

DESIGN FOR NATURE-BASED, CLIMATE-ADAPTIVE, EQUITABLE STREETSCAPES' REGENERATION

Alessandro Raffa^a

^aUniversity of Basilicata, Matera, Italy

How to cite

Raffa, Alessandro. "Design for Nature-based, Climate-Adaptive, Equitable Streetscapes' Regeneration" In *Proceedings of 4th Valencia International Biennial of Research in Architecture. Wellbeing for all*. Valencia. 2024. <https://doi.org/10.4995/VIBRArch2024.2024.18313>

ABSTRACT

Climate change disproportionately impacts vulnerable populations with limited resources for adaptation. Yet, cities are at the forefront of climate adaptation, using urban design to address both current and future climate challenges while promoting equity in development. Innovative cities are implementing Nature-based Solutions to transform infrastructures into urban commons, enhancing livability and well-being for all residents. Streetscape design is particularly crucial in creating greener, climate-sensitive, and inclusive urban environments. However, medium-sized and small cities in the Southern European Mediterranean region have not fully leveraged these opportunities, and existing design research lacks innovation. To bridge these gaps, this EU-funded research seeks to establish design principles and procedures for mainstreaming nature-based, climate-adaptive, and equitable streetscape regeneration in smaller cities. Utilizing a research-by-design methodology—comprising research about design, research by design, and research for design—this study will formulate a design oriented operational methodology, which will be tested and refined through design-driven experiments in Matera, Southern Italy. This contribution will focus on one such experiment, discussing its limitations and advancements in developing the operational methodology to enhance

climate adaptation and social equity through nature-based urban streetscape regeneration.

KEYWORDS

Nature-based Regeneration; climate adaptation; equity; streetscape; design

1. INTRODUCTION

Urban streetscape regeneration has gained significant attention over the past two decades, recognized by scholars and cities as a key asset in adapting to climate change. The concept of urban regeneration, which has evolved over the last 30 years and is an elastic concept (Lehmann, 2019), has increasingly embraced global urban challenges. Drawing on the definitions of Paul Hawken's regeneration (2021) and Roberts (2000, 17), urban regeneration is viewed as an integrated design-oriented approach addressing climate, justice, biodiversity, and human well-being simultaneously. «Urban regeneration brings back underutilized assets and redistributes opportunities, increasing urban prosperity and quality of life. [...] urban regeneration ensures affordability, access to services and involvement of local residents to promote local economic development, [...] [enhance] public space [...] [as] a key

element of interventions, and [...] reduce environmental impact and GHG emissions». (UN-Habitat 2023) Streetscapes, in particular, are seen as one of the most underutilized public resources (NYC Public Design 2022, 9). Streetscapes is defined as the design quality of a streets, it includes its physical and aesthetic quality, encompassing buildings, surfaces, fixtures, and the socio-ecological dynamics they support (Torbay Council, 2004, 12). As urban regeneration evolves towards climate resilience and inclusivity, streetscapes are increasingly recognized as sites of climate inequality (Wartsila, 2023). Yet, their extensive presence in cities also presents opportunities to address climate change impacts, local inequalities, and enhance spatial quality and well-being. Framed within green city model (Green City Network, 2023), the regeneration of streetscapes through the Nature-based Solution (NbS) approach, has been explored across various disciplines and urban experiments. NbSs offer a means to address climate, environmental, social, and economic challenges, by protecting and managing natural or modified ecosystems, while simultaneously fostering human well-being, resilience, and biodiversity (UNEA, 2022).

2. LITERATURE REVIEW

In order to explore the present state of the art concerning the entanglements between climate adaptation, equity and nature-based regeneration of streetscapes from a spatial design perspective, a literature review has been conducted through Scopus and Google Scholar database, as well as through open-source international organization report and city's authorities plans and planning reports. The literature review focuses on contributions developed over the past 20 years, highlighting the growing interest and advancements in the field of streetscapes' regeneration, as well as current gaps.

This period marks significant progress in understanding the complex relationships between climate adaptation, equity, and nature-based regeneration within urban streetscapes. Studies conducted during this timeframe employ diverse methodologies, including analytical-comparative approaches (Steenbergen et al. 2008), experimental design (Nijhuis & Bobbink, 2012), and interdisciplinary research, which together provide a comprehensive overview of current design research. Klemm et al. (2017), through a participatory Research through Design approach, a set of guidelines for landscape architects to improve urban green infrastructure and addressing climate adaptation challenges, also working at the neighborhood street scale. Tamminga et al. (2020) propose a design-oriented methodology that systematically identifies and extracts a catalog of NbSs implemented at the interface between streets and buildings across ten European cities. This abacus of NbSs is designed to be adaptable and transferable to varying urban contexts, offering a versatile neighborhood-scale framework for the application of NbS in diverse environmental and spatial conditions through a participatory process. Hagen et al. (2021), within the context of an interdisciplinary project employing a Living Lab approach, introduce processes and strategies for the regenerative co-design of greener and climate-adaptive streetscape in a Wien densely populated neighborhood. This participatory framework, based on community engagement during the whole process and tactical urbanism actions, facilitates collaboration among stakeholders to develop sustainable and resilient urban solutions tailored to local environmental challenges and community's needs. Furchtlener et al. (2022), within a landscape design-led multidisciplinary research project, offer qualitative and quantitative guidelines for transforming Wien's streetscapes into sustainable urban spaces. Their work

focuses on integrating these streets into the city's green infrastructure to address climate change and ecological challenges, providing a framework for resilient urban development. Lotfata et al. (2023), by research through design methodology developed a conceptual study to test the feasibility of nature-based solutions into different street sections inside an informal neighborhood in Cairo. Moscatelli and Raffa (2023) through design-driven research explore the interconnection between neighborhood streetscape green regeneration, energy transition and climate change through NbSs design in arid climate.

3. KNOWLEDGE GAPS AND RESEARCH QUESTIONS

From a theoretical standpoint, research on nature-based streetscape regeneration is fragmented and underexplored. Despite its acknowledged potential for contributing to sustainable urban development, the subject remains insufficiently studied. Current literature rarely, if ever, addresses the intersection of climate adaptation, equity, and streetscape regeneration in a comprehensive manner. The fields of architecture and design are often marginalized, and their critical role in shaping the spatial dimension of nature-based streetscape regeneration, climate adaptation, and equity is frequently underestimated. Existing design and planning frameworks are limited in scope and fail to fully exploit the opportunities that arise from the convergence of these elements in urban streetscapes. From an applied perspective, research in this area has had minimal influence on practical applications and has not successfully mainstreamed climate-adaptive, equitable, and nature-based streetscape regeneration. Although some pioneering cities around the world have begun exploring these concepts in their urban design and planning processes (i.e., New York, Boston, Los Angeles, Copenhagen,

Rotterdam, Melbourne), only a select few have developed robust methodologies that can significantly enhance the quality and inclusivity of streetscapes at the urban scale. In addition to the primary objective of this literature review, several key considerations have emerged: (i) Geographical Asymmetry: Urban areas in the United States and Northern Europe are at the forefront of implementing and researching climate-adaptive, equitable, and nature-based streetscape regeneration. Their advancements not only exert substantial global influence but also contribute to the homogenization of urban landscapes. This trend raises concerns about the potential loss of local diversity and distinctiveness in urban environments as standardized practices become more prevalent. (ii) Urban Size: Large cities are at the forefront of climate-adaptive, nature-based regeneration efforts, whereas medium and smaller cities are lagging behind due to structural limitations, missing out on global trends in streetscape regeneration. This research seeks to address both the theoretical and operational gaps identified, leveraging design-based research to explore potential solutions. The following research questions have emerged: (a) What are the defining characteristics of climate-adaptive, equitable, and nature-based regenerative urban streetscapes? (b) What design methodologies, procedures, and tools can facilitate the mainstreaming of climate-adaptive, equitable, and nature-based streetscape regeneration in medium-sized cities in Southern Europe?

4. RESEARCH METHODOLOGY

The methodology is organized into three interconnected phases: Research About Design, Research by Design, and Research for Design. Each phase offers distinct insights while simultaneously informing and validating the others within a continuous

feedback loop. **Research About Design:** This initial phase entails a comprehensive literature review, coupled with case study analysis and comparison, to elucidate the characteristics of climate-adaptive, equitable, and nature-based streetscapes. Through a deductive approach, this phase aims to define (i) the essential attributes of such streetscapes and (ii) the design principles and procedures necessary for the regeneration of existing street spaces (see table 1). Findings from the literature review are progressively verified and enriched through the analysis and comparison of case studies, facilitating the development of generalized knowledge. Approximately 40 case studies from the hermeneutical circles of the U.S. and Europe have been selected, analyzed, and compared based on various themes and criteria. Additionally, 20 design guidelines and reports from different cities have been examined to gain insight into current design practices and procedures (Macaione et al., 2024).

Research by Design: The second phase leverages the findings from the initial phase, treating them as provisional insights to be tested further. This phase, where the interplay between design and research is critical, aims to establish a design-based operational methodology for Climate-Adaptive, Equitable, Nature-Based Regenerative Streetscapes. The city of Matera, Southern Italy, and its streetscapes, is envisioned as a prototype for medium-sized cities in Southern Europe, where to test and refine the operational methodology. Reserch by Design phase is made up of three integrative steps. The first step, which is analytical, involves an extensive mapping process to discern patterns of climate change and social inequality, focusing particularly on the city's green infrastructure. Building upon this urban analysis, the second step seeks to identify the city's most vulnerable neighborhoods and characterize their street networks through morpho-typological analysis. Vulnerabilities and

Themes	Parameters
Ecology & Biodiversity	Ecological connectivity; Green Infrastructure & NbS; Vegetation layering; Native vegetation; Wildlife habitat; resource quality
Climate Resilience	Stormwater management; Flooding mitigation; Heat mitigation; Drought resistance; Extremes preparedness
Mobility	Accessibility; Slow mobility; Multi-modality
Wellbeing & Health	Accessibility; Active transportation; Air quality; Noise reduction; Social Interaction & Cohesion; Food production; Experience
Social Equity & Inclusivity	Accessibility; Safety & Security; Social Equity; Cultural Sensitivity; Program; Empowerment
Energy & Smart	Reduce consumption; Energy efficiency; Smart Infrastructure; Smart Monitoring
Value Creation	Property Value Enhancement; Economic Development; Tourism & Recreation; Green Economy

Table 1. Nature-based, Climate-Adaptive, Equitable streetscapes. Space-related Criteria, Parameters, and definitions. Source: (Elaboration of the Author)

regenerative strategies will be developed at the neighborhood scale, integrating local knowledge to enhance relevance and applicability. The third step consists of an experimental co-design process aimed at proposing climate-adaptive and equitable nature-based strategies, which will be further refined through specific projects. **Research for Design:** The operational methodology will be informed and validated in the final phase, which seeks to explore future climate-adaptive, equitable, and nature-based design scenarios at the neighborhood scale. A set of design-oriented guidelines will result in order to support local authorities and design professional to innovate current practices. In the subsequent sections, a design-driven experimentation will be presented, situated at the intersection of the second and third phases. This experimentation aims to test and refine the operational methodology established in the Research by Design phase while incorporating issues relevant to the Research for Design phase, in alignment with the research feedback loops. The experimentation will navigate the operational methodology of phase two, proposing solutions at the neighborhood scale to effectively address the complexities inherent in urban streetscapes, while simultaneously validating and verifying the operational methodology, also from an applicational perspective.

5. NATURE-BASED, CLIMATE-ADAPTIVE, EQUITABLE STREETSCAPES REGENERATION DESIGN-DRIVEN EXPERIMENTATION. THE CASE OF A NEIGHBORHOOD IN MATERA, ITALY

The insights derived from the Research about Design phase have guided a design-driven experimentation in the Piccianello neighborhood, Matera. This neighborhood is significant for several reasons, as its streetscapes encapsulate the complexities

of the entire city, revealing both vulnerabilities and opportunities. Piccianello, one of Matera's historical districts, consists of various sub-neighborhoods, each exhibiting unique characteristics. Notably, it was home to the first modern residential complex built in 1935 to house individuals displaced from the Sassi, followed by the construction of the Spine Bianche neighborhood in 1965, which is recognized in Italian architectural discourse as a prominent example of post-WWII social housing. Nevertheless, Piccianello has also been adversely affected by urban deregulation and subsequent low-quality expansion. The streetscapes within Piccianello are spatially multifaceted, marked by a range of ecological, social, and economic vulnerabilities and inequalities that climate change is likely to exacerbate. The design-driven initiative to be discussed holds experimental value, aimed at verifying and refining the principles and testing procedures that emerged from the previous research phase. This initiative has been conceived as a year-long Urban Living Lab designed to develop an operational methodology.

5.1. Neighborhood Analysis between Adaptation and Equity

The urban analysis conducted for the Piccianello neighborhood integrated expertise from various disciplines to address climate adaptivity and social equity. The disciplines involved included urban planning, landscape architecture, environmental and climate science, social sciences, hydraulic engineering, and agronomy. Additionally, local knowledge was acquired from residents through participatory methods, like interviews and workshops. This trans-disciplinary and comprehensive approach enabled a detailed mapping and understanding of climatic and socio-ecological vulnerabilities, inequalities, and adaptation opportunities at the urban scale.

5.2. Mapping through a landscape-based approach

The complexity of the Piccianiello neighborhood was systematically analyzed utilizing a landscape-based layers approach. This methodology enabled the integration of diverse data sources and analytical frameworks, yielding a comprehensive assessment of the neighborhood's inequalities, needs, and opportunities.

Climatic and Socio-Ecological Vulnerabilities. The neighborhood was evaluated through multiple spatial layers, each representing distinct dimensions of climatic and socio-ecological vulnerabilities. This included mapping areas prone to extreme heat, drought and floodings, while identifying socio-economic disparities that could exacerbate these vulnerabilities. The spatial distribution of vulnerable populations—such as low-income households, elderly residents, and children—was also taken into account.

Adaptation Opportunities. In addition to identifying vulnerabilities, the analysis highlighted areas with potential for adaptation and improvement. Green spaces, underutilized areas, and existing infrastructures amenable to enhancement for improved climate resilience were mapped. This dual focus on vulnerabilities and opportunities aimed to balance immediate needs with long-term resilience design.

Intersection with Climate Data and Projections. Current climate conditions, including temperature variations and precipitation patterns, were spatially represented to establish a baseline understanding of the neighborhood's climatic conditions and their spatial impacts. Future climate scenarios, concerning heat stress, flooding and drought periods, were integrated into the analysis. This involved employing climatological models to project how these conditions might evolve over time, facilitating proactive design and intervention strategies. Present and projected climate data were

spatialized using Geographic Information Systems (GIS), which enabled a visual and analytical overlay with other information layers. This spatial representation facilitated the identification of high-risk areas and informed the prioritization of interventions.

Mapping Green Inequalities. To specifically address disparities in green space access. Tree canopy cover has been analyzed together with socio-economic and environmental factors, identifying areas with low canopy cover and a high need for greening initiatives.

5.3. Identification and Characterization of Critical Streetscapes

In conjunction with mapping vulnerabilities and opportunities at the neighborhood scale, the streetscape network was systematically classified according to typological criteria, identifying and characterizing critical streetscapes based on local contexts.

Streetscape Network Classification: The streetscape network was categorized into four typologies: (i) **Residential Streets**, which exhibit lower traffic volumes and higher pedestrian activity, allowing for greater potential for green interventions; (ii) **Commercial Corridors**, facing unique challenges due to elevated foot traffic and business activities; (iii) **Mixed-Use Streets**, which serve multiple functions and require flexible solutions to accommodate diverse activities; and (iv) **Arterial Roads**, which necessitate tailored strategies to manage high traffic volumes while enhancing green cover and resilience.

Streetscape Selection and Characterization: For each typology, a critical streetscape was selected based on specific criteria that considered unique challenges and opportunities identified in previous analyses. This criteria-supported approach facilitated localized analysis, ensuring that proposed interventions effectively address local vulnerabilities while promoting equitable outcomes. The following methods

were applied. (i) **Vulnerability Assessment:** Streetscapes were evaluated for susceptibility to climate impacts, such as heat stress, flooding, and air pollution, prioritizing areas with heightened vulnerability to maximize protective benefits from green infrastructure. (ii) **Equity Assessment:** An analysis of equity revealed streetscapes in socio-economically marginalized neighborhoods lacking access to green spaces. Streets with minimal tree canopy coverage and substantial enhancement potential were identified to ensure that proposed interventions benefit underrepresented communities. (iii) **Community Feedback Analysis:** Insights gathered from community meetings, workshops, and surveys provided qualitative data illuminating local priorities, concerns, and aspirations. This analysis emphasized the importance of aligning selected streetscape designs with residents' needs, fostering ownership and engagement in the decision-making process. (iv) **Flow Analysis:** An assessment of traffic dynamics, encompassing both pedestrian and vehicular movement patterns, was incorporated into the selection process to enhance the usability and accessibility of streetscapes while improving their environmental performance, climate resilience, and aesthetic appeal. (v) **Morphological Analysis:** The morphological assessment involved examining various spatial characteristics defining the urban landscape, including street width, building density, and existing green infrastructure, to identify potential constraints and opportunities for integration. (vi) **Streetscape Transect Analysis:** This analysis provided a nuanced understanding of the urban landscape across the selected streetscapes, enabling the identification of climatic vulnerabilities, socio-ecological inequalities, and emerging opportunities. The collaborative process ensured that selected sections reflected the values, needs, and aspirations of residents, enhancing the relevance and applicability of the proposed interventions.

5.4. Co-designing process for Streetscapes transformation

The criteria and parameters, as outlined in table 1, were employed to evaluate the generative sections and propose design solutions that align with local opportunities and constraints. These criteria also served as qualitative metrics to assess streetscape improvements both before and after the implementation of design outcomes. For each streetscape, three alternative design diagrams incorporating Nature-Based Solutions (NbS) were developed for each generative section. These designs underwent verification through iterative workshops with local residents. These collaborative sessions not only facilitated community input but also provided an opportunity to disseminate knowledge about the benefits of NbS. Moreover, they aimed to shift public perceptions regarding these techniques and promote their selection in a context-sensitive manner. The co-design approach fostered an iterative process that enabled the transfer of elements and solutions across different design options. This flexibility allowed for the progressive refinement of a shared proposed section, ensuring that the final design was both comprehensive and contextually relevant. Each generative section includes additional layers for understanding the anticipated transformations: (i) **Design Actions and Nature-Based Spatial Solutions.** Specific design actions were defined to integrate NbS spatial solutions effectively. (ii) **NbS Families and Techniques, Processes, and Benefits:** Utilizing the FELIXX classification framework (World Bank, 2021), various families and techniques of NbS were identified. This classification facilitated the selection of appropriate NbS tailored to each specific context, ensuring the solutions are both effective and feasible. The potential processes and benefits associated with the implementation of these solutions were also emphasized. (iii) **Three Tier Method.** Each section was designed to incorporate



Figure 1. Generative section of a residential streetscape in Piccianello, Matera. Streetscape Diagram with Nature-based Solution, Processes and Benefits. Source: (Author, 2024)

the Three-Tier Method, which delineates the implementation of interventions based on complexity, economic feasibility, and levels of community participation (UFEC, 2024). Actions are categorized into three tiers: Immediate, Intermediate, and Long-Term Actions. This phased approach effectively manages financial and logistical constraints while accommodating uncertainties inherent in the design process. By anticipating potential shifts that may impact the project, the design remains flexible and adaptive.

6. DISCUSSION

The design-driven experimentation conducted in the Piccianello neighborhood aimed to address the complex interplay of climate adaptability and social equity via NbS implementation through a transdisciplinary design-based approach to streetscape regeneration. From this experimentation some critical limitations had emerged that can suggest future research advancements. From a methodological standpoint, the

complexity of transdisciplinary integration presents significant challenges. Although the incorporation of diverse disciplines—such as urban planning, landscape architecture, environmental science, and social sciences—enriches the design process, it also increases the intricacy of collaboration. The diverse methodologies, terminologies, and disciplinary perspectives often result in communication barriers and misaligned goals. To mitigate these challenges, the development of a standardized, design-oriented framework for transdisciplinary collaboration is essential. This framework should incorporate integrated tools and establish a shared terminology, thereby fostering greater coherence and facilitating a more streamlined and effective design process. The limitations and potential future advancements will be examined and discussed below in relation to the three phases of the design experimentation. Concerning landscape-based mapping: (a) **Data Availability and Resolution:** The analysis heavily relies on available data, which can vary significantly in quality and granularity. As the experimentation in Piccianello has

shown, data may be outdated or not specific enough to capture localized vulnerabilities, undermining the accuracy of the assessment. Future advancements must prioritize partnerships with local institutions to ensure ongoing data collection and analysis, fostering a more responsive and informed approach. (b) **Qualitative Limitations in Vulnerability Mapping.** The experimentations also show how relevant is the integration of qualitative data throughout the whole process. Future iterations should integrate qualitative assessments in the neighborhood vulnerability mapping, to provide a more holistic view of the neighborhood's conditions. (c) **Reflection of Future Scenarios.** While current climate projections are incorporated into the analysis, the reliance on existing climatological models may introduce uncertainties regarding their applicability to local contexts. The dynamic nature of climate change necessitates more adaptive methodologies that account for evolving scenarios. Future methodologies could benefit from integrating participatory climate modeling that involves community stakeholders in envisioning potential future conditions. Concerning Streetscape selection and characterization: (a) **Improve typological categorization:** The current typological classification may oversimplify the complex interactions occurring within urban streetscapes. By categorizing streets into rigid typologies, the methodology may overlook the nuanced realities of mixed-use streets or the varying dynamics within a single typology. A more fluid categorization that reflects the variability and complexity of urban environments would enhance the robustness of the analysis. (b) **Improve the analysis of temporal dynamics.** The analysis had focused primarily on spatial conditions without considering the temporal dimensions of urban dynamics, such as seasonal variations in use or the impact of socio-economic changes over time. Longitudinal studies that account for these temporal aspects should be incorporated, allowing

for a more comprehensive understanding of the neighborhood's evolution. Concerning Co-design process for streetscape transformation: (a) **Community engagement:** future iterations should seek to deepen engagement by integrating community members into all stages of the design process, from ideation to evaluation. (b) **Challenges in knowledge transfer.** While workshops aim to disseminate knowledge about NbS, the effectiveness of this knowledge transfer can vary significantly among participants. Diverse levels of prior knowledge, interest, and understanding can lead to disparities in how well community members grasp the proposed solutions. Future methodologies should adopt design-based tailored educational approaches that cater to different audience segments, ensuring broader comprehension and engagement.

7. CONCLUSION

The design-driven experimentation in Piccianello underscores both the opportunities and challenges of developing nature-based, climate-adaptive, and equitable regenerative streetscapes. Overcoming these limitations requires a multi-method approach that includes improving interdisciplinary integration, strengthening community engagement, ensuring the quality of data, and developing flexible, context-responsive design strategies and solutions. Future research steps will focus on expanding experimentation to additional neighborhoods within Matera to further refine and validate the proposed methodology by applying it to different contexts. These experiments will provide critical insights into how the methodology can be adapted to diverse urban contexts within the city, allowing for a more nuanced understanding of local challenges and opportunities. Additionally, the research aims to establish a comprehensive operational framework that translates the

refined methodology into a practical toolbox. This framework will serve as a structured guide for local administrators and urban design professionals, facilitating the effective implementation of nature-based, climate-adaptive, and socially equitable interventions. By providing clear protocols, best practices, guidelines and scalable strategies, the framework will support decision-makers and designers in applying the methodology to real-world urban regeneration projects, ensuring that design solutions are context-sensitive and resilient over time. The framework will be also tested in comparable cities across Southern Europe and the Mediterranean region, to improve its applicability. The ultimate goal is to bridge the gap between theoretical research and practical application, empowering local authorities and design professionals to proactively address climate risks and urban inequalities while fostering sustainable and inclusive urban environments.

funds assigned to Basilicata University (PP4.3.1 - Green Shapes for the Urban Regeneration Processes, Environmental, Social, Cultural and Tourism Sustainability, Scientific referent: M. Mininni) - Technologies for climate change adaptation and quality of life improvement”, field of intervention “1. New approaches and design paradigms to insertion and development of “green shapes” in the cities, to raise the architectural and urban quality, the environmental, social and cultural benefits”, Code ECS00000009 – CUP C43C22000400006, Sc. Res. I. Macaione.

ACKNOWLEDGEMENTS

Research and writing was supported by the research: (i) Urban Green Shape (2022-2025), funded by PON R&I and FSE-REACT-EU. Axis IV “Education and research for recovery”—Action IV.4—“PhD programs and research contracts on innovation topics” and Action IV.6—“Research contracts on green topics” and FSE-REACT-EU; Research Contract number 38-G-14879-1, CUP C49J2104334000, carried out by A. Raffa, Sc. Res. I. Macaione; the investigation has been also nurtured by the research carried by out by A. Raffa as Fulbright Visiting Scholar at University of Florida, College of Design, Construction and Planning and FIBER-Florida Institute for Built Environment Resilience (August-February 2024). The research activity, from October 2023, is shared with B. Andaloro, post-doc researcher, funded by Next Generation UE - PNRR Tech4You Project

REFERENCES

- Cabaneq, A., Zingoni de Baro, M.E, and Newman, P. "Biophilic streets: a design framework for creating multiple urban benefits". *Sustain Earth* 3, no.7 (July 2020). Accessed June 5, 2024: <https://doi.org/10.1186/s42055-020-00027-0>
- Green City Network. "Charter for the Green City Urban Regeneration." Accessed May 5, 2024. <https://www.greencitynetwork.it/wp-content/uploads/CHARTER-FOR-THE-GREEN-CITY-URBAN-REGENERATION.pdf>
- Felixx, Gementee Groningen (2021), *New space for living. Design guideline - quality of public space*. Accessed February 2, 2024. <https://gemeente.groningen.nl/sites/groningen/files/2022-03/New-Space-For-Living---Quality-Of-Public-Space.pdf>
- Furchtlehner, J., Lehner, D., and Lička, L. "Sustainable Streetscapes: Design Approaches and Examples of Viennese Practice." *Sustainability* 14, no.2 (January 2022):961.
- Hagen, K., Totzen, T., Mienharter, E., Millinger, D., Ratheiser, M., and Formanek,S. *How to Make Existing Urban Structures Climate-Resilient?* Accessed June 3, 2024. https://www.corp.at/archive/CORP2021_38.pdf
- Hawken, Paul. *Regenerating. Ending the Climate Crisis in one Generation*. London: Penguin Books, 2021.
- Klemm, W., Lenzholzer, S., and Brink, A., van den. "Developing green infrastructure design guidelines for urban climate adaptation", *Journal of Landscape Architecture* 12, no.3 (February 2018): pp. 60–71.
- Lehmann, Steffen. *Urban Regeneration. A Manifesto for Transforming UK Cities in the Age of Climate Change*. Milton Park: Taylor & Francis, 2019.
- Lotfata, A., Cortesão, J., Zinsmeister, H., Steeneveld, G.-J., van Zeven, J., Taylor, Z., Tan, W., and Elkhateeb, S. "Climate adaptation in informal areas in hot arid climates." *Sustainable Development* 31, no.1 (July 2023): 777–794.
- Macaione, I., Raffa, A., Andaloro, B. "Climate-Adaptive Nature-Based Regenerative Urban Green Streetscapes: Design Exploration from the City of Matera." *Sustainability*, no. 16 (August 2024): 6811. Accessed June 5, 2024. <https://doi.org/10.3390/su16166811>
- Moscatelli, M., and Raffa, A. "Syn(En)ergies in neighbourhood regeneration. Al Safarat experimental laboratory in transition." *TECHNE - Journal of Technology for Architecture and Environment*, no.26 (October 2023): 94–102. Accessed June 5, 2024. <https://doi.org/10.36253/techne-14419>
- Nijhuis, S., and Bobbink, I. Design-related research in landscape architecture, *Journal of Design Research* 10, no.4 (2012): 239-357.
- NYC Public Design Commission. *Designing New York: Streetscapes for Wellness*. NY: NYC Public Design Commission, 2022.
- Roberts, Peter. "The Evolution, Definition and Purpose of Urban Regeneration." In *Urban Regeneration: A Handbook*, edited by Peter Roberts and Hugh Sykes, 9–36. London: SAGE Publications, 2000.
- Steenbergen, Clemens M., Meeks, Sehi, and Nijhuis, Steffen. *Composing Landscapes. Analysis, Typology and Experiments for Design*. Basel: Birkhäuser, 2008.
- Tamminga, K., Cortesão, J., and Bakx, M. "Convivial Greenstreets: A Concept for Climate-Responsive Urban Design." *Sustainability* 12, no.9 (May 2020): 3790.
- Torbay Council, *Torbay Streetscape Guidelines*. Torquay: Torbay Council, 2004.
- UFEC (2024), *LA Urban Forest Equity: Assesment, Tools, and Reccomendations*. Accessed June 10, 2024: <https://innovation.luskin.ucla.edu/wp-content/uploads/2024/04/Los-Angeles-Urban-Forest-Equity-Assessment-Tools-and-Recommendations.pdf>

- UN-Habitat. "Urban Regeneration." Accessed September 5, 2023. <https://unhabitat.org/topic/urban-regeneration>
- UNEA. "Nature-based solutions for supporting sustainable development-Resolution adopted by the United Nations Environment Assembly on 2 March 2022." Accessed June 5, 2024. <https://wedocs.unep.org/bitstream/handle/20.500.11822/39864/NATURE-BASED%20SOLUTIONS%20FOR%20SUPPORTING%20SUSTAINABLE%20DEVELOPMENT.%20English.pdf?sequence=1&isAllowed=y>
- Wartsila, Urban streetscapes: A Hotspot for climate-change inequality. Accessed May 5, 2024. <https://www.wartsila.com/insights/article/urban-streetscapes-a-hotspot-for-climate-change-inequality>
- World Bank (2021), *A Catalogue of Nature-Based Solutions for Urban Resilience*. Accessed June 10, 2024: <http://hdl.handle.net/10986/36507>