PLEA SANTIAGO 2022

November 22 - 25, 2022

WILL CITIES SURVIVE?

The future of sustainable buildings and urbanism in the age of emergency.

BOOK OF PROCEEDINGS VOL 2 ONSITE SESSIONS

Conference Chairman
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Co-Chair
Felipe Encinas
Magdalena Vicuña

Editorial Team
Waldo Bustamante
Mariana Andrade
Pablo Ortiz E.

Hosting Organization
Pontificia Universidad Católica de Chile
Avenida Libertador Bernardo O'higgins 340

Graphic Design Project
Nicolás Gutierrez

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PLEA STGO 2022

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FACULTAD DE ARQUITECTURA, DISEÑO Y ESTUDIOS URBANOS
PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
Facultad de Arquitectura, Diseño y Estudios Urbanos UC
fadeu.uc.cl

Universidad de Concepción
udec.cl

Agencia Nacional de Investigación y Desarrollo
Ministerio de Ciencia, Tecnología, Conocimiento e Innovación
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PLEA STGO 2022: WILL CITIES SURVIVE?

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ABOUT

PLEA Association is an organization engaged in a worldwide discourse on sustainable architecture and urban design through annual international conferences, workshops and publications. It has created a community of several thousand professionals, academics and students from over 40 countries. Participation in PLEA activities is open to all whose work deals with architecture and the built environment, who share our objectives and who attend PLEA events.

PLEA stands for "Passive and Low Energy Architecture", a commitment to the development, documentation and diffusion of the principles of bioclimatic design and the application of natural and innovative techniques for sustainable architecture and urban design.

PLEA serves as an open, international, interdisciplinary forum to promote high quality research, practice and education in environmentally sustainable design.

PLEA is an autonomous, non-profit association of individuals sharing the art, science, planning and design of the built environment.

PLEA pursues its objectives through international conferences and workshops; expert group meetings and consultancies; scientific and technical publications; and architectural competitions and exhibitions.

Since 1982 PLEA has been organizing highly ranked conferences that attract both academia and practicing architects. Past Conferences have taken place in the United States, Europe, South America, Asia, Africa and Australia.

After almost a decade the PLEA conference is coming back to South America, Santiago (Chile), to be organized by the Pontifical Catholic University of Chile (PUC). Inevitably, the theme of PLEA 2022 is inspired by the current pandemic which has put the whole world on alert and makes us rethink our built environment in terms of health and safety. Whereas due to its current social unrest and significant social divide Santiago and South America in general provides a great ground to talk about inequalities and revisit social movements, that spanned around the globe from Lebanon, France to Chile and other countries just before the pandemic hit.

The aim of the PLEA 2022 is to question the whole idea of a city, the way we inhabit and use them generating the definitive inflection point that a sustainable city requires.

GOAL AND THEME

For decades, the climate crisis has been demanding our action and commitment. Numerous efforts to reach an international consensus via climate summits, such as COP25, and Paris Agreement have not had any expected results yet. However, even though the COVID-19 pandemic has intensified the sense of urgency, many talks about climate change were put on hold during 2020, when the new virus put the world on alert.

In no time it has become a global issue and provoked various reactions from political leaders around the world—from absolute denial to the harshest restrictions—adjusting and learning in the process by trial and error.

This process has not been easy as COVID-19 highlighted critical deficiencies in our built environment and urban design. Even though infections battered affluent areas too, the pandemic hit the hardest when the virus reached sectors with high rates of poverty. Dense neighborhoods and overcrowded buildings could facilitate the rapid spread of infections due to the difficulty of generating social distancing and the application of extensive quarantines.

Yet, various changes have been adopted rapidly. Hygiene protocols, wearing masks, social distancing and other strategies has become part of our ordinary life. On top of that, the use of public spaces, streets, parks, homes and all buildings had to be adjusted to control the spread of the virus transforming our habits and conception of them. Numerous studies showed great variations in the use of transportation during the pandemic too. But the questions are: are those changes here to stay? What does the future hold for our built environments?

Some even go as far as to question: Will cities survive? While many intellectuals and academics call for the end of cities (at least as we know them), some stakeholders urge to return to normality, or so-called status quo.

Is this the last opportunity to effectively build a healthy, livable and equitable city? It is clear that cities can no longer be conceived as before and it is time to question the way we inhabit and use them. What are the standards, mechanisms and criteria to define a sustainable city and building? Do they respond to the problems and deficiencies in the age of emergency? History shows us how cities reacted to and changed after health crises similar to COVID-19; this is the time to question everything around us and strive for environmentally sustainable and socially just cities.

The aim of PLEA 2022 is to be a relevant part of the discussion and bring about proposals to the developing and developed world. It is a great chance to talk about the changes that affected cities around the globe since the start of the pandemic and bring the scientific knowledge generated in this short time to the discussion.

Social inequality should also be a part of the debate as both health and climate emergencies may further increase the injustice and, at the same time, the inequality may make such crises worse. Latin America, as the most unequal region, and Chilean case might serve as a great example of such issues and could become a source of inspiration to find the definitive inflection point that a truly sustainable city requires.

WELCOME TO SANTIAGO DE CHILE

Dynamic and cosmopolitan Santiago is a vital and versatile city. Home to many events showcasing the very best of Chilean culture, it also hosts superb international festivals of sound, flavor and color. The Chilean capital breathes new life into all its visitors!

The city's diversity shines through in its many contrasting neighborhoods. Set out to explore the city streets and you'll discover beautiful and original art galleries, design shops and handicraft markets, as well as a great selection of restaurants, bars and cafes. Night owls can enjoy a taste of lively Latino nightlife in hip Bellavista!

Visit downtown Santiago to get a real feel for the city. Learn more about the country in its many fine museums, or wander around the famous Central Market – a gourmet's delight.

Fans of the great outdoors can head for the hills that surround the city and marvel at panoramic views of Santiago with the magnificent Andes as a backdrop. Take the opportunity to grab a picnic and visit one of the city´s many parks.

In Chile there are places that have not seen a drop of rain in decades, while there are others where the rain brings out the green in the millenial forests.

This diversity captivates and surprises its visitors. Because, as a consequence of its geography, Chile has all the climates of the planet and the four seasons are well differentiated. The warmest season is between October and April and the coldest, from May to September.
The temperature in Chile drops down as you travel south. In the north, the heat of the day remains during the day while the nights are quite cold. The central area has more of a Mediterranean climate and the south has lower temperatures and recurring rainfall throughout the year.

The conference will be held at the Centro de Extensión de la Pontificia Universidad Católica de Chile, located at Avenida Libertador Bernardo O'Higgins 390, Santiago, Metropolitan Region. Universidad Católica subway station, Line 1

The Center is located in the center of the city of Santiago, with excellent connectivity to the rest of the city and the most characteristic neighborhoods of the capital, either through the Metro network (Line 1) or other means of public transport such as Transantiago (Santiago's public bus network).

To make your hotel reservations, we recommend looking in the Providencia or Las Condes districts, close to Metro Line 1. We also have some suggestions for accommodation close to the conference venue.

WILL CITIES SURVIVE?: TRACKS

1. Sustainable Urban Development
– Regenerative Design for Healthy and Resilient Cities
– Sustainable Communities, Culture and Society
– Low Carbon Neutral Neighbourhoods, Districts and Cities
– Urban Climate and Outdoor Comfort
– Green Infrastructure
– Urban Design and Adaptation to Climate Change

2. Sustainable Architectural Design
– Resources and Passive Strategies
– Regenerative Design
– Energy Efficient Buildings
– Net-zero Energy and Carbon-neutrality in New and Existing Buildings
– Vernacular and Heritage Retrofit
– Building Design and Adaptation to Climate Change

3. Architecture for Health and Well-being
– Comfort, IAQ & Delight
– Thermal Comfort in Extreme Climates
– IAQ and Health in Times of Covid-19
– Comfort in Public Spaces

4. Sustainable Buildings and Technology
– Renewable Energy Technologies
– Energy Efficient Heating and Cooling Systems
– Low Embodied Carbon Materials
– Circular Economy
– Nature-based Material Solutions
– Water Resource Management and Efficiency

5. Analysis and Methods
– Simulation and Design Tools
– Building Performance Evaluation
– Surveying and Monitoring Methods
– User-building Interaction and Post-occupancy Evaluation

6. Education and Training
– Architectural Training for Sustainability & Research
– Professional Development
– Sustainable Initiatives and Environmental Activism
– Methods and Educational Practices
– Strategies and Tools

7. Challenges for Developing countries
– Energy poverty
– The Informal City
– Climate Change Adaptation
– Affordable Construction and Architecture Strategies
– Urban Planning and Urban Design Policies for Sustainable Development
– Housing and urban Vulnerability

CRISTINA DORADOR

Keynote speaker
CHILE

Between July 2022 and July 2022 she served as a member of Chile's constitutional convention. She is currently back to teaching at the Universidad de Antofagasta.

Chilean scientist, doctor and politician who conducts research in microbiology, microbial ecology, limnology and geomicrobiology. She is also an associate professor in the Department of Biotechnology of the Faculty of Marine Sciences and Natural Resources at the University of Antofagasta. From July 2021 to July 2022 she served as a member of the Constitutional Convention representing District No. 3, which represents the Antofagasta Region.

Her achievements include the coordination in Chile of the Extreme Environments Network for the study of ecosystems in the geographic extremes of Chile and having developed biotechnological tools to value the unique properties of some altiplanic

microbial communities such as resistance to ultraviolet radiation to elaborate cosmetic creams, joining the field of cosmetic Biotechnology. She has also led application projects such as the development of textile material using the photoprotective properties of altiplanic bacteria.

She was a member of the transition council of the National Commission for Scientific and Technological Research in 2019 that gave rise to the National Agency for Research and Development of Chile, and has been recognized nationally and internationally as one of the most relevant researchers in Chile.

ADRIANA ALLEN

Keynote Speaker
ARGENTINA

Professor of Urban Sustainability and Development Planning at The Bartlett Development Planning Unit (DPU), University College London and President of Habitat International Coalition (HIC).

Adriana has over 30 years of international experience in research, graduate teaching, advocacy and consulting in over 25 countries in the global South, she has specialized in the fields of development planning, socio-environmental justice and feminist political ecology.

She is currently President of Habitat International Coalition (HIC), as well as a regular advisor to UN agencies, positions from which she is actively engaged in promoting urban justice through advocacy and policy evidence, social learning and fostering international collaboration both within UCL and globally.Through the lens of risk, water and sanitation, land and housing, food and health, her work examines the interface between everyday city-making practices and planned interventions and their capacity to generate transformative social and environmental relations.

Adopting a feminist political ecology perspective, her work combines qualitative, digital/mapping, and visual research methods to decolonize urban planning practices and elucidate the "cracks" in which transformative planning can be reinvented, nurtured, and pursued. Her work focuses on three interrelated themes: urban justice, everyday city-making, and transformative planning.
Over the years, she has worked at the interface between insurgent practices and planned interventions and their capacity to generate socio-environmentally just cities.

This work stems from her engagement with the analysis of governance approaches to address structural deficits at the interface between "policy-driven" and "needs-driven" approaches and emerging improvements at scale – in water and sanitation, as well as in other areas such as food security, land, housing and health. Since 2008, she has explored the intersection of urbanization and climate change, with a particular focus on the generation and distribution of risks, vulnerabilities and capacities for action in southern cities. A third strand of her research focuses on urban planning as a field of networked governance and pedagogical strategies to decolonize planning education and shape pathways for urban equality.

ANACLAUDIA ROSSBACH

Keynote speaker
BRAZIL

Economist with a track record of more than 20 years working on the issues of slums, social housing and urban policy.

She is currently Director for Latin America and the Caribbean at the Lincoln Land Institute of Policy. She also serves as a member of the editorial board of Vivienda magazine of INFONAVIT – México. And previously she worked as a consultant on housing and urban development issues for the IDB (Inter-American Development Bank).

She worked in the Prefecture of São Paulo, supporting the Brazilian Ministry of Cities in the design and implementation of the Brazilian housing policy. She founded and served on the board of directors of the NGO INTERAÇÃO, which supported the development of high-impact projects in communities in the state of São Paulo and Recife.

As a senior consultant to the World Bank, she provided technical assistance for the development and implementation of Brazilian housing policy and slum upgrading for 10 years, including two major programs: the "PAC Favelas" slum upgrading and the "Minha Casa, Minha Vida" housing subsidy.

She acted as a senior specialist in social housing for the World Bank and other research and project organizations in Brazil and several countries around the world such as the Philippines, China, India, South Africa and Mozambique, among others.

She was Regional Manager for Latin America and the Caribbean for the Cities of Alliance Global Informality Program where the exchange of experiences and knowledge through different networks was consolidated and structured.

The main achievements in Latin America are the Urban Housing Practitioners Hub (UHPH), which brings together practitioners and networks working in the field of social housing. In the global south, multi-sectoral and disciplinary communities of practice on the theme of slum upgrading in the global south with emphasis on the countries: Mexico, Guatemala, El Salvador, Paraguay, Brazil, South Africa and India.

GIANCARLO MAZZANTI

Keynote Speaker
ARGENTINA

Born in Barranquilla, a port city in northern Colombia, Giancarlo Mazzanti is an architect graduated from Pontificia Universidad Javeriana with postgraduate studies in industrial design and architecture in Florence, Italy.

He has been a visiting professor at several Colombian universities, as well as at world-renowned academic institutions such as Harvard, Columbia and Princeton, and is the first Colombian architect to have his works in the permanent collection of the Museum of Modern Art in New York (MoMA) and the Centre Pompidou in Paris.

Giancarlo has more than 30 years of professional experience and his studio, El Equipo Mazzanti has gained notoriety due to its design philosophy based on modules and systems, which generate flexible elements capable of growing and adapting over time, seeking an architecture that is closer to the idea of strategy than to a finite and closed composition. The idea of architecture as an operation was born from exploring the different forms of material and spatial organization, considering concepts such as repetition, the indeterminate, the unfinished, instability, arrangement and patterns.

Equipo Mazzanti also stands out for its research on play and its link to the world of architecture. It is precisely this interest in the play-architecture relationship that has led it to seek new collaborations with professionals from different areas of knowledge, finding new opportunities for cooperation and developing projects and exhibitions that have been presented throughout the world under the We play You play brand.

Social values are at the core of Mazzanti's architecture, who seeks to realize projects that give value to social transformations and build communities. He has dedicated his professional life to improving the quality of life through environmental design and to the idea of social equality.

His work has become a reflection of the current social changes occurring in Latin America and Colombia, demonstrating that good architecture manages to build new identities for cities, towns and inhabitants, transcending reputations of crime and poverty.

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Mechanical Civil Engineer from the University of Chile. Master in Urban Development from the Pontifical Catholic University of Chile and PhD in Applied Sciences from Catholic University of Louvain, Belgium. Professor at the Faculty of Architecture, Design and Urban Studies from the Pontifical Catholic University of Chile. Director of the Centre for Sustainable Urban Development (CEDEUS).

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Architect from the Pontifical Catholic University of Chile. Master of Science from the University of Nottingham in the United Kingdom and a PhD in Architecture and Urbanism from the Catholic University of Louvain, Belgium. Academic Secretary at the Faculty of Architecture, Design and Urban Studies (FADEU). Researcher at the Centre for Sustainable Urban Development (CEDEUS) and Associate Professor at the School of Architecture in the Pontifical Catholic University of Chile.

Magdalena Vicuña
Architect from the Pontifical Catholic University of Chile. Master in Community Planning from the University of Maryland in the United States and PhD in Architecture and Urban Studies from the Pontifical Catholic University of Chile. Director of Research and Postgraduate Studies at the Faculty of Architecture, Design and Urban Studies (FADEU). Associate Professor at the Institute of Urban and Territorial Studies and Associate Researcher at CIGIDEN.

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Architect from the University of Concepcion. Master of Architecture from the University of Washington, USA. PhD in Architecture from the University of Oregon. Researcher of the Centre for Sustainable Urban Development (CEDEUS) and Assistant Professor of the Department of Architecture, University of Concepcion.

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Massimo Palme
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FOS GIS to support regenerative design processes in urban areas

MATTEO CLEMENTI [1] ALESSANDRO ROGORA[1] MANUELA ROMANO[1]

[1] Department of Architecture and Urban Studies, Politecnico di Milano

ABSTRACT: The paper presents a method and connected tools useful to support regenerative design activities in an urban area. In particular, the insights presented in this paper are part of a research funded by the Department of Architecture and Urban Studies of Politecnico di Milano, aimed at developing a game that can be used by students and local public administrations (Rogora, 2020). The aim of the game is to develop improvement scenarios oriented towards local self-sustainability and functioning regeneration of local natural ecosystems. The proposed method is divided into the following steps: (1) Recognition of free data that can be processed through GIS and referred to the local urban context. (2) Mapping of energy, carbon and water flows, in particular: imported energy and material flows, energy and material flows available locally, energy and material flows exported from the local reference context. (3) Mapping of specific indicators able to support strategies consistent with the main goal functions of a natural ecosystem. This paper focuses on the potential use of Free and Open Source (FOS) GIS and open data in order to develop support maps for regenerative design processes.

KEYWORDS: regenerative design, FOS GIS, solar mapping, carbon balance, water balance.

1. NOTES ON REGENERATIVE DESIGN

With Regenerative Design (RD) (Pedersen Zari, 2018) we refer to a type of design oriented towards energy and material sustainability, characterized by an improvement approach on the functioning of natural ecosystems that interact with the territorial metabolism associated with the project. A regenerative design approach involves knowledge of:

- The general features of the ecosystem in which the territorial metabolism activated by the project is located
- The main players in the system.
- Consequently the flows of energy and matter exchanged between them.

RD, starting from the awareness of the strategies normally used by a natural ecosystem in evolutionary process (goal functions) (Fath et al., 2001), is mainly oriented towards the integrated design management of the main dynamics that characterize the territorial area of reference with the twofold objective:

- Maximize the amount of local solar energy useful for carrying out work (Odum, 2006), in the specific case of the anthropized environment, useful for carrying out the main activities that characterize the local territorial metabolism, reside and work, nourish and clean, transport and communicate (Baccini, Brunner, 2012).
- Ensure an maximize matter circularity. In fact, the inclusion of anthropogenic dynamics in natural dynamics implies the maintenance of the balance between the flows and stocks of production and consumption. In particular, the actual development phase of the game is aimed at providing useful information to transfer such strategies to regenerative design initiatives in existing neighbourhoods. This paper focuses on the potential use of Free and Open Source (FOS) Geographic Information Systems (GIS) and open data in order to develop support maps for regenerative design processes, laying the foundations for a Design Oriented Georeferenced Database (DOGD).

2. METHOD

The proposed method is divided into the following steps:

- Recognition of free data that can be processed through GIS and referred to the local urban context.
- Mapping of:
  - imported energy and material flows,
  - energy and material flows available locally
  - energy and material flows exported from the local reference context.

Attention is paid to the main dynamics exchanged between the nodes of the local urban system (energy flows, carbon flows and water flows) (Chrisoulakis, 2015).

- Mapping of specific indicators able to support strategies consistent with the main goal functions of a natural ecosystem.

The paper summarizes some of the results of applying the method to a portion of the urban fabric of the Corvetto district in the southern part of Milan.

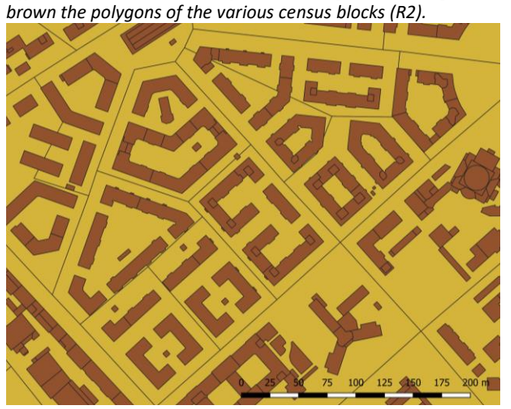
2.1 Free Open Source FOS GIS

The current development of the open source software allows to carry out operations of equal complexity compared to the proprietary sw and at the same time gives the possibility of using complex data even to actors who cannot purchase a proprietary sw such as local administrations, especially minor ones, and designers who are not directly involved in urban planning. These tools represent an important opportunity to process and communicate information to support decisions aimed at both planners and local administrations. The open source feature of these tools allowed the creation of specific institutions and related websites that report news relating to the current level of development of such tools, such as the Open Geospatial Foundation (https://www.osgeo.org/). Among the open source GIS tools made available, the elaborations of this work used Quantum GIS (https://www.qgis.org) and GRASS-GIS (https://grass.osgeo.org).

2.2. Available Open Data

The elaborations presented in this work were carried out on a portion of the urban fabric of Milan, in particular in the Corvetto district in the southern outskirts of the city.

Figure 1:
Portion of the area considered in this work, in brown the different volumetric units of the buildings (R1), in light brown the polygons of the various census blocks (R2).



The main georeferenced data available identify three main types of cartographic documentation:

R1 - vector maps elaborated from aero-photogrammetric surveys, which show the geometry of the buildings, the relative heights of the eaves and the different land uses (Figure1).

R2 - vector maps of census blocks that store data relating to the resident population and the present work activities (Figure 1).

R3 - Lidar surveys at a resolution of 1 meter per pixel that add additional information to the geometry of existing buildings and greenery, in particular trees and roof geometries (Figure 2).

Figure 2:
Lidar model of the same area, resolution of 1 pixel/m².

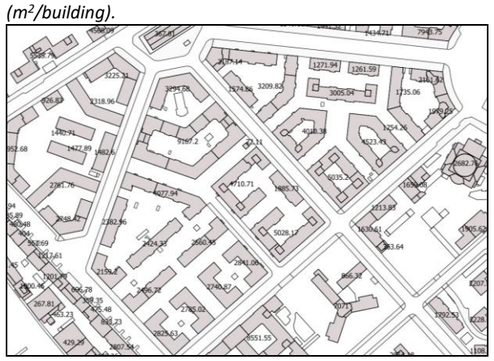
2.3. Mapping Energy Flows

Imported energy flows

As regards the imported energy flows, the available georeferenced data allow to map specific shape indicators that can be associated with each single building or a portion of the urban fabric identified by a census block, mapping useful information in order to assess the energy consumption of existing buildings. Starting from what can be read and processed through FOS GIS, it is possible to create specific thematic maps (TM) that publish significant data on the shape of buildings and the relationships between them and outdoor areas (Morganti et al. 2022) :

- TM1 - the amount of vertical surfaces exposed to the outside (Figure 3)
- TM2 - the combination of TM1 with data relating to the number of inhabitants associated with each census blocks, makes it possible to map the availability of different amount of building surfaces per person in order to assess the per capita weight of building efficiency measures (Table 1).
- TM3 - building shape indicators such as the Exposed Surface to Volume ratio ES/V.}

Figure 3:
Amount of building vertical surfaces exposed (m²/building).



Locally available energy

The availability of information relating to the height of buildings volumetric units together with the data relating to the local orography allow to use FOS GIS to create a high-resolution Digital Elevation Model (Figure 4). These are raster maps in which a pixel corresponds to a square surface of 0.5 m side which represents as gray tones the different heights of the buildings present in the analysed urban area. Starting from this model it is possible to represent particular urban form indicators as the Sky View Factor (Figure 5) and then proceed with the mapping of the incident solar radiation (Hofierka, Suri, 2002) (Figure 6, 7, 8).

Figure 4:
Digital Elevation Model of the area, 1pixel side equal to 0,5m.

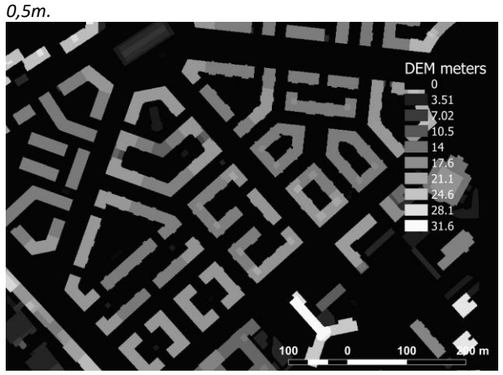
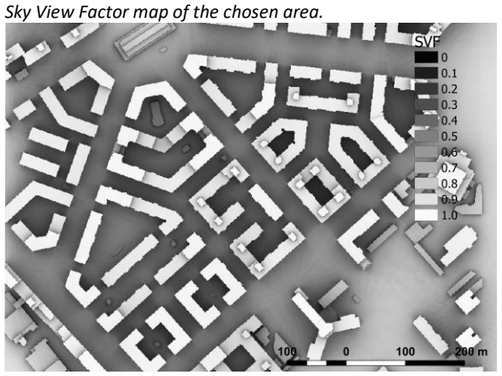


Figure 5:
Sky View Factor map of the chosen area.



This processing allows to create various types of thematic maps, for instance:

- TM4/5 – Direct solar radiation mapping on the horizontal plane to associate production capacities with the building's rooftop and outdoor areas (Figure 6, 7) (all the maps refer to the average daily monthly irradiation).
- TM6/7/8/9 – Direct Solar radiation available per person on rooftop and outdoor areas for each census block.

Figure 6:
*Direct solar irradiation representative of an average day in December (Wh/m²*day).*

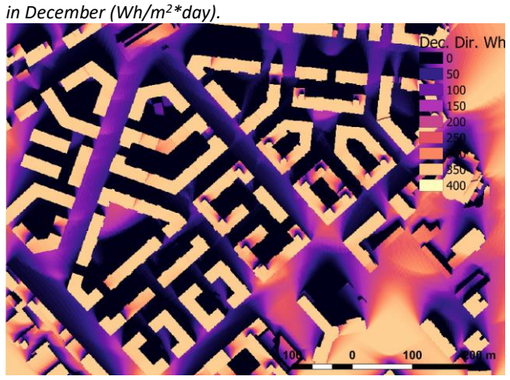


Figure 7:
*Direct solar irradiation representative of an average day in June (Wh/m²*day).*

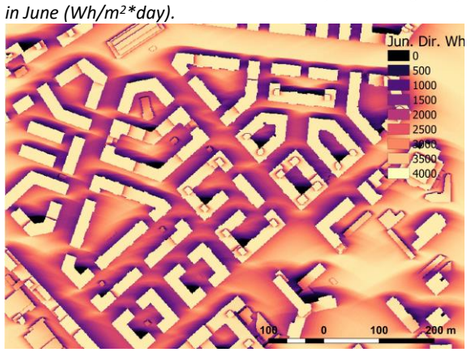
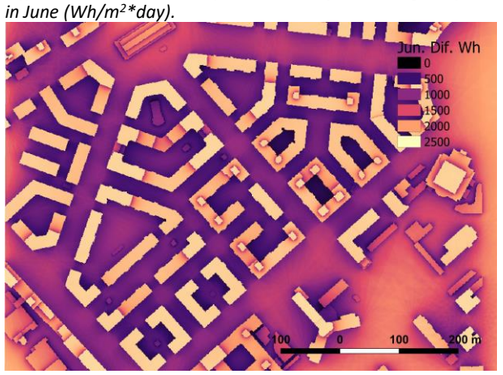


Figure 8:
*Diffuse solar irradiation representative of an average day in June (Wh/m²*day).*



Furthermore, by using lidar surveys, the georeferenced database (DOGD) is enriched with important new information such as the geometric configuration of the existing roofs and trees. This data are of fundamental importance to develop maps of the local renewable potential from solar energy. At the current state of the study, the elaborations carried out on the lidar model have proved to be very effective in detecting the geometric consistency of the trees. As for those conducted on the roof coverings, they were found to be unusable due to the low resolution of the maps, 1pixel/m², they require future further elaborations (Figure 9).

Exported Energy

In this case, the flows of urban waste exported from paper, the flows of organic and metabolic waste (potentially useful for the production of biogas), the biomass produced by the maintenance activities of the parks (tree pruning, for example), have to be taken into consideration.

2.4 Mapping Carbon Flows

Imported carbon flows

A local carbon balance needs to complement information on carbon emissions with data on carbon storage and sequestration. In the first case, R1 can provide information relating to the extension of the green areas detected, this information can be enriched by integrating the Lidar data (R4) into the GIS by carrying out specific processing to calculate the volume of trees (Figure 10). The mapping of solar radiation on the ground and on the roofs can supports the choice of herbaceous or tree species to be cultivated and the effective possibility of absorbing CO_2 based on the available energy. Indeed, this capacity depends on the availability of solar energy as well as on the availability of water and nutrients.

The numerical values currently adopted in the calculation methods proposed in the regulations of the Milan municipality, and used for the calculation of the CO_2 emission, are equal to 6 kg of CO_2/year per square meter of green vegetated surface, and to 50kg of CO_2/year for each tree (Comune di Milano, 2020).

Locally available carbon

This indicator refers to the quantity of woody biomass present.

- TM10 - Volume of trees present in each census block (m³).
- TM11 - Volume / person of trees present in the census block (m³/person).

Figure 9:
Direct solar irradiation during the 21st of June on lidar model (1pixel/m²).

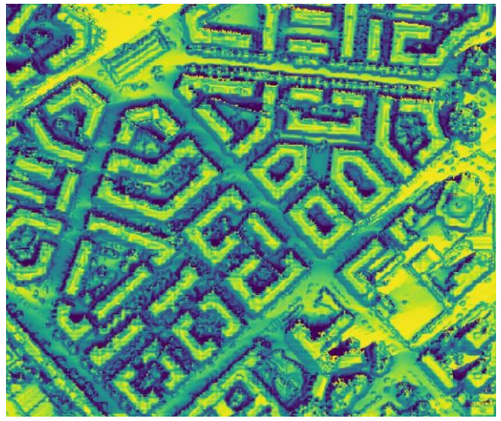


Figure 10:
Lidar map relating to tree volumes. In order to reduce the inaccuracies due to the low resolution, buildings have been eliminated from the map by using a mask increased by a buffer zone of 3 meters. To reduce some defects detected at higher altitudes, interval from 1 to 20 m from the ground has been considered (the white parts of the trees refer to volumes above 20 m).

Exported carbon flows

The mapping of the energy consumption of buildings, if combined with information relating to the type of energy sources, can be used to assess the CO_2 emissions into air associated with building energy consumption. The same census data can be used to map the amount of carbon exported as municipal solid waste (from organic waste to paper). Another aspect in which the regenerative systemic design favours the implementation of carbon neutral strategies is related to the possibility of locally producing nutrients. Buildings regularly export nutrients in the form of metabolic waste and organic waste. In the second case, the local treatment of organic waste would provide a contribution to the ability of local ecosystems to absorb CO_2 both in the soil and in the metabolic activity of plants (Chrisoulakis, 2015).

- TM12 - maps of carbon flows emitted into the air in the form of carbon dioxide.
- TM13 - maps on the amount of carbon and nitrogen emitted through organic waste.

2.5 Mapping Water Flows

Imported water flows

The number of inhabitants and the number of employees associated with a production activity present in the census block can be used to map the flows of imported water

TM14 - incoming water flows used in local residential and work activities.

Locally available water

Making this information available requires associating information relating to the quantity of rain incident monthly and annually on the roofs to the geometric data provided in the aerial photogrammetric survey relating to buildings and open spaces (R1). This information refers to data representative of the annual average and data relating to extreme events not representative of the average but representative of the possibility that an extreme event occurs in a multi-year interval of time usually 20, 50 or 100 years. In the case of the data referring to the monthly average, the open data website of the municipality of Milan reports the monthly average of the atmospheric precipitation values (Comune di Milano, 2022). Rainfall was measured in the urban area in Milan between 2008 and 2014, values ranging from January 2008 to December 2014. Data show an average annual quantity equal to 1006 mm, with monthly average values that fluctuate depending on the month from 50 in August to 100mm in April, with the exception of November where values around 170 mm are recorded.

The mapping of rainwater availability makes it possible to use rainwater not only for irrigation but also to reduce the water consumption from the aqueduct. To understand the precise effectiveness of this solution it is important to compare the capture capacities of roofs and waterproof open spaces with the mapping of water consumption per building. As in the case of solar energy mapping, starting from data concerning the climatic variables (in this case the pluviometry in the different months of the year), it is possible to enrich the database (DOGD) with information to support the design process.

- TM15/16 - the amount of rainwater incident monthly on roofs and open spaces
- TM17/18 - the amount of rainwater incident annually on roofs and open spaces

Exported water

This category includes the flows of water introduced into the sewer by weather events and by local residential and production activities.

- Tm19 - Waste water in the sewer from residential activities

3. RESULTS AND CONCLUSIONS

3.1 Results and indicators

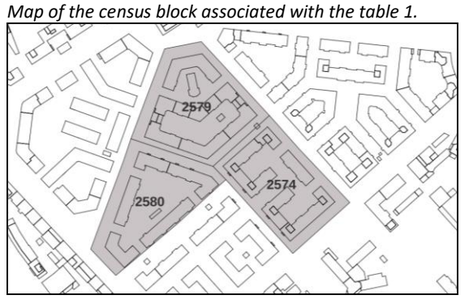
The results illustrate how the integration on the same geo-database of data relating to energy, carbon and water flows allow the mapping of effective indicators, able to verify the transferability of good regenerative design practices, consistent with the main ecological goal functions. In particular, the indicators refer to:

The amount of available solar radiation used to perform work and specifically to meet the needs related to housing, mobility and food.

Closing the cycles on a local scale, reducing the quantity of exported flows and increasing the flows that close in the census block or in the area share by several blocks.

Figure 11:

Map of the census block associated with the table 1.



The quantities reported in the various thematic maps constitute useful information to verify the transferability of good practices through specific indicators, for example:

- Average monthly solar irradiance incident on the roofs of buildings and outdoor spaces used by the local community for housing, mobility or food production (data can be quantified per square meter of census block or per inhabitant)
- The ratio between the quantity of carbon stored and the emitted amount per inhabitant in each census block.
- Local water balance by census blocks: Ratio between water used in buildings and the one collected from their roofs and outdoor space in different months of the year.

Table 1:

Some numerical values relating to the thematic maps described in the text and referring to three census blocks of the area under study (Figure 11)

Thematic maps	Census blocks	2574	2579	2580
TM1	m^2	11695	12535	11044
TM2	m^2/person	32,13	38,69	50,20
TM3	ES/V	0,2761	0,2571	0,2840
TM6	Wh/p*d June rooftops	31416	41165	48870
TM7	Wh/per*d June outdoor	29664	40369	60774
TM8	Wh/per*d Decemb. rooftops	2644	3745	4538
TM9	Wh/per*d Decemb. outdoor	711	419	1126
TM10	m^3	25557	22203	19809
TM11	m^3/person	70,21	68,52	90,04
TM17	liters/per*year rooftops	8590	11258	12910
TM18	liters/per*year outdoors	14914	19193	27008

The association with the census block of quantitative data relating to energy inputs and outputs, CO_2 emissions and water within the same territorial information system allows the development of profitable strategies to interlace the dynamics activated by the various ecosystem actors, including human activities. The possibility of operating in this tran-scalar environment allows:

- on the one hand to identify strategies that take advantage of the different metabolic features of the census blocks by identifying possible complementarities and therefore synergies;
- on the other hand to verify the transferability of scale sensitive strategies. Associating data to census blocks allows to use GIS to aggregate values and therefore to verify the actual transferability depending on the extent of the territorial area of reference..

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