NEW ENERGIES FOR THE CITIES

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Alessandro Rogora and Paolo Carli

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PART II - Evaluation and Modelling Systems, and Tools

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PART I

URBAN CLIMATE AND MICRO CLIMATE

206, p.109305.

Gastellu-Etchegorry, J.P. (2008). 3D modeling of satellite spectral images, radiation budget and energy budget of urban landscapes. Meteorology and atmospheric physics, 102(3-4), p.187.

Irons, B.M. (1966). Numerical integration applied to finite element methods. In Proceedings Conference on Use of Digital Computers in Structural Engineering, University of Newcastle, Newcastle, UK. (“This was a complete résumé of my ideas on isoparametric elements. Unfortunately, the organizers required that the length be halved, thus excluding the section on large deflections, etc.”).

Izumi, Y. and Otani, M. (2021). Relation between Direction-of-Arrival distribution of reflected sounds in late reverberation and room characteristics: Geometrical acoustics investigation. Applied Acoustics, 176, p.107805.

Settles, G.S. (1997). Visualizing full-scale ventilation airflows. ASHRAE J, 39(7), pp.19-26.

Vollmer, M. and Klaus-Peter, M. (2017). Infrared thermal imaging: fundamentals, research and applications.

Ward, G. (1998). Radiance, viewed 04 April 2023, https://www.radiance-online.org/.

Pluvial Flooding in Compact Neighborhoods: Dynamic Analysis for Climate-Adaptive Buildings and Urban Spaces

Michele Morganti, Simona Mannucci and Ilaria Fiocchi

Mediterranean compact cities are increasingly at risk because of climate change and, in particular, extreme rainfall events. The increased intensity of these phenomena poses a significant threat in terms of infrastructure damage and human loss. The proposed work aims to create an unambiguous methodological process that can be repeated in any context and at any geographic scale to create adaptive urban planning and reduce pluvial flooding risk, within compact urban fabric. The realized process creates a dynamic simulation of rainfall flows within the urban fabric, depending on topography, housing density and the presence of permeable surfaces. This parametric simulation allows to highlight buildings and areas exposed to risk from extreme rainfall events, through iterative analytical processes. The research highlights suitable urban spaces for introducing sustainable drainage systems and nature-based solutions useful to reduce environmental, social and economic damage from heavy rainfall and subsequent flooding.

Urban climate change

Since the advent of the Anthropocene, cities have been particularly susceptible to climate risks, but nowadays is getting increasingly evident due to frequent extreme climate events: flash floods and hailstorms, floods, intense heatwaves, droughts, etc. (Folland et al. 2001). Counteracting the urban climate risk is of paramount importance due to implications for the safety and health of individuals, as well as the significant economic costs associated with damages to infrastructure and urban areas. Floods, in particular, are closely linked to hydrogeological disasters and the expansion of urban land use, contributing to increasing hydraulic risk in urban areas (Bonanni, 2020; Bonanni 2020). Currently, research debate in the urban planning and design fields seeks to explore cutting-edge approaches to conceive new methods and tools to better grasp and analyze the inherent complexity of floods dynamic in urban areas (Naboni et al. 2019; Mannucci, Morganti, 2022).

In Europe, The European Climate Action forms a comprehensive framework for promoting the above-mentioned debate and reaching objectives on sustainable development, resilience, and climate action, following the United Nations Framework Convention on Climate Change and The Sustainable Development Goals (SDGs) 11 and 13 (UN, 2015; Guterres, 2020). The European Climate Action further reinforces these goals by offering specific policies, strategies, and funding mechanisms to support climate change mitigation and adaptation efforts across the region. European nations strive to achieve sustainable urban development, foster environmental-friendly communities, and enhance climate resilience. The SDGs and the European Climate Action are guiding principles, providing a roadmap for policy formulation and implementation and encouraging research and innovation in sustainable design solutions and practices.

This study focuses specifically on urban flooding – a phenomenon closely linked to average temperatures rise – which recently occurs at an increased rate and extreme intensity, exposing urban areas to high risks.

The escalating process of urbanization contributes to flood vulnerability due to the extensive concentration of impermeable areas, impeding the natural cycle of accumulation and discharge of water into the aquifers, and disrupting the natural processes of water runoff (Rosso et al., 2019).

The scientific literature on urban climate change highlights the importance of adapting cities to cope with extreme events. Namely, the urban system should accommodate rapid changes facilitating a swift recovery of usual activities. This concept is closely associated with resilience, often translated into architectural and urban design measures to enhance public spaces' spatial and thermal quality (Folland et al., 2001; Folland et al., 2001). Since the 20th century, developed countries have formulated policies and strategies to address water-related issues, progressively shifting their approach from excluding to making room for water in urban areas.

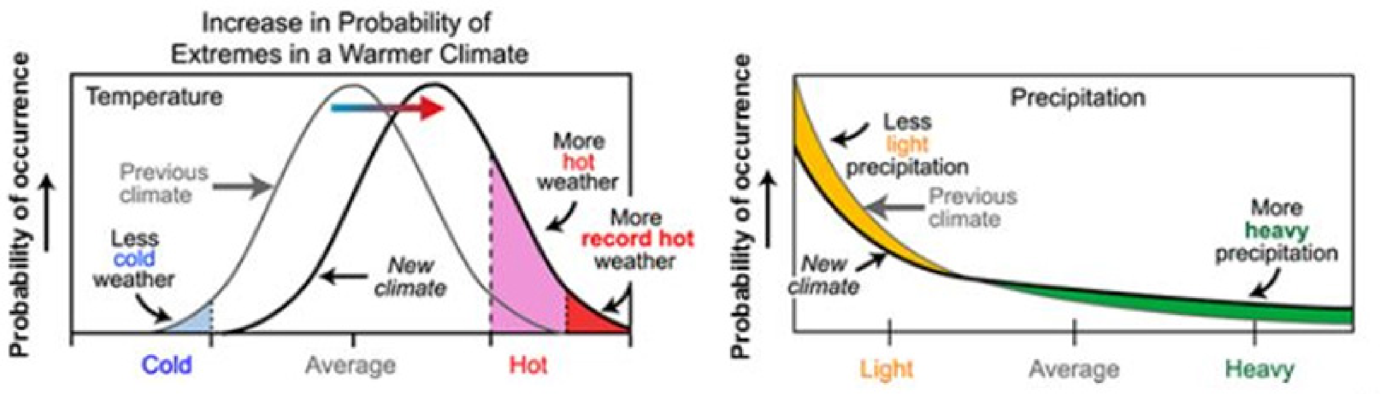

Figure 1- Folland C. K., Karl T.R., Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of Intergovernmental Panel on Climate Change - Curves illustrating the causes of increased hydraulic risk.

These strategies aim to achieve an integrated system of urban water management (IUWM) (Schuetze, Chelleri 2013) encompass practices of best management (BMPs), low-impact development (LID), water-sensitive urban design (WUSD) (Lloyd, Wong, and Porter, 2002), sustainable urban drainage systems (SuDS) (Griffiths, 2016) and Sponge City (Chan et al., 2018).

Notably, the Sponge City project was introduced following the Beijing flood in July 2012 by Professor Kongjian Yu, Turenscape's founder, and a Peking University professor. This new concept for cities is based on the idea of allowing pluvial water to infiltrate the ground, be retained locally, and be used for the city's water supply. By reducing the flow rates and increasing the collection times of the sewer system, the water reaches the final receiving bodies with a delay, thereby reducing peak flows and the risk of flooding (Nguyen et al., 2020). This concept has spread globally, including in Europe; Berlin became the first European city to embark on this path in 2016. The core idea is to enable the city to balance the effects of urbanization, such as reduced soil permeability, implementing sustainable urban drainage systems (SuDS), managing stormwater effectively, and restoring the hydrological balance. The main solutions involve natural-based approaches (NBS) (Zandersen et al., 2021) that have a low impact but are widely integrated into the urban fabric. Broadly speaking, we can summarize the three-fold objectives of Sponge City as follows: Firstly, it aims to control urban flood disasters. Secondly, it seeks to improve water quality through self-purification systems, which have additional co-benefits for public health and microclimate. Lastly, the concept aims to recycle rainwater and transform it into a valuable resource for use during periods of drought.

In this perspective, in Europe, several cities have taken measures to address the issue of hydraulic risk by transforming urban plans into climate adaptation plans (Reckien et al., 2014). For example, cities such as Amsterdam, Rotterdam, and Copenhagen have developed master plans using analytical models to identify areas within the cities where excess rainfall accumulates during heavy rain events. These areas have been classified according to different risk levels, which have led to the identification of interventions to be implemented in terms of infrastructure and environmental modifications. These strategies have resulted in a shift in approach by local administrations, moving from a purely hydraulic focus to a functional one, investing in urban spaces and buildings to improve the quality of urban environments and the lives of

citizens holistically. In Barcelona, conversely, due to its rigid urban fabric, a system for collecting rainwater has been developed using underground storage tanks, supporting the process of greening neighborhoods by acting on urban spaces and road networks to increase security and health for citizens and urban quality. A similar system has been planned for the city of Paris, which, in addition to utilizing sustainable urban drainage systems, has also focused on citizen awareness projects (Bassolino, 2019).
Despite frequent extreme weather events followed by catastrophic consequences in Italy, the adaptation process is still in its early stages. The cities of Milan and Rome have joined organizations, such as 100 Resilient Cities and C40 Cities Climate Leadership Group, which seek to define strategies for adapting cities to climate change. The only regulatory instrument in Italy is the 'Flood Risk Management Plan' established by Directive 2007/60, approved by the European Parliament and Council, and implemented into Italian law by Legislative Decree 49/2010The directive sets common guidelines for all member states to develop maps representing flood hazards and risks and to prepare a specific Flood Risk Management Plan. The directive also requires that the plan be prepared at the level of River Basin Districts: Eastern Alps, Po River, Northern Apennines, Central Apennines, Southern Apennines, Sardinia, and Sicily. Flood risk management is expected to be prioritized in areas with a significant potential risk of flooding or where such risk is likely to occur. The plan establishes four measures to reduce the negative consequences arising from the significant potential risk of floods: prevention, protection, preparedness, and return to normal conditions. Furthermore, it divides the territory into River Basin Districts, which identify hydrographic basins characterized by homogeneous areas.
Nevertheless, despite the growing attention to urban climate change is promoting new methods and paradigm shifts from the usual design planning conceptions, there is currently a lack of a multiscale approach, that allows for a unified treatment of the issue, regardless of the specific area or desired scale. To address these limitations, we propose a novel workflow based on a constellation of digital tools. The workflow enables the dynamic simulation and interactive representation of extreme rainfall events in urban areas, highlighting the most vulnerable buildings and areas using parametric software and color gradients. For this study, we selected a relevant case study to explore the potential of the proposed workflow, analyzing and addressing the issue of hydraulic risk in compact Mediterranean cities. Specifically, we focused on the River Basin District of Central Apennines, the Tiber River basin, and the city of Rome. In the following sections, we introduce and discuss the case study characteristics and the workflow application, highlighting current limitations and potential for further research and planning outlooks.

Pluvial flooding in the compact city

For the application of the workflow presented in this study, we selected relevant case studies in the Metropolitan City of Rome. The most vulnerable areas within the Grande Raccordo Anulare (the ring road motorway that surrounds the city), have

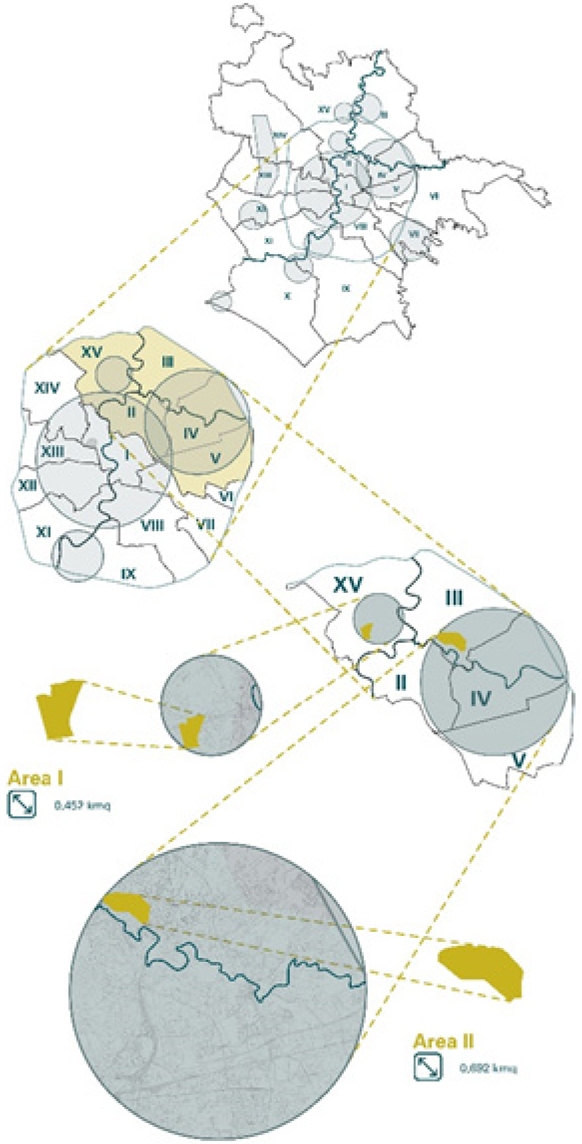

Figure 2 – Keyplan of selected areas in Rome (IT).

been identified by overlapping territorial maps, containing classes of hazard and the Areas at Significant Risk.

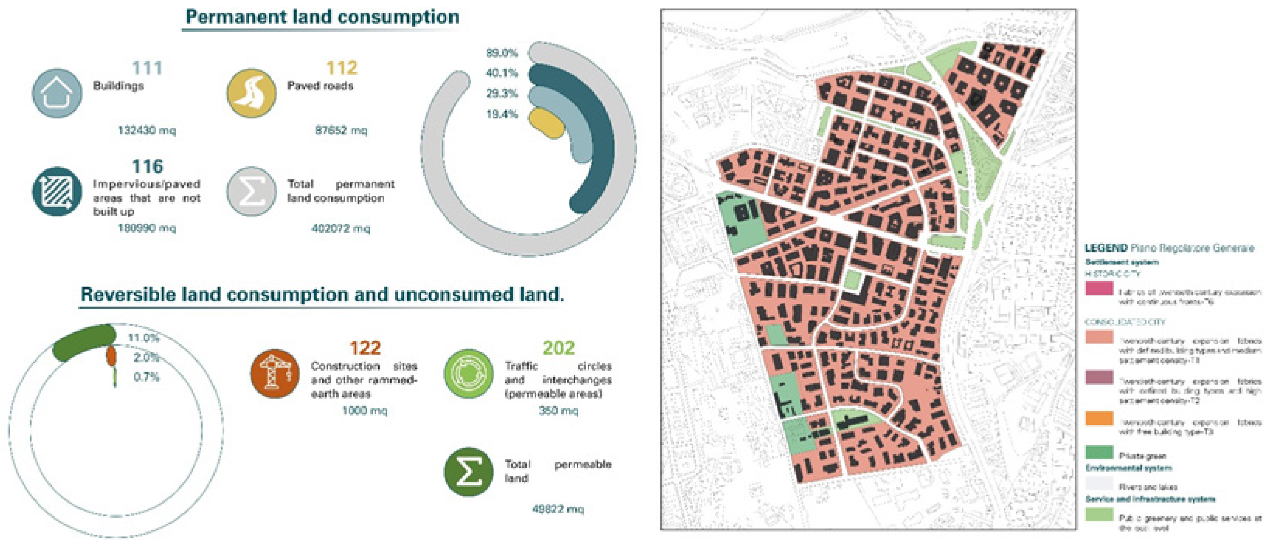

Figure 3 - Example of urban analysis and associated metrics of the Conca D'Oro area

Estimating the number of inhabitants and assets exposed to risk, along with the classification of water bodies, the set of measures adopted for the area, and the cartography of the Master Plan for Hydrogeological Planning, enable the identification of specific Areas at Significant Risk where a priority risk management must be implemented. The outcome highlighted two distinct areas with high vulnerability to flash floods: Significant Risk Areas INT-TEV-7 and INT_ANI-PRA-TOS-1 in the III and XV Municipalities, corresponding to the Conca D'oro and Tor di Quinto neighborhoods. Both the urban texture are characterized by a compact pattern, consistent with the definition provided in the General Master Plan of the City of Rome in 2008.

An analysis of the territory was conducted on these areas using open data provided by the Institute for Environmental Protection and Research (ISPRA). The analysis shows that the surfaces with a permanent land consumption level (89%) are higher than permeable areas.
In these areas, an urban form analysis based on the Spacemate method was developed (Berghauser Pont, Haupt. 2010). This method relates density metrics and urban form through four main variables: base land area, network length, gross floor area, and footprint. These variables generate density indicators such as floor space index and gross space index, allowing for a parameterized description of the city. Based on numerical analysis – despite having different footprints and heights – the analyzed areas fall into the class medium-height row buildings (E). This analysis also enables the correlation of these parameters with others, establishing relationships between the qualitative characteristics of urban form, energy performance, environmental aspects, heat island effect, and comfort.

High-resolution dynamic modeling

The focus of the work has been on the development of a high-resolution methodological process for identifying buildings and areas at higher hydraulic risk in an urban context through dynamic simulation of rainfall phenomena.
This simulation was developed through six main steps:

1. Data gathering was carried out on the National Geoportal and the ISPRA website for spatial data suitable for Geographic Information System tools (QGIS). These data

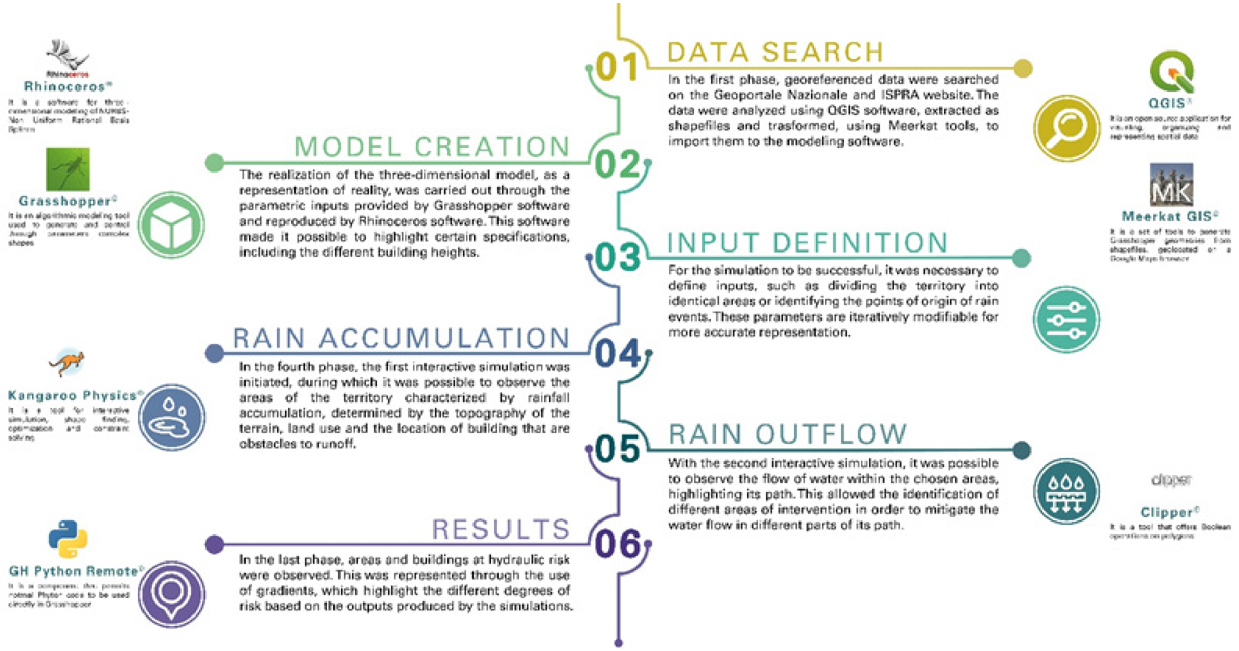

Figure 4 - Workflow for the dynamic simulation of hydraulic risk in urban areas following extreme rainfall events.

were transformed into shapefiles and used for the model through Meerkat (a plugin that generates geometries for the Grasshopper software from geolocated shapefiles on a Google Maps browser).

2. The obtained data were used for creating the model on the Rhinoceros interface through processing performed using Grasshopper.
3. To obtain a reliable simulation, prespecified input parameters, e.g. the parts dividing the area, were considered that can be iteratively modified for a more accurate representation.
4. Following these steps, the first interactive simulation was conducted to identify rainfall accumulation areas. These areas are determined by the terrain topography, land use, and the position of buildings, which obstacles the runoff.
5. The path of stormwater runoff is highlighted in the second dynamic simulation.
6. Finally, the simulation makes it possible to visualize buildings at higher hydraulic risk through color gradient maps.

The data gathering focused on three different types of information and associated sources:

- A Digital Elevation Model (DEM) provides the necessary data to generate georeferenced terrain topography through the open-source software QGIS.
- Land use data provided by ISPRA
- Building datasets provided by the National Geoportal to create georeferenced maps

Based on these data, after further file format modifications, into shapefiles, it was possible to create a georeferenced and interactive three-dimensional model of the areas of interest using Grasshopper software and displayed it on the Rhinoceros interface.
Once the model was created, the initial parameters were defined to divide the topography into equal areas and determine the number of elements composing the simulation. This determines the simulation's accuracy level, which can be modified later for a representation closer to reality.

Pluvial flooding in compact neighborhoods

In case studies, the topography was divided into a grid of 90x90 sectors, resulting in 8,100 elements constituting the meteoric water, each located at the center of each zone, symbolizing the rainfall event represented by the simulation. By initiating the dynamic simulation, the elements, represented by spheres associated with a rainfall intensity derived from pluvial data, accumulate in certain zones based on the topography and the presence of buildings or permeable areas, symbolizing the rainfall event in a specific zone.
As mentioned, a more detailed simulation was then carried out, taking into account the final accumulations of meteoric water and the actual pathway within the urban fabric. This process highlights areas most affected by the runoff of pluvial water, which allows the identification of effective urban design strategies not only in the accumulation areas but also along the entire runoff pathway.

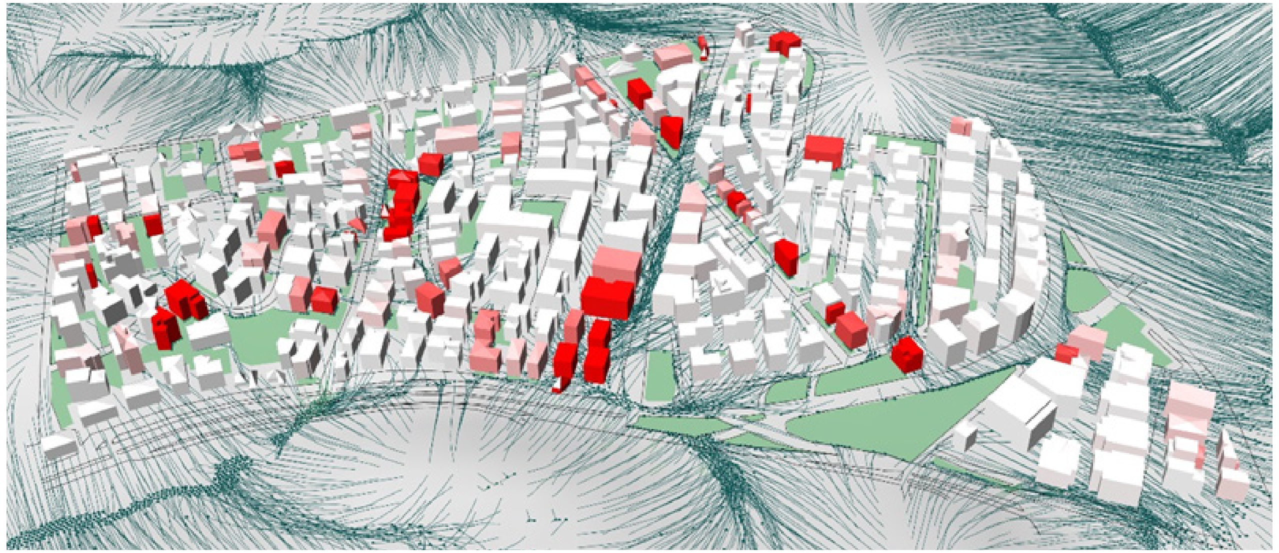

Figure 5 - Step 4. Rainwater accumulation at the end of the first dynamic simulation in the reference area – 'Significant risk area I-INT-TEV-7'.

Figure 6 - Step 6. Results of the buildings subject to greater hydraulic risk within reference area I represented with color gradients - 'Significant risk area I-INT-TEV-7'.

The process allows the accurate visualization of buildings at higher hydraulic risk. The representation is achieved through color gradients based on the results of the dynamic analysis. Grasshopper software can track the elements that reach different buildings during a pluvial event's timelapse and represent them with a color scale. Once the simulation is completed, this results in a comprehensive representation of buildings at higher hydraulic risk. In addition, based on the simulation results, the areas subjected to a higher water concentration were identified. This was achieved through Surfer software, which allowed for representation using contour lines, also characterized by color gradients. These contour lines were obtained using values derived from the spatial distribution of water elements at the end of the simulation, representing the amount of water affecting individual buildings and urban spaces after a rainfall event.
To establish soil permeability and the presence of aquifers, the method is based on a hydrogeological analysis using maps of the considered areas.

For the definition of sustainable urban drainage systems, we considered the different types of spaces commonly found within the European compact city: main and secondary urban streets, squares and gardens, parking lots, and private courtyards. After the identification of the different spaces within the selected neighborhoods, we assessed how the implementation of SuDS (Sustainable Drainage Systems) can be achieved based on the specific needs of different urban spaces(Mannucci et al., 2022).

Figure 7 - Significant pluvial flood risk gradients in case studies.

Among the applications of SuDS at the urban scale, we selected detention basins. These basins are designed to collect and temporarily store excess water, thus reducing the volume of water that flows into the sewer system. Specifically, to proceed with the basin sizing, we considered the rainfall intensity through a statistical analysis that defines the probability rainfall curves, which vary based on the return period. The intensity was considered constant during the rainfall event to define a rectangular design hyetograph. Furthermore, we calculated the flow rate at the closing section using the inflow factor. In line with the scope of the project, this coefficient has been considered as 0.3 in permeable areas and 0.8 in impermeable areas to make the calculation more realistic compared to the values provided by the simulation (taking into account the inflow coefficient as 0 in permeable areas and 1 in impermeable areas). An additional step to evaluate the correct sizing of the basin is the assessment of the kinematic method, and calculation of the critical event, defined as the duration required for water to travel from the furthest point within a watershed to the outlet of the watershed.

To quantify the volume of the detention basin, we relied on the Rational Method (Metodo delle sole piogge o formula razionale)(Guo, 2001), considering the principle of hydraulic invariance as requested by the Italian Flood Risk Management Plan. From a quantitative perspective, the inflow basin of a detention basin consists of various elements that reach the area of interest at the end of the process, some of which are located in the impermeable zone and others in the permeable zone. Therefore, in addition to graphically and numerically identifying buildings and areas subject to higher hydraulic risk, the developed process can also be used for sizing the storage volumes of various sustainable urban drainage systems.

Climate-adaptive neighborhoods

The proposed workflow has been tested through the dynamic analysis of two typical compact neighborhoods in the city of Rome, as it has been tailored to studying the compact city model and its response to extreme pluvial flooding. The approach at the base of the workflow and the associated method explores the potential innovative digital tools for supporting dynamic studies on pluvial flooding and hydraulic risk analysis in urban areas. The main characteristics and associated advantages of this approach are:

High-resolution analysis: we obtain to investigate the spatial distribution and read associated gradients of hydraulic risk at the neighborhood scale according to the characteristics of the urban fabric.
Digital tools integration: we combine existing digital tools for architects and engineers intending to collect necessary data and properly develop the modeling and visualizing results (QGIS, Rhino, and Grasshopper plugins)
Design-oriented: we offer non-specialized designers the possibility to include pluvial flooding analysis in their professional practice by providing an approach based on widely-spread digital tools and using visualization as a powerful tool for clearly communicating the result of complex analysis; moreover, the Grasshopper parametric design platform has been selected as it is becoming increasingly the more diffused design environment that provides open-source plugins for building and urban environmental analyses.

Grasshopper has the potential to include and analyze different environmental phenomena; therefore, the same workflow could be applied for further assessments relying on several plugins requiring a specific dataset. By producing evidence-based maps and visual scenarios, urban spaces and buildings that are more exposed to hydraulic risk during extreme rainfall events can be identified. This can assist designers and decision-makers in formulating strategies to prioritize and spatial-defining solutions to facilitate climate change adaptation by introducing sustainable urban drainage systems. The implementation of these systems helps reduce hydraulic risk while simultaneously improving the quality of urban spaces, safety, and residents' well-being throughout the year (Masseroni et al., 2018; Masseroni et al., 2018).

References

Bassolino, E. (2019). The Impact of Climate Change on Local Water Management Strategies. Learning from Rotterdam and Copenhagen. Journal of Urban Planning, Landscape & Environmental Design, 4(1), 21–40. http://upland.it

Berghauser Pont, M., & Haupt, P. (2010). Space, Density and Urban Form. TU Delft.

Chan, F. K. S., Griffiths, J. A., Higgitt, D., Xu, S., Zhu, F., Tang, Y. T., Xu, Y., & Thorne, C. R. (2018). 'Sponge City' in China—A Breakthrough of Planning and Flood Risk Management in the Urban Context. Land Use Policy, 76(March), 772–78. https://doi.org/10.1016/j.landusepol.2018.03.005.

Folland, C. K., Karl, T. R., Christy, J. R., Clarke, R. A., Gruza, G. V., Jouzel, J., Mann, M. E., Oerlemans, J., Salinger, M. J., & Wang, S. W. (2001). Observed Climate Variability and Change. Climate Change 2001, 99.

Griffiths, J. (2016). Sustainable Urban Drainage. Reference Module in Earth Systems and Environmental Sciences. https://doi.org/10.1016/B978-0-12-409548-9.10203-9.

Guo, J. C. Y. (2001). Rational Hydrograph Method for Small Urban Watersheds. Journal of Hydrologic Engineering, 6(4), 352–56.

Guterres, A. (2020). The Sustainable Development Goals Report 2020. United Nations Publication Issued by the Department of Economic and Social Affairs, 1–64.

Lloyd, S. D., Wong, T. H. F., & Porter, B. (2002). The Planning and Construction of an Urban Stormwater Management Scheme. Water Science and Technology, 45, 1–10.

Mannucci, S., & Morganti, M. (2022). Il DMDU per Contrastare Le Fragilità Climatiche. Un'Integrazione Con Il Progetto Rigenerativo. Techne, no. 23, 45–53. https://doi.org/10.36253/techne-12136.
Mannucci, S., Rosso, F., D'Amico, A., Bernardini, G., & Morganti, M. (2022). Flood Resilience and Adaptation in the Built Environment: How Far along Are We? Sustainability, 14(4096), 1–22. https://doi.org/https://doi.org/ 10.3390/su14074096.

Naboni, E., Natanian, J., Brizzi, G., Florio, P., Chokhachian, A., Galanos, T., & Rastogi, P. (2019). A Digital Workflow to Quantify Regenerative Urban Design in the Context of a Changing Climate. Renewable and Sustainable Energy Reviews, 113(July), 109255. https://doi.org/10.1016/j.rser.2019.109255.

Nguyen, T. T., Ngo, H. H., Guo, W., & Wang, X. C. (2020). A New Model Framework for Sponge City Implementation: Emerging Challenges and Future Developments. Journal of Environmental Management, 253(May 2019), 109689. https://doi.org/10.1016/j.jenvman.2019.109689.

Reckien, D., Flacke, J., Dawson, R. J., Heidrich, O., Olazabal, M., Foley, A., Hamann, J. J. P., et al. (2014). Climate Change Response in Europe: What's the Reality? Analysis of Adaptation and Mitigation Plans from 200 Urban Areas in 11 Countries. Climatic Change, 122(1–2), 331–40. https://doi.org/10.1007/s10584-013-0989-8.

Rosso, F., Mannucci, S., Morganti, M., Mariani, S., & Ferrero, M. (2019). The Effect of Sustainable Urban Drainage Systems on Outdoor Comfort and Runoff. https://doi.org/10.1088/1742-6596/1343/1/012023.

Schuetze, T., & Chelleri, L. (2013). Integrating Decentralized Rainwater Management in Urban Planning and Design: Flood Resilient and Sustainable Water Management Using the Example of Coastal Cities in The Netherlands and Taiwan, no. May 2015. https://doi.org/10.3390/w5020593.

UN. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. Vol. 22. https://doi.org/10.1163/15718093-12341375.

Zandersen, M., Oddershede, J. S., Pedersen, A. B., Nielsen, H. Ø., & Termansen, M. (2021). Nature Based Solutions for Climate Adaptation - Paying Farmers for Flood Control. Ecological Economics, 179(February 2020), 106705. https://doi.org/10.1016/j.ecolecon.2020.106705.

Association Between Spatial Characteristics of Courtyards in Different Historical Periods and Microclimate. A Case Study from China

Qian Zhang

The extreme heat events in cities appear with an increasing frequency, which is more intense in the old urban areas with chaotic construction conditions. Scholars have proved that microclimate can be optimized by changing the spatial characteristics of buildings. However, most of these conclusions were drawn from the analysis of the current urban space. To explore the influence of spatial changes that can reflect the real living needs of residents on microclimate, we simulate the summer microclimate of a courtyard in different historical periods, which is the first time that one residential courtyard with a time span of more than 400 years has been used for simulation research. Then the correlation between courtyards with different spatial characteristics and their microclimate is analyzed. The results suggest that the average daytime temperature of the courtyard in the east-west direction is lower than that in the north-south direction. In addition, the increase in the height of surrounding buildings will lead to a rise in the average daytime temperature in the courtyard. For courtyards with openings in different positions, the average daytime temperature in the courtyard with only one opening in the direction of prevailing wind is the lowest, while that of the enclosed courtyard without opening is the highest. This research gives fully consideration to the reflection of the changes in the living needs of residents in different periods on the spatial characteristics.

Matthews, T. (2023). Greenovation: Urban leadership on climate change, by Joan Fitzgerald. Journal of Urban Affairs, 45(8), 1532-1533. DOI: 10.1080/07352166.2022.2162783

Pagani, R. (2011). Efficienza energetica e innovazione nei sistemi urbani: i trend che sfidano la crisi = Urban energy efficiency: a breakthrough vs. the global crisis. Techne: Journal of Technology for Architecture and Environment, 1(1), 54-61. Firenze University Press. DOI: http://digital.casalini.it/10.1400/186293

Rogora, A. (2021). New proposals for sustainable design: The imitation game as an experience of shared co-design. In Sustainability in Energy and Buildings 2020 (pp. 527-537). Springer Singapore.

Tozzi, L. (2023). L'invenzione di Milano. Culto della comunicazione e politiche urbane. Cronopio, Napoli.

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Urban settlements are constantly increasing, and we are approaching a point where over half the human population will live in cities. This human concentration gives rise to complex problems, ranging from pollution to difficulties providing resources to sustain the inhabitants' lives. This situation results in low resilience of urban settlements to events that may affect the territory and the settled society. The complexity of consumption patterns and the flows of energy and matter in transit (inflows and outflows) require a profound rethinking compared to the past, as these flows differ in magnitude and complexity. This book, New Energies for the City, represents an initial attempt to reflect on the complexity and specificity of urban metabolism, as well as on potential solutions to address and transform the identified critical issues into possible elements for mitigating problems. New Energies for Cities explores the challenges and opportunities related to the transition towards more sustainable and resilient cities, with particular reference to Milan.

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