming trend of urban cycling, where people transfer the role of streets as their new playground to be out, exercise, and engaged with their communities.

#### **4. Jakarta's Public Parks Uses Adaptation during the COVID-19 Crisis**

##### **4.1 Parks Closures and Re-openings**

Public parks are known as one of the most favourable public spaces for society. Parks could provide great attractions for society in many various uses. Whilst on the other hands, as mentioned by Jane Jacobs, these city parks could not also be separated from their practical, tangible uses, and the tangible effects on them of the city districts, as well the uses that touch them (Jacobs 1961, 111).

The restriction upon physical distancing measures during the COVID-19 situation might change the usual practice and people's behaviour to be in the public sphere as argued by many. However, this might not change the basic values that belong to every culture, particularly in each city context. From the ethnographic point of view, Setha Low argues that there is a link between social and economic relations in producing space, whereas spatialization presents the culture and vice versa (Low 2003, 36).

This perspective is also in correspondence with Jacobs' argument that explains parks are drastically affected by how society acts upon them (Jacobs 1961, 95). Thus, the relationship between parks and society during the pandemic apparently will coincide with the socio-culture aspect in each context differently, as the pandemic trajectories are varied in each affected country.

Due to the pandemic event, the discourse concerning the re-opening of public space has been debatable. Many cities and countries have re-opened their public parks with adjustment, following the ongoing COVID-19 transmission rate status in their region. The same condition happened in Jakarta, where the policy upon re-opening public parks is dynamic and attached to the open-ended COVID-19 situation. Public Parks in Jakarta have been temporarily closed and re-opened several times since 14th March 2020.

As mentioned in the previous chapter, public parks have so many values in cities' daily lives, in this paper context, especially in the context of public life and wellness. It is even more crucial and presents a strategic position for the city of Jakarta, which is contested for its rapid urban developments and lack numbers of green infrastructures. The dense urban development and population have left Jakarta with not many options for outdoor space. To such a degree, it made Jakarta's citizens have a high dependency on public parks as their 'living room' outside their narrow living space and housebound lives.

Some variables upon the park positioning, physical configurations, and dedicated or given facilities differentiate how the public utilizes the public parks in Jakarta. This study observes six physical attributes, which are considered attach to the public parks' social construction and public engagement. These attributes are highly determined the parks' capacities and adaptability both before and within the pandemic periods.



Physical Attributes	Description
<b>Location</b>	Location indirectly differentiates parks' users/visitors' character and type.
<b>Area</b>	Park size area determines the park programs, capacity, and space quality.
<b>Site Positioning</b>	Park positioning within the urban context determine the ease of park accessibility.
<b>Surrounding Road Hierarchy</b>	Surrounding roads actuate public visitation willingness in relevance to its street edge character.
<b>Public Transport Access</b>	Proximity to public transport nodes defines public engagement with the park.
<b>Surrounding Land use/ programs</b>	Surrounding programs generates parks' branding, character, and users' engagement.
<b>Spatial Design</b>	Spatial design (including the given facilities) articulates the park's activities, both direct and indirectly.

#### 4.2 Cases of Three Public Parks: Taman Menteng, Taman Cattleya, and Taman Lapangan Banteng

This paper's observations exposed how public parks are still entangled in the public lives of Jakarta's citizens during the COVID-19 pandemic event. The visitations were held upon three public parks in Jakarta, both when these parks were in the re-opening and closure status. These three public parks are Taman Menteng, Taman Cattleya, and Taman Lapangan Banteng. These public parks have a different context, both in location/positioning and users. Taman Menteng is a public park in Central Jakarta, which is attached to a residential area and is used mostly by young people and communities. Taman Cattleya is a lush public park, which is situated underneath a busy high-traffic intersection in West Jakarta. The last case is Taman Lapangan Banteng, which is a prominent public park in the city center of Central Jakarta and is surrounded by mostly government complexes and nation-level facility buildings. In addition, Taman Menteng and Taman Lapangan Banteng have historical value for the city of Jakarta, which made them work as cultural and tourism spots at the same time. Each of these public parks has its distinct character, that correlates to its contextual location, history, spatial design, and users. The above three parks were built and re-built following the city government projects in securing more green infrastructure and qualified public parks for Jakarta.

Taman Menteng was built in 2007, as a transferred function from a Soccer Stadium (Nursanto 2011). The ±2.4 ha site was situated in an exclusive residential district area, which was planned as a Garden City in colonial times. The park location is also strategic as it is in between two of Jakarta's Business District areas of Bundaran Hotel Indonesia and HR. Rasuna Said, Kuningan. Taman Menteng is comprised of some sports fields equipped with outdoor fitness park equipment, a children playground, two "greenhouses" for events, a 4-stories carpark, a jogging track, and facilities such as a small food court. Different from other public parks in Jakarta, Taman Menteng was claimed to have a different concept. It was designed with 44 infiltration wells and planted with 30 species vegetation. Although the development of this park was controversial with rejection from the local neighbourhood, Taman Menteng gradually becomes a favourite place for many young people and communities. This condition still could be found during the COVID-19 pandemic when the government re-opened the park. On a weekend afternoon, groups of children and teenagers (mostly boys) are found playing soccer and basketball, couples of young people pairs gather or do exercise, people taking pets for walks and young families do afternoon walks with their toddlers. The condition is not much different from before the COVID-19 crisis, except the visitor registration, wearing a mask, physical distancing policy, and less operating hours. There are also park security guards, who actively warn the visitors if there any forbidden actions happened in the park.

[SCh11] Figure 5a-b. Re-opening of Taman Menteng in May 2021. Source: Diana Zerlina, 2021



[SCh11] Figure 6a-b. Re-opening of Taman Cattleya in October (left) and November 2020 (right). Source: Diana Zerlina, 2020



The second case is Taman Cattleya, a ±3.2 ha public park, which was revitalized in 2013. The Park was previously built upon a revitalization project of a slum settlement under a busy flyover intersection of West Jakarta in 2001-2002. The site of Taman Cattleya is quite “strategic” at the heart of West Jakarta’s commercial district, but spatially hard to be reached. The access to it is not connected with a proper pedestrian pathway, nor a good connection from the nearest public transit point. Most of the visitors came to this park by private vehicles, such as cars and motorcycles, some come by bicycles. However, the site of Taman Cattleya is linked to an urban settlement on its back front. Some visitors came from this settlement and entered the park without any guard or surveillance. In contrast to Taman Menteng, which is rich with hardscape components, Taman Cattleya is predominantly covered with lush landscape and a lake within the park. It is supported by some facilities such as a jogging track, a water fountain feature on its gateway, outdoor fitness park equipment, and parking lots. Taman Cattleya is mostly visited by young families with toddlers and some senior citizens. Its “unknown” access made this park is not famous compared to Taman Menteng and Taman Lapangan Banteng.

During the pandemic time, Taman Cattleya is still favored by its usual visitors. On weekends within the park re-openings, many young families visit the park in the morning, and most of them come with their children. The water fountain feature is the favorite spot for children in this park. In line with Jakarta’s City Government policy toward park re-openings, the same COVID-19 measurements were also applied in Taman Cattleya. It includes body temperature check before entering the park, washing hands, wearing masks, and managing physical distancing min. 1 m from other visitors.

The next case is Taman Lapangan Banteng, which is a quite famous public park in the city. Taman Lapangan Banteng was one of the historic squares which transformed several times since the colonial period. The current park was revitalized in 2017 and inaugurated in July 2018.

Taman Lapangan Banteng is situated in the city center, formed on a rectangular island and physically enclosed by roads on its four sides. With about 10 ha total area, the transformation brought new programs to the park. The programs consist of soccer fields, basketball court, jogging track, children’s playground, plaza, a semi-circular amphitheater with a water fountain pond, and a historic liberation monument in its center as the park’s landmark.

The area around the monument was designed to give ceremonial character to the park, whilst at the same time could provide a spacious hardscape area for activities or events.

The Park was busy at the weekends prior to the COVID-19 pandemic, where many visitors came for a jog, sports exercise, social gatherings, picnic, and many more. Similar to the other two cases, visitation to Taman Lapangan Banteng during the pandemic is also high. Although some areas within the park are closed to be accessed and visitor registration is required, people are still enthusiasts to visit the park.

An interesting phenomenon appeared during the park closure status of Taman Lapangan Banteng. Although the park was fully closed to be accessed, the crowd was still coming, gathering, and exercising on the park's perimeter area. In the narrow pedestrian pathway around the park, some activities are found such as jog, playing badminton, doing small exercises, snacking with the street vendors, and gathering in a group.

Another phenomenon to be captured during the pandemic in Indonesia was the cycling trend, especially in Jakarta's urban society. The restriction on public space uses has made people find other options to keep them healthy, both mentally and physically. The pandemic cycling trend was considered as a way out for the people to refresh from their boredom with WFH activities (Bimantara 2020), although the city's infrastructures are not ready yet to facilitate urban cycling.

During the pandemic, many people are going out in a group by bicycles to explore the city and made stops at some spot points such as coffee shops and public parks. The observations found the phenomenon that happened in the three public park cases with different behaviors, which correlated to the park's location.

Amongst the three park cases, Taman Lapangan Banteng is the most visited by these groups of bikers, both in the state of parks' re-openings and closure. Many bikers found stop by to take pictures with the monument from the park's front side. Additionally, a group of food street vendors in front of the park becomes another magnet for the bikers to stop a little bit longer.

[Sch11] Figure 7a-b. Re-opening of Taman Lapangan Banteng in October 2020. Source: Diana Zerlina, 2020



[Sch11] Figure 7c-d. Visitor registration desk and access limitation on Taman Lapangan Banteng in October 2020. Source: Diana Zerlina, 2020



Taman Menteng is in the mediate stance of being visited since the road in front of this park is part of the common biking routes, that are commonly passed-by by the bikers. Whereas Taman Cattleya is the least visited, concerning the park is facing a busy wide arterial road which is considered not friendly for bikers.

The three cases have shown the same pattern from bikers, which are stopped by for a short rest and to take a group picture.

[SCh11] Figure 8a-b. In front of the entrance of Taman Menteng (left) and Taman Cattleya (right) during park closure in August 2021. Source: Diana Zerlina, 2021



[SCh11] Figure 9a, b, c, d. Appropriation activities outside the perimeter area of Taman Lapangan Banteng during park closure in August 2021. Source: Diana Zerlina, 2021






### 4.3 Physical Attributes to Identify Parks Appropriations

The field observations reveal public behaviors in appropriating the public parks are highly attached and correlated with some physical attributes of the park itself. The identified physical attributes, both direct and indirect, have shaped the dynamics of the spatial appropriating process in the three public park cases during the pandemic events. Those attributes are the location, area, site positioning, surroundings road hierarchy, access to public transport points, surrounding land use, and spatial design. Location is the first critical aspect that filters the parks' users. City Park, which is located in the city center would invite a different kind of users compare to a City Park which is located in the city's peripheral area. The second attribute is the area, where public parks with spacious areas are considered to give more space for people's movements and activities. During this pandemic time, these places would bring more safety feelings for the visitors. Associated to the area is the site positioning aspect, which strategically positioned the park within its surrounding built environment to be accessed and reached. A single-detached lot of public parks would have better access than those attached to other development lots. The road hierarchy of a park perimeter would define the accessibility and user willingness to visit the park. It is further another adding factor for users to measure the level of convenience to be at the park.

Parks which are confronting busy roads are less favorable than those which are adjacent to a collector or local road. In conjunction with this connectivity aspect, access to public transport also plays a critical role. Public Parks with easy access and within walkable distance proximity to the public transit points will draw more visitors. In the Indonesian context, a comfortable walking distance is considered within 350 - 400m distance from one point to another. The sixth physical attribute is the park's surrounding land use/ programs which influences the character and branding of a park. This aspect, indirectly bring impacts to the way people perceived the park. Parks that are in the neighborhood area would engage the local community of the surrounding neighborhood, whilst parks in the midst of the city center would engage an interest-based community. Moreover, the spatial design of the park will also be essential to engage the users. This spatial design is related to the composition of hardscape and softscape elements. The composition will affect how engaging the park is and what kind of users will be attracted to visit the park. Parks with a bigger proportion area of hardscape are mostly had a bigger portion of plazas or sports courtyards.

[SCh11] Table 2. Physical Attributes of Taman Menteng, Taman Cattleya, and Taman Lapangan Banteng. The proportion of area were calculated based on Google Earth identification. Source: author elaboration.

Physical Attributes	Taman Menteng	Taman Cattleya	Taman Lapangan Banteng
<b>Location</b>	Central Jakarta (Jakarta City Center)	West Jakarta (West Jakarta City Center)	Central Jakarta (Jakarta City Center)
<b>Area*</b>	± 2.4 ha	± 3.2 ha	± 10 ha
<b>Site Positioning</b>	 At the collector/ secondary roads intersection	 At the busy arterials and toll roads intersection	 At the heart of public buildings area
<b>Surrounding Road Hierarchy</b>	2 Collector Roads 2 Local Roads of gated residential complex	2 Arterial Road & Toll Road/ Highway	2 Collector Roads 2 Local Roads
<b>Public Transport Access</b>	1 Public Bus Stop in front of the park	1 BRT Stop within 460m walking distance	- 1 BRT Stops within 200m walking distance - 1 BRT Stops within 400m walking distance
<b>Surrounding Land use/ programs</b>	- Landed Residential (exclusive neighborhood) - Retail/ Small Commercials - Hotel - School	- Offices - Mixed Use Superblock (Apartment and shopping malls) - Apartments - Landed Residential Kampong/ Urban Settlement	- Government Offices (Ministry Offices) - Cathedral and National Mosque (National Worship Facility) - School (Public Facility) - National Post Office - 5* Hotel
<b>Spatial Design*</b>	Approx. 36% covered by hardscape (includes futsal and basketball courtyard, water fountain area, & plaza)	Approx. 7% covered by hardscape (includes water feature area & parking lot)	Approx. 25% covered by hardscape (includes amphitheater & plaza area)

These public parks, with many sports courtyards, are most likely embracing more young users, whilst those with fewer courtyards are preferable for senior citizens. All the mentioned attributes bring influence to the public park positioning and its relationship with the user engagement.

## 5. Conclusion

As happened in many places globally, the role of public space as a social sphere becomes critically argued when the pandemic hits. Public spaces in the city, most parks, plazas, and squares, are avoided to be used since they were considered vulnerable to spreading the corona virus easily.

Many cities closed their parks following the social/ physical distancing policy and suggest limiting people's movement outside their living places during the outbreak crisis. The pandemic raises uncertainty about how our future relation to public space in the post-COVID time would be and how to adapt to the crisis evolution (Honey-Rosés et al. 2020).

Cities are struggling to find ways and define the best solutions to live within the pandemic situation, while at the same time preserving their citizens' health. The 'new normal' situation has disrupted how the cities used to work in every aspect and reinforce the great transformation.

As stated by Jacobs, parks are delightful features of a city and economic assets to their surroundings (Jacobs 1961, 89). Park provides many opportunities for urban citizens for activities and an escape place to retreat and recreate from the strains of the hectic urban environment, particularly in pandemic situations. People's relations with public parks are not dismissed, on the contrary, the urgency is even bigger in pandemic events.

In the context of Jakarta's populous and high-dense urban environment, the restrictions and limitation measures in Jakarta's public parks during the COVID-19 crisis do not drastically change people's engagement with them.

The park's closure looks not fully effective in terms of containing the virus transmission, as public life is still lively happening around the park during the park's closure time. The concern leads to the next question of how to set up an adaptive policy instead of only establishing the banning policy as cities should look forward to living with or without the pandemic in the near future.

Jakarta's public responses to crisis are commonly unchanged through the times. The uncertain situation always stimulates public appropriation in perceiving the park's utilization with distinct adaptations, which possibly lead to the disproportionate risks that the city should face. Jakarta's COVID-19 pandemic trajectories have demonstrated the fluid circumstance of policies, which is associated with the status of the ongoing pandemic situation. The three park cases have shown how the public of Jakarta perceives and reclaims their public parks during the COVID-19 outbreak situation, which is highly dynamic. Jakarta's citizen's senses of adaptability still put public parks as the locus of their public realms.

Thus, the park's physical attributes play an important role as a tool to mitigate and measure the park performance to be adaptable and resilient in any circumstance. There are six physical attributes introduced in this study, which could help to identify the public interface with public parks. They are location, area, site positioning, surrounding road hierarchy, public transport access, surrounding land use/ programs, and spatial design.

Through a comprehensive approach and reflection on these contextual aspects, the city could rethink and reconceptualize how the green infrastructure nourishes the city holistically as much the green infrastructures will nurture and secure the urban society to live healthy and happy.

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Photo Credit: Angela Colucci

# PART IV. Key Messages

# [RCh 9] Resilience practices and the Covid 19 crisis: the contribution of community and territorial resilience in facing new urban challenges

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*In recent years, there has been a remarkable expansion in the use of the resilience concept and a parallel wider diffusion of resilience practices, making territorial and societal quality a central element in urban and territorial innovative actions and investments. Moreover, looking at recent years' experiences, the concept of resilience seems particularly effective in mobilizing local resources and funding around the community and territorial-based projects to enhance the quality of life and the natural environment. However, it is during the Covid 19 pandemic that resilience has definitely become one of the most popular words at the global level. So popular that there has been a severe risk to make it lose its original meaning and power. It is important to underline that there are so many possible information and knowledge sources about the "stories from the pandemic" that it is impossible to mention some of them without excluding very important ones. For these reasons this short essay proposes a common reflection made by an international group of researchers and scholars during the writing of a book about resilience practices in year 2021 (Colucci and Pesaro, 2022). Starting from the narrative of resilience practices which were already part of the book, the group tried to highlight how territorial and community resilience practices could have been regarded as resources for better facing the impacts of Covid 19 and other similar potential territorial risks. Communities having already experienced or developed resilience practices, revealed to have more capabilities to cope with it, because of the communities' adaptation efforts already accomplished or in action to better face risks and crises, whatever their implementation field and interventions might have been.*

*Taken assumed the central role of health, some main cross-cutting elements and challenges for communities arose from the direct observation of scholars and researchers which were experiencing the pandemic and the social responses from the territorial communities, being of course involved themselves in the crisis.*

*The temporary relief of the natural environment and its role*

*Being people confined because of the risk of infection, nature and the activities related to nature have, to some extent, found relief from the high pressures produced by the everyday life dynamics of contemporary societies.*

*The quality of natural resources has increased quite everywhere globally, and the benefits have been visible, even if only in a temporary perspective. The effects in Europe have been well described in a report of the European Environment Agency in 2022 (EEA, 2022). Starting from the first half of 2020, the unprecedented national lockdowns, the mobility and travel restrictions and the closing of some production activities considered as non-essential or useful during the lockdowns have led to short-term improvements in the quality of the environment in Europe. The document reports that reductions in traffic, shipping and aviation led to sudden improvements in air quality and noise levels, with the concentration of nitrogen dioxide (NO<sub>2</sub>) in some cities declining by up to 60% compared with the same period in 2019. Moreover, preliminary data show that EU greenhouse gas (GHG) emissions decreased by 10% from 2019 to 2020, while the reduction in human activities and movements (due to lockdowns and restrictions all over the world) gave to natural habitats the chance to recover and to animal and plant species the opportunity to occupy new territorial spaces and niches.*

*On the other hand, a different relationship of citizens with nature and the role itself of nature as a relief for people has been observed by all scholars participating in the reflections, as well as recorded in many reports and articles worldwide even before the pandemic (among others, see ten Brink et al. 2016). Nature, even that available in urban environments, is beneficial to general well-being and spending time in nature,*

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of course according to the governmental rules enforced during the crisis, revealed to have clear positive impacts on health itself and be able to create a sense of space and community. Nature and the natural environments can therefore be recognized as resilience resources also in the case of health diseases, both physical and psychological ones. Some activities, such as spend time in green areas inside and outside cities and growing one's food, have become common among people who have experienced confinement within their homes, whether large houses with gardens or small flats. Beyond having a good time and keeping busy doing different activities, stay in contact with the concrete natural environment and observe the growing of plants and vegetables have evidenced the psychological and spiritual positive effects which have already been investigated over the last 20 years (see, among others, Chaudhury and Banerjee 2020, Sempik, Hine and Wilcox 2010).

These practices, enhanced and better diffused over time during the pandemic can be premises for more space and recognition, in the future, for the development of projects and activities based on nature protection and valorization, and on the quality of natural resources as tools for territorial and community resilience enhancement looking at many different categories of territorial risks and crises.

Finally, according to the report of the European Environment Agency already mentioned above (EEA, 2022) the pandemic also had the immediate effect of encouraging people to choose more active modes of travel and prompted cities to become more bike friendly, including by introducing new cycling infrastructure, thus enhancing adaptation and transition in the field of urban mobility.

In a more general perspective, on the one side the pandemic accelerated the diffusion of resilience practices involving the protection and the valorization of the natural environments, the activities linked to the sustainable fruition of nature, the demand for high quality and natural food and new more sustainable mobility attitudes. On the other side, it is important to understand if and to what extent this new awareness will be able to increase space and recognition for the development of projects and initiatives based on nature protection and valorization. Moreover, there is still the need for a stabilization of tools and interventions which will allow the quality of urban natural environments (green, air, water...) definitively become resources and tools for territorial and community resilience enhancement, able to produce positive externalities at the socio-economic level.

### **Economy and economic resilience**

This unprecedented crisis revealed vulnerabilities of contemporary economies that certainly existed before but were not so visible and their impact not fully predictable. This, among others, because Covid 19 can be regarded as an international level natural disaster, which has produced effects simultaneously in all the economies of the world, developed or developing ones. In addition, differently from other natural catastrophes, it did not directly destroy the economic activities themselves, the production and consumption resources, the buildings hosting production and commercial activities or the infrastructures. At an overall level, we can say that it had 4 main immediate effects on economies: (i) it reduced the human exchanges tremendously, thus making commercial and other services sectors particularly exposed and vulnerable; (ii) it reduced the production itself because of the reduction of workers able to continue their activities, thus producing scarcity of final products and services themselves but also a cascading effect in supply chains due to the reduction in the availability of raw materials and other production resources; (iii) it reduced the mobility of goods and raw materials, thus producing the same effects as in the previous point; (iv) it produced inequalities in different economic sectors according to their role in facing the crisis and for their being crucial or not for everyday life or for facing the impacts of the crisis (like the medical, health and pharmaceutical sectors during the pandemic).

The high complexity of contemporary societies and of the variety of activities with their related dynamics, also become part of the problem. At different territorial levels, from the overall to the very local ones, it has been particularly evident the difficulty to identify the whole of the economic activities to be considered for the design and implementation of economic support interventions by the national governments. The complexity of relationships, sharing dynamics, and exchanges need to be better understood to increase the resilience capabilities of the different categories of territorial subjects according to their roles and functions. This while the evidence of different possible working models, available thanks to the enhanced role of ICTs and digitalization, has increased while, again, producing new inequalities. A scenery of overlapping dynamics that requires profoundly researching territorial and community sustainability and

reasoning about a possible rebalancing of regions and of the urban/rural and local/over local interactions. On the other hand, these dynamics also produced positive externalities on some economic activities, like food production. Agroecological food producers started to deliver food at home or enhanced already existing delivering services in many countries, contributing to the permanence of people at home and expanding the network of producers and their possibilities of generating income. At least in Europe, there has been also evidence that organic food consumption has increased (see, among others, data provided in Rehder, Krautgartner and Bolla 2022), thanks to an improvement of online commerce, thus increasing the farmers' revenues and making the activities linked to organic and zero kilometers agriculture more attractive. The coherence with many resilience practices in food production and distribution are evident, as well as the importance of the economic dynamics at the local and micro scale territorial levels. The same mechanisms have been observed in activities related to the valorization of the local territorial natural resources, explored, and relaunched during this period. Activities which can actually be regarded as premises for more space and recognition, in the future, to the development of projects and activities based on nature protection and valorization and on the improvement of the quality of natural resources as tools for the enhancement of territorial and community resilience.

Some questions remain open. The first one is about the capabilities of communities, both at the local and over local level, to cope with the increasing complexity of relationships, sharing dynamics, and exchanges which are characterizing all economic activities. A point which also recall the need for the availability of governance and economic tools aiming at promoting and supporting economic actors at different territorial levels. This issue is strictly related to a second point, about the capability of economic systems as a whole to increase the resilience of the different categories of territorial subjects according to their roles and functions without losing a system perspective. Covid 19 demonstrated how much important it has been to foster not only national level instruments but also local level ones, much more able to solve or at least relieve the specific problems raising at this territorial scale. Here resilience practices have been particularly effective, being already available and dimensioned according to the local needs. In the light of these elements, a final issue has to be considered: will communities be able to look ahead and not give in to the "deceptive comfort" that comes from looking back to the past?

### **Technology and digitalization as resilience tools**

The availability of means and technologies to overcome some of the limits imposed by the pandemic was clear but has become, at the same time, a source of stress for different reasons. The scientific perspective in understanding problems and design solutions has become more popular than in the past but, at the same time, source of debates and misunderstandings because of the uncertainty which still come with it.

The need to quickly adapt to ICT and digital technologies as the only or significant ways to teach and learn, buy and supply, produce and consume, work and spend leisure time, and even contact the loved ones created ambivalent reactions and digital divide. The feeling of being able to overcome the contingent problems has been many times balanced by the fear for the need to abandon the comfort zones of the previous normality and past lifestyles.

At the same time, another critical impact has occurred during the pandemic. Online and remote working has become more widespread and improved, normalizing, and making many collective activities more effective. Moreover, ICTs have been able to produce extraordinary benefits by looking at the participation of people in meetings, workshops, and other activities offered in distance mode, allowing large audiences to be involved in initiatives and dissemination about various issues, among which resilience, sustainability, and green (see, among others, Hacker et al. 2020). It has also been an opportunity for transition initiatives, most of which are group-based, to continue meeting and innovating with remote transition strategies. Finally, it is evident that the heritage of the strengthening of the dematerialized and distance activities represents an opportunity for the re-development of marginal territorial spaces and regions, rebalancing also the gaps existing between urban and rural areas.

The main issue here is the availability of resources and capabilities to deal with the divides which still characterize different territorial areas, among which many of the so-called "internal areas", looking at the quality and capillarity of physical ICT networks and infrastructures and at the diffusion of education and training of all communities' members, whatever might be their age and conditions, for the use of ICT and digital devices.

At the same time, practices for the enhancement of social-based territorial resilience should be activated or enhanced to allow territorial communities to become more competitive, reaching capabilities to deal with technologies and science in a more mature way and take advantage of them minimizing the negative impacts and conflictual behaviors.

### **Networks and networking as community resources**

One of the most cross-cutting and common elements highlighted by the crisis has been the direct and indirect involvement of communities and individuals in mutual support networks to better face the pandemic's impacts in everyday life and overcome difficulties in the supply of essential goods and services (see, among others, Al-Omouh et al. 2022). The availability of previously existing networks, many times activated as part of the activities implemented in resilience practices funded at the local level, together with the capability to establish new ones when needed, revealed to be an essential resource for community resilience. There have been specific local practices activated in many places all over the world revealing how much people need social and mutual networking not only looking at specific solutions to face specific problems but also to make individuals and families feel not alone and part of a community, so far coupling practical and psychological help. Likewise, there has been a recovery of contact with the neighborhood community, there has been greater visibility of a sincere concern for family and loved ones, and in general, the bonds of solidarity towards certain groups (those most affected by the pandemic) have been extended. The organization itself of societies and groups, on the other hand, is one of the elements explaining the diffusion of the infection. In many places, especially (but not only) in the developing countries, the infection has spread around because of a mix of social dynamics and poor quality and accessibility conditions of the infrastructures and public services organization. For instance, the interactions linked to the provision of services and domestic work provided by low-income social groups can explain some specific infection trends. The lack of infrastructure endowment and quality in low-income urban settlements (in particular of water supply) demonstrated how an essential resource is crucial in preventing hygiene measures and disease diffusion. Moreover, the strong dependence on commercial activities to generate income for the population, especially the work in local fairs and markets, often reflects the intense urban-rural interactions that strongly contributed to the local spread of the pandemic. Similar reflection can be related to the dependence on city-based health care or the everyday supplies to an urban population that has revealed itself as highly vulnerable.

However, during the last year, communities' members seem eager to come back to their "old lives", as the pandemic might have been a parenthesis in the "normal flows" of their lives. Will the networks created during the pandemic be able to stabilize themselves? For sure, according to these lessons, the design of networks in resilience practices should be enhanced as a strategy to better cope with future crises and risks.

### **Evidence of the role of resilience practices during the pandemic: lessons learned**

The fast changes experienced during the pandemic, which produced and still produce impacts on our societies, clearly demonstrated the fundamental importance of resilience resources and capabilities at the individual and social levels. The pandemic has besieged countries worldwide, and all typologies of society and people have found themselves exposed to the same event simultaneously. On the other hand, it has revealed different vulnerability degrees and fragilities in different population groups and individuals. For example, the situation of isolation and the pressure, in some cases, lived as coercion. Adapting to distance relationships and exchanges (when and if possible) for quite all the teaching-learning and working and not-working time has generated a considerable health impact and psychological cost. Many people have become exhausted from virtual and teleworking tools, and the need to maintain physical human contact and go outdoors has become evident. This emotional stress has been compounded by the fear caused by the possibility of catching the virus, the suspension of certain freedoms, the economic instability, and the fragmentation of citizen security. Precisely because of these factors, inner transition work to alleviate this fatigue, anxiety, fear, or frustration is becoming increasingly meaningful, while it is now more evident that the inner transition approach is not replaceable by the outer transition. In addition, the pandemic context has shown that one of the groups most affected by the conditions of confinement and social distance has been the children. That phenomenon so impacting this specific population sector has solicited the movements working on resilience enhancement at the community level to embrace more explicitly the

youngest, helping them develop remote tools and outer practices and strengthening their capacities for emotional resilience.

*There are hundreds of thousands of possible examples of how collectivities and individuals have organized themselves worldwide during the Covid 19 crisis. As in "normal times," what is essential for future development is to learn from the practices and stabilize the new solutions and the created capabilities and innovation as a heritage for the future. The legacy in terms of resources, activities, creativity, and improvements comes from the crisis, allowing societies to move towards new and renewed ways of making the territorial system and communities more sustainable and resilient. A legacy of experiences to be treasured from all viewpoints, from the functioning of our production and consumption models to the impacts they have on our natural environments and their equilibriums up to the new/renewed centrality of the values attached to the availability and quality of all kinds of public services and proactive behaviors and involvement of collectivities and organizations at all territorial scales, starting from the local. A heritage of practices to be carefully studied and understood so to highlight the most important values and resources a community should preserve and continuously regenerate – material and immaterial ones, public and private ones, related to nature and culture protection, to welfare and health, to new networking and connections building – as a precious territorial capital.*

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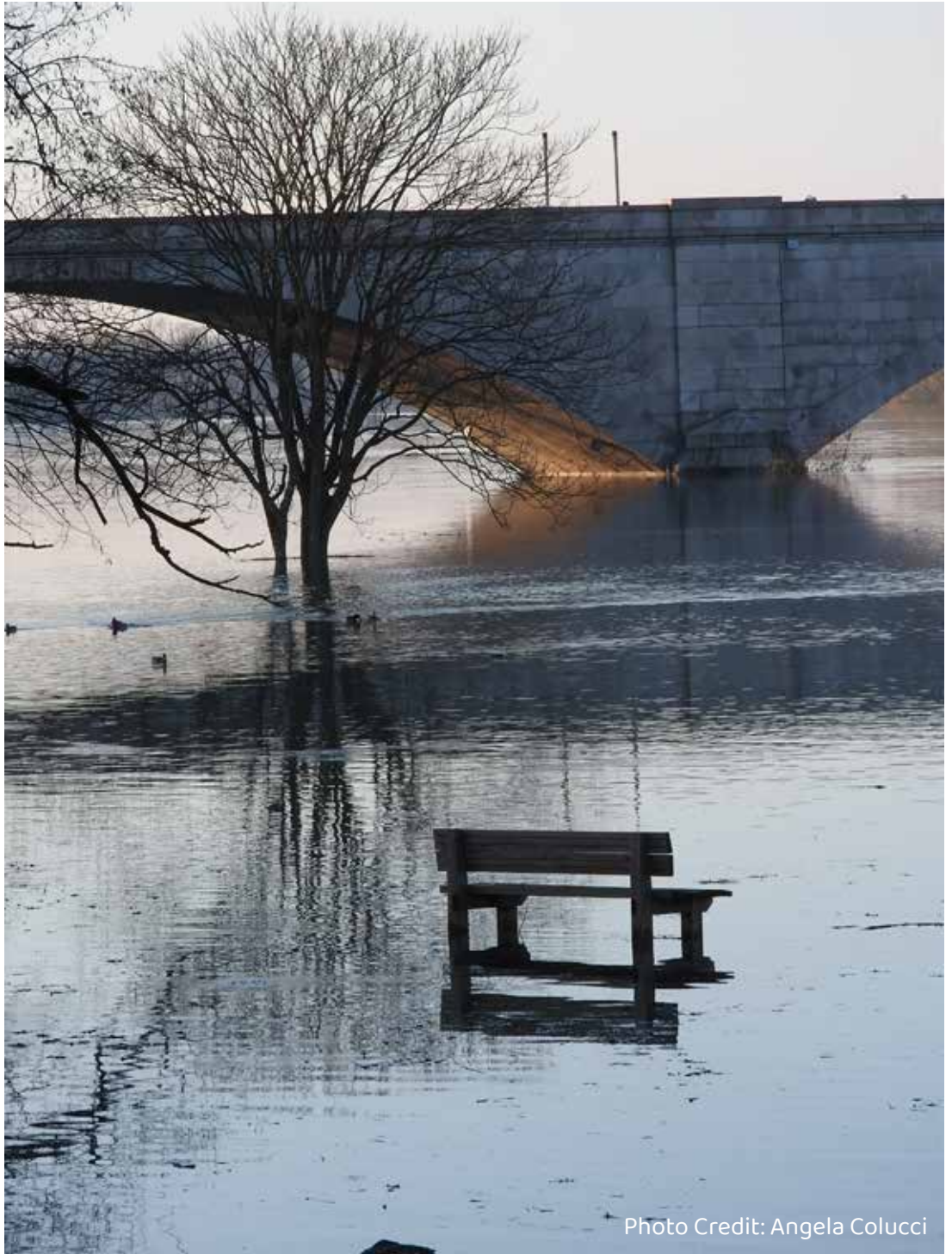


Photo Credit: Angela Colucci



# [RCh 10] Urban Envisioning Perspectives and Key Messages

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*Urban Resilience and Planetary Health are undoubtedly inextricably interconnected concepts sharing approaches and principles. Both concepts are rooted in the complex approach by recognizing the core role of interconnections among complex systems components, the dynamic and evolutionary perspectives, and the interconnection among ecological and human visions.*

*Resilience is the capacity of social-ecological systems to face and respond to perturbations, stress, and shocks preserving their structure and essential functions (Colucci, 2012; Gunderson & Holling, 2002; Holling, 1973; Walker et al., 2004). Urban visions based on a resilience approach imply recognizing that humanity depends on ecosystems to survive. The resilience capacity enables (socio) ecological systems to tolerate and face perturbations events without collapsing. Moreover, in considering the socio-ecological systems, it is essential to consider the capacity of humans to envision (better) future pathways (Davoudi et al., 2013).*

*Planetary health is defined as “the achievement of the highest attainable standard of health, wellbeing, and equity worldwide through judicious attention to human systems—political, economic, and social—that shape the future of humanity and the Earth’s natural systems that define the safe environmental limits within which humanity can flourish” (Whitmee et al., 2015). Planetary health concept invite in recognizing and understanding the relationships between the health of humans and natural ecological systems as multilevel biological, societal, and environmental causes determinants impacting human and ecological components of health (Ostrom, 2009).*

*Resilience/Urban Resilience and Planetary Health are rooted in a systems-level conceptual framework based on and the interconnection of Social-Ecological Systems theory complexity (Lansing, 2003)*

*Envisioning resilient urban systems responding to planetary health requires a common effort to hybridize disciplinary approaches and principles because of the phenomena dynamics’ ecological and human (social, economic, and organizational) connection.*

*Urban envisionings must be rooted in the resilience capacities of complex systems improvements and in preserving the ecosystem and natural components’ functionality towards Planetary Health.*

## **Creative diversity for our common futures**

*In particular, creative diversity (and redundancy) emerges as propriety to be urgently boosted and promoted in complex urban system envisioning, design, and actions. The REsilienceLAB recognized the relevance of Creative diversity and redundancy propriety for resilience in social-ecological systems, promoting creative diversity for our common futures co-production path (REsilienceLAB, 2022).*

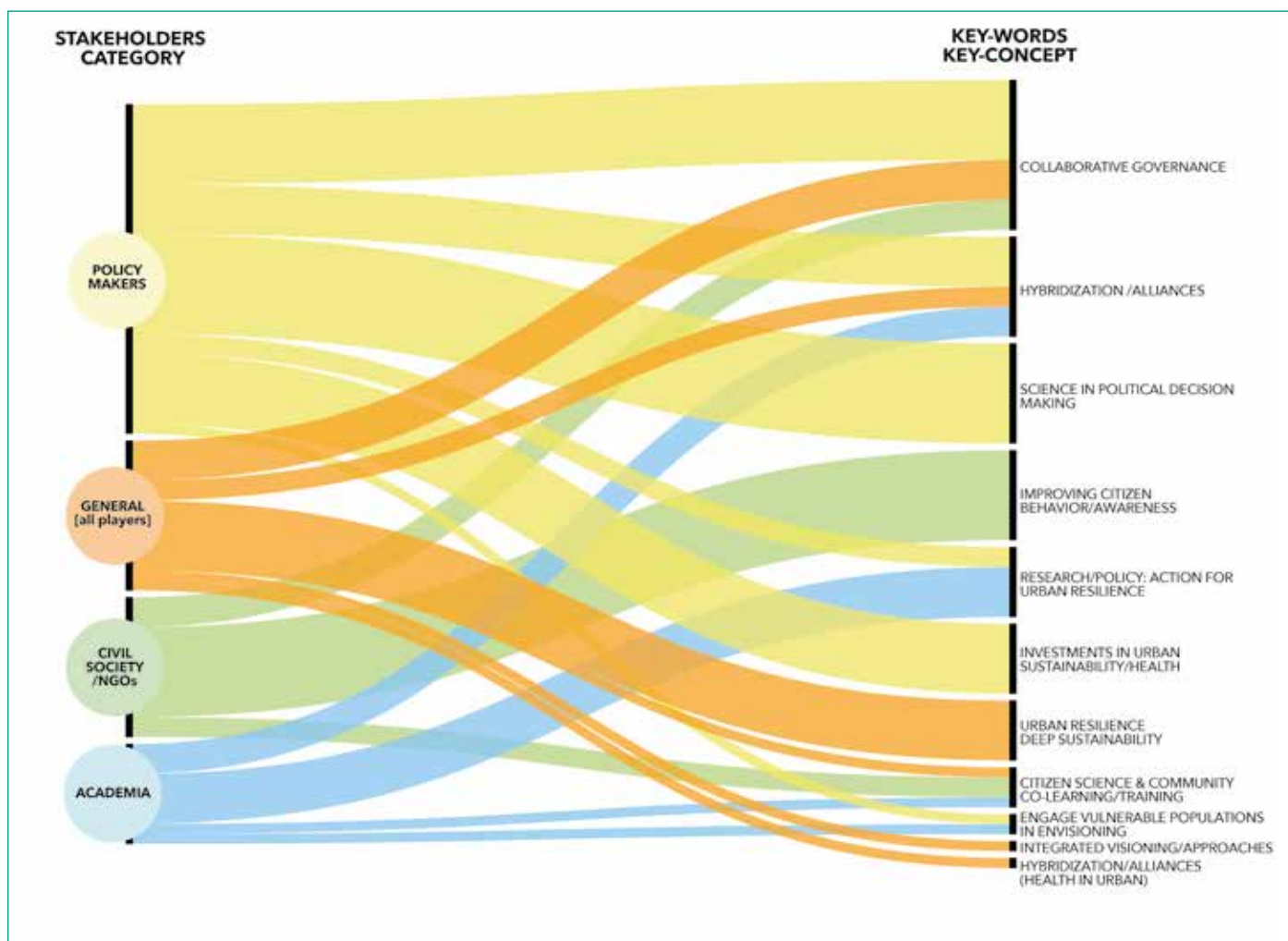
*Redundancy and creative diversity could be recognized as the immediate sources for replacing functions lost due to a disruptive event and provide the “stock” for activating adaptive responses concerning a multiplicity of temporal and spatial dimensions. An ecosystem has three types of diversity: biological, genetic, and functional. Each species is a single component of biodiversity itself, stored in the species’ lineage (genetic diversity) and expressed through its behavior (functional diversity). Functional equivalence (or functional redundancy) is the ecological phenomenon in which multiple species representing various taxonomic groups may share similar, if not identical, roles in ecosystem function. Redundancy and creative diversity are insurance strategies for maintaining ecosystems’ recognizability/functionality (preferred regime threshold). Functional diversity is crucial concerning response diversity (when components react differently to disturbances) ((Elmqvist et al., 2003)*

*Creative diversity and redundancy are also strategic resources in psychology and sociology: social systems are generally more robust when multiple components participate. Research noticed how diversity (community participation) in decision-making processes improves innovative strategies, leading to better regimes for human-environment interaction (Colucci, 2022b). Finally, diversity is one of the core*

properties of complex adaptive systems (Page, 2011)

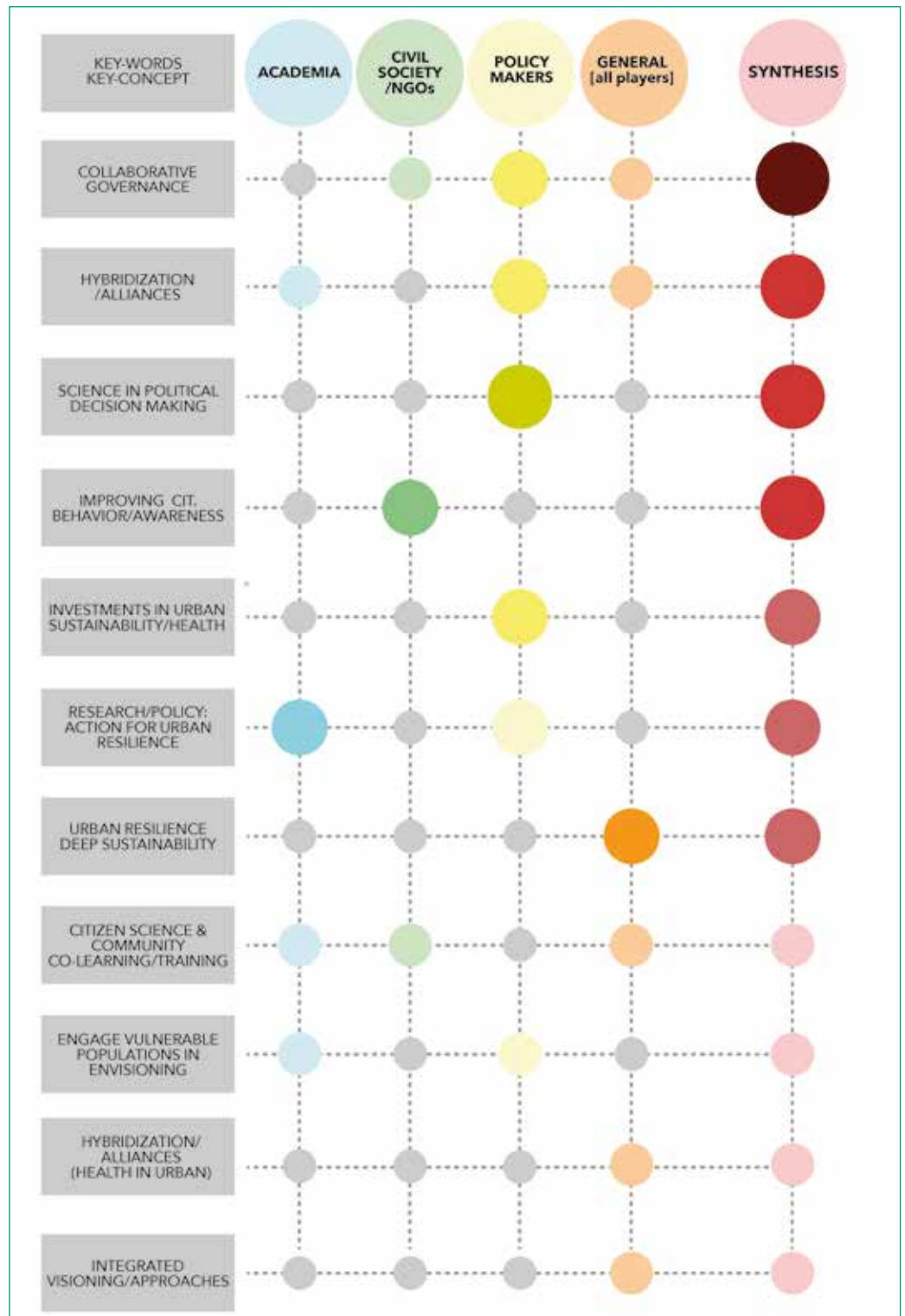
The First Principle for Resilient Systems proposed by the Stockholm Resilience Centre (Biggs et al., 2015) is precisely that of maintaining diversity and redundancy: in the socio-ecological system, all components (species, landscape types, knowledge systems, actors, cultural groups, or institutions) offer different options in coping with uncertainty and shocks. The principle underlines how systems with differentiated components, including actors, or knowledge sources, are more resilient than simplified systems. In general, redundancy is confirmed as complex systems insurance compensating for the loss or failure of single components.

[RCh10] Figure 1. Graphical representation of the key-concepts clusters and the stakeholders category. Source: Author data elaboration



# KEY MESSAGES FOR URBAN RESILIENCE AND PLANETARY HEALTH ENVISIONING

The key messages outlined are rooted in the book contributions, the dialogues among authors during the editorial process, and the co-production activities promoted in the Creative Diversity for our common futures (resilience Dissemination project) and the Urban Resilience and One Health international conference debate. All the contributions collected in shared in collective virtual spaces, processed, and reorganized to identify the following recurring fundamental principles and strategic key message clusters.



[RCh10] Figure 1. Graphical representation of the connection among the key-concepts clusters and the addressed actor: the dimension of the circle indicate the relevance of the key message addressed. Source: Author elaboration

# KEY MESSAGES FOR URBAN RESILIENCE AND PLANETARY HEALTH ENVISIONING

## 1\_ Urgency to embrace complex approaches able to reframe Urban Resilience and Planetary Health, shifting the models towards Deep Sustainability principles

**Urban resilience, Planetary health, and (deep) sustainability** emerged as recurring approaches to face the Anthropocene challenges supporting both the understanding of the phenomena and to support the envisioning. Complexity and the complex approach is emerging as common ground. As stressed in the introduction to this chapter, embrace the complexity and the socio-ecological approaches as a paradigm is urgent for understanding the phenomena and for designing multi-beneficial and synergic strategies/solutions. All actors and players must understand the human and natural complex interdependency in all decision-making processes from the global to local (institutional and community-led) processes since the citizen and individual behavior spheres.

Understanding and acting on the **complexity** is a core commitment for academia, practitioners (or technical actors), and third-sector players of complex urban systems to **envision more resilient and healthy places for all living**.

## 2 Hybridization and alliances

Adopting Planetary Health and Urban Resilience approach fosters scientists, policymakers, and citizens toward **multidisciplinary collaborations** emphasizing the interdependences and dynamic phenomena between human and natural systems components (Iyer et al., 2021).

It requires an effort to adopt perspectives across scientific domains connecting scientists from ecology to earth and human sciences while fostering the diffusion of crosscutting policies among the consolidated sectors and action. The multidisciplinary approach (including all the conceptual declinations fostering the synergies among disciplines and sectors activation) must constitute a principle for **accelerating alliances and synergies between sectors and areas of intervention** in the decision-making processes of public/institutional policies and for community-led transition processes and initiatives.



### Key message for Academia: hybridization/alliances (health in urban)

Boost **synergies and hybrid research** among disciplinary fields acting on complex urban systems. In particular, the need for a common effort to develop more structured alliances and research integrating health/medical and scientific sciences with urban/architectural design and social sciences emerges. The reinforcements of the alliance among these disciplinary fields emerge as crucial to renovate the **role of (planetary) health in urban planning/design**. The collaboration must be rooted in the synergic process of mutual hybridization to avoid useless overlay and promote collaborative multidisciplinary research and urban innovation for Urban Resilience and Planetary Health.



### Key message for Academia and Civil Society/Communities: boosting alliances for research innovation

**Collaboration among academia and communities** emerges as a factor for research innovation. The active involvement of local communities in urban research enriches the process of understanding complex urban phenomena and orients the research to more feasible and tangible outcomes able to produce direct (scientific research outcomes) and indirect benefit for local and global communities (empowerment and awareness/knowledge co-production). Academia and research must also include fragile and vulnerable communities in the research process to ensure that no one is left behind in solution developments (EG children).

### 3 Improving behavior/awareness

The involvement of citizens is also crucial in developing credible strategies impacting **citizen and local community behavior and awareness**. To reach the long-term cultural shift in individual behaviors, alliances, and empowerment of communities in research for urban resilience and Planetary health is a precondition.



#### Key message for Academia, Civil Society and All Players: foster citizen science & community co-learning/training

**Citizen science in Urban resilience and health** is a promising strategy for creating healthier and more equitable neighborhoods and communities (Grootjans et al., 2022). The interaction of **citizen scientists with the community members** positively increases public engagement, contributes to a higher degree of legitimacy of decisions, positively affects social cohesion (Ellwood et al., 2023), and promotes local awareness. The crucial role of alliances and citizen science is demonstrated by several programs promoted by the international organization and European Union. For example, the World Organization of Family Doctors (WONCA) launched the Air Health Train the Trainer Program as an educational program focused on a key aspect of planetary health, focusing on the intersection of air pollution, human health, and climate change.

### 4 Action for urban resilience

A recurring urgency is the need to focus on the **action and implementation dimension: tangible transformations towards more resilient and healthy urban systems**. The solicitation to focus on the action domain is addressed to academia and policymakers. Academia and research actors are responsible for improving tangible implementation and action in our urban context. This could be achieved and improved through collaboration with actors (academia, civil society, and institutional actors) and inviting academia to develop action research.

The 2023 Global Risk Report (WEF, 2023) ranked “Climate action failure” the Top Global Long term Risks. Climate and environmental risks are the core focus of global risks perceptions over the next decade – and are the risks for which we are seen to be the least prepared. The lack of profound, concerted progress on climate targets has exposed the divergence between what is scientifically necessary to achieve net zero and what is politically feasible.

The international agenda for transition and sustainability recognizes the urgency in enabling implementation and tangible results and achievement in climate mitigation, improving the Planet Health and local urban socio-ecological context components and systems.



#### Key message for All Players: accelerating urban innovation and community-led processes

The transition initiatives became fundamental actors in the decision-making process and policy implementation. They demonstrated their crucial role in activating responses to support local communities during the Covid 19 pandemic (such as local food distribution, social/health monitoring, and self-help network). The increased recognition is also visible in the active involvement of practices in international decision-making processes (examples are platforms such as UN-Habitat, ICLEI, and many others that dedicate maps and active spaces for enhancement) as well as the diffusion of platforms aimed at offering spaces for practices and experimentations networking (a recent example is that of the EU new Bauhaus which, precisely in practices and experiments from below, has an axis for the innovation of European urban models towards greater sustainability and adaptation).

**Activating alliances among academia and resilience practices to generate networking and cooperation among associations/practices emerges a promising perspective for providing capacity building, training, and cultural instruments to support local and community-led/spontaneous interventions and improving the capacities for fast responses activation during emergencies and crises** (Colucci, 2022a).



## Key message for Policy Makers: foster investments in urban sustainability/health

the urgency to act and implement policies includes the importance of **increasing Investments in urban sustainability/health**.

## 5 Collaborative and multilevel governance

The need to renovate governance represents an explicit goal of international and regional programs: Sustainable Development Goal number 17 refers to the need to “Strengthen the means of implementation and revitalize the global partnership for sustainable development,” several UN-HABITAT campaigns promote the Good Urban Governance (UN Habitat, 2022) and the improvement of territorial/urban governance is the core issue and challenge of Interregional EU policies (Knieling & Leal Filho, 2013). The shift from current governance models towards more adaptive and collaborative models is a common challenge for cities all over the world, being cities increasingly called upon to integrate emerging community-led and transition initiatives, institutional climate strategies into the broader process of sustainable development of more and more complex urban systems (Colucci, 2022c).

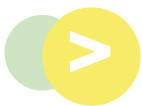
The literature debate (Dietz, 2003; Ostrom, 2004) in denouncing the need for a general renovation of governance processes, proposes alternative/innovative models as adaptive governance (Folke, 2007) or reflexive governance (Maesschalck, 2017; Voss et al., 2006) embracing cross-scale interactions and embedding the multi-scale phenomena and dynamics of complex systems. Governance (as structures and processes that allow social organizations to make decisions and share power enabling the conditions of collective action and organizational social coordination) is a key factor in determining how cities and states respond to crises such as COVID-19 and its multitude of challenges and trade-offs.



## Key message for All Players: multilevel governance

**Multilevel urban governance** that is needed to respond to climate change is also critically important for the response to a pandemic as it provides ways to deal with early warning signals, trade-offs between public good and perceived economic risks, and supports the capacity to build partnerships with a common agenda

Multilevel governance for policy decision-making can incorporate more extensive partnerships to support the targeted results in CC mitigation, environmental and natural systems functionalities (EG ecosystem performance), adaptation, and resilience capacities improvement.



## Key message for Policy Makers: engage vulnerable populations in urban envisioning

Governance model innovation promotes and incorporates **local experimentation and community practices as a driver for the model transition** and for the empowerment of the vulnerable in the envisioning.



## Key message for Policy Makers: science in political decision-making processes

It is essential to root **public decision-making processes in scientific evidences**. A crucial aspect of the innovation of governance models is integrating academia and research as key players in decision-making processes. At the same time, as international and European institutions suggested, the academia has the task of approaching and actively involving institutional actors and citizens to transfer scientific evidence and advances effectively.

In this perspective, constructing complex processes of co-production of knowledge constitutes an essential integration to the innovation of governance models.

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# ENVISIONING RESILIENT CITIES for a POST- PANDEMIC ONE HEALTH

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*ABSTRACT\_ The book explores and discusses the Urban  
Resilience and Planetary Health concepts to activate  
synergic dialogues among disciplinary research fields and  
action domains toward urban vision challenges rooted in  
resilience and adaptive experiences promoted by  
academia, experts, the third sector, and communities.  
Rooted in the "Urban Resilience and One Health"  
international conference outcomes, the book editorial  
process enlarged the perspectives to transfer innovations  
and advancements in urban systems' transformation  
processes, fostering a radical shift in the decision-making  
phase, design solutions and tools, and implementation  
processes.*

*This collective manuscript, enriched by multidisciplinary  
contributions from academic and civil organization  
perspectives from all the continents, integrates research  
advancements and experiences discussing and  
contributing to envision a post-pandemic future for our  
cities.*

*The book has been organized into four parts that are core  
for the envisioning process:*

- **PART I: Urban Resilience (UR) and One Health (OH) Proximities**, dedicated to discussing and reframing the core concepts
- **Part II: Resilience between Territorial Planning and Healthcare**, exploring how different scholars from planning, policy, governance, and architecture disciplines and the healthcare sector perceive the concept of resilience.
- **Part III: Reality Check**, presenting testimonies, life stories, and social evidence to double-check the theories with what truly happened in practice.
- **Part IV: Key messages**, dedicated to the citizens' experiences and role for a healthier future and outlining the recurring key messages and perspectives to academic, institutional, and citizenship actors to envision resilient and Health complex systems.