Designing with Nature Climate-Resilient Cities: A Lesson from Copenhagen

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Technological Imagination in the Green and Digital Transition

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Chapter 76
Designing with Nature Climate-Resilient Cities: A Lesson from Copenhagen

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Abstract Climate change is accelerating at a faster rate than previously anticipated, and a significant number of cities remain unprepared for this transition. There is a pressing need to reconsider the approach to the design of public spaces, directing attention towards the development of design concepts that can impart knowledge for adaptation to climate change. Landscape architects, through nature-based solutions, can emerge as key figures capable of regenerating urban spaces. The case study of this research is the city of Copenhagen, which has become the stage of the most innovative experiments to create climate-resilient urban spaces. It is evident that a multidisciplinary and site-specific approach can be the critical components for a successful transition. Such a transition necessitates innovative project management that involves the collaboration of municipalities, private stakeholders, and citizens. Natural-based solutions, through an ecosystem approach, can effectively address the environmental, social, and economic challenges presented by climate change.

Keywords Nature-based solution · Climate change adaptation · Landscape architecture · Urban design · Copenhagen

76.1 Introduction

Climate change is showing that our cities are still inadequate to respond resiliently to hazards (Roggema et al. 2021) such as flash floods or urban heat island, caused by the interaction of climatic factors and anthropic activities within cities (Panno et al. 2017). In the Mediterranean urban contest, rapid floods and heatwaves are among the main threats to human safety and well-being in European cities (Sanesi et al. 2011); specifically, the associated hot temperatures in urbanized settlements are becoming a significant public health challenge (Hajat and Kosatky 2010; Bosch and Ode Sang 2017).

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Considering that over 70% of Europe's population lives in cities and is expected to increase (Kabisch and Haase 2011), it is necessary to establish strategies for a healthier and less polluted urban environment for better well-being, by reconsidering the living space not limited to the residential unit, but the whole urban scale. Nature can be a mitigation tool both to increase urban resilience and to reduce psycho-physical problems generated by degraded places, that lack green areas (Bosch and Ode Sang 2017; Vries et al. 2003; Negrello and Ingaramo 2021). This would prevent socioeconomic inequality, offering all direct access to natural spaces and achieving equal resilience.

Studies on the regenerative potential of green space planning show that the use of nature as a design strategy contributes to improving urban conditions (Inostroza 2014) and approaching climate mitigation and adaptation goals (Kabisch et al. 2016). In Europe, urban planners have continuously advocated that nature and climate factors, proximity, and access to natural spaces should be integrated into sustainable urban planning (Fan et al. 2017; Gehl 2013).

76.2 Managing the Climate Transition

Climate impacts are expected to fundamentally change the way we live, and plan and design, our cities, and landscapes (Roggema et al. 2021). From policy to action, the architect plays a key role in the creation and management of adaptation and mitigation projects. In fact, in the last fifteen years, the architect's area of action in responding to climate change has broadened, no longer limited to the power of technology to make buildings more efficient but going on to re-consider the urban fabric as part of the metabolism that needs to be re-designed.

It is imperative to go beyond the logic of the individual building. This approach, although aiming at maximum local energy efficiency, does not contribute to generating an adequate impact on the urban energy transition goals in a decisive way because it tends to consider each building cell as a closed-loop system (Leone and Tersigni 2018); this reflection highlights the need for a shift in scale that involves individual building structures and public space in a comprehensive transition project that has an impact on the urban microclimate and, consequently, on energy consumption, the environment, and the well-being of citizens. A transition model based on this approach requires a professional figure capable of managing a transition that considers built and unbuilt, permeable, and impermeable layers, and natural and man-made surfaces. The role of the architect, and in particular the landscape architect, requires additional knowledge to deal with a new form of design that integrates urban and environmental needs, as they are two sides of the same coin. Today, we can see an evolution of this role which has become the emblem of a multidisciplinary player able to approach different scales of implementation.

At the same time, skills from different disciplinary fields (technology and humanities) and local engagement become indispensable building blocks for redefining an environment capable of influencing the microclimatic behavior of space and that of its inhabitants.

However, the challenge is not only related to the technical–technological aspects of this transition: once the concept of the machine city—whose objective is maximum efficiency, also referring to Le Corbusier's concept of the *machine à habiter*—has been abandoned, there is still the question of creating an environment that can meet the demands of citizens, promoting better well-being through the creation of an urban space designed using biophilic criteria.

The natural element does not only represent a decorative element or an urban planning standard but also a substantial climatic device for both public and built environment, to face the challenges of the new urban climate scenarios, and to create environmental conditions in symbiosis with the inhabitants (Eekelen and Bouw 2020).

The public space adaptation project becomes emblematic of developing site-specific solutions that transform these places into resilient urban systems. However, given the intensification of the impacts of climate change on urban areas, both now and in the future (according to the 2050 and 2100 scenarios studied by the IPCC in its annual reports), adaptation must be carried out in a capillary way, starting with the common urban fabrics, such as squares, small green areas, but also pavements, roofs, and not merely in the current green areas, which are already areas of resilience.

76.3 A Lesson from Copenhagen: Changing to Adapt

Among the European cities that have acted on morphological modification of urban space to increase the resilience of the built fabric, Copenhagen stands for having displayed interesting approaches and rapid transformations. The Danish capital represents a virtuous example of how climate change represents an excellent chance for urban development (Xu et al. 2021). Starting in 2011, the municipality to face the climate crisis has adopted a proactive plan to reduce the impact of future hazards, after the extreme cloudbursts that hit the Greater Copenhagen area on July 2, 2011, causing over DKK 6 billion in damage (Gerdes 2012). This flood has represented how future climate events could impact the city: It has been estimated that the costs of damage will be higher (DKK 18 billion) than DKK 16 billion based on an assessment of rainfall events in recent years (City of Copenhagen 2015).

In particular, the Copenhagen Municipality has launched three main plans:

- *Copenhagen Climate Adaptation Plan (2011)* Long-term and massive actions to strengthen resilience to extreme events by ensuring that stormwater is retained or discharged into the harbor and lakes, consequently reshaping a greener city and new jobs.

- *Cloudburst Management Plan (2012)* Prioritize cloudburst management efforts where the risk is greatest and where there is an opportunity for synergies with urban development in general
- *Climate Change Adaptation and Investment Statement (2015)* It describes the inputs, effectiveness, and challenges of the climate change adaptation plan (Xu et al. 2021). It also identifies the potential for urban space improvements in the districts (City of Copenhagen 2015).

76.4 Nature-Based Solutions as Strategical Action for Adaptation/Mitigation

The plans described are based on simple principles: prevent the damage, minimize the damage, and reduce the city's vulnerability. Following those principles, actions for adaptation and mitigation have been deployed, building on the ecosystem-based approach (EbA), from which the nature-based solutions (NBSs) derive and find bases (Eggermont et al. 2015). According to the EU Commission, NBSs are defined as actions that are inspired, supported by, or copied from nature; those have an enormous potential to be energy and resource-efficient and cope with the challenge of climate change in urban areas. The European Commission Directorate (Commission 2015) has identified solutions for reducing greenhouse gas emissions goals and helping to conserve and expand carbon sinks, which include: ecosystem restoration, greening of gray surfaces, and integrated broad-scale climate change mitigation and adaptation measures (Bosch and Ode Sang 2017). However, it is necessary to emphasize how these strategies have to be adapted to site-specific conditions to have results that provide economic, social, and environmental benefits (Commission 2015). Moreover, the NBSs are ecosystem services that play a critical role in promoting a cultural shift from a resource-intensive growth model toward a more resource-efficient, inclusive, and sustainable one. Those radical innovations involve actors from different sectors, domains, and scale levels in the co-design and co-implementation of solutions (Faivre et al. 2017; Meene et al. 2011), as in the case of Copenhagen, where negotiation and cooperation have been applied among multiple stakeholders (Xu et al. 2021).

76.5 Building the Resiliency: Case Studies in Copenhagen

The Danish capital has defined strategies and areas of urban regeneration, investing in the reconversion of public infrastructures, and ambitious projects of climate adaptation parks to respond to the heavy rainfall. Copenhagen has taken the opportunity to redesign its city considering water as a risk, firstly, but also as a resource and designing new attractive urban spaces. In this section, some case studies of resilient urban development based on NBS are presented, chosen for their esthetic, environmental, and inclusion qualities—values of the New European Bauhaus.

The Copenhagen adaptation project starts from a systemic vision of interventions in the public space. In the first phase, it has been defined an area particularly subject to climate risks: Østerbro. The idea was to create the first climate-resilient neighborhood within which to develop a series of urban redesign interventions to increase the quality of public space as well as ecosystem service. This plan expects to realize green spaces for 50,000 m^2 and slowly disconnect 30% of the stormwater from the underground mixed storm sewer network (City of Copenhagen 2016).

In 2013, the Danish firm Tredje Natur realized the masterplan for the project identifying major development areas characterized by low permeabilization: Skt. Kjelds Plads, Bryggervangen, and Tåsinge Plads.

Skt. Kjelds Plads and Bryggervangen (2016–2019). The projects, realized by SLA, transformed a congested infrastructure (the traffic circle Skt. Kjelds Plads and Bryggevangen road, Fig. 76.1) into a new green space and responsive to different climatic hazards, such as extreme heat waves or flooding. It has been designed with the idea of bringing a new nature into the city to benefit both the environment and the well-being of all citizens. The intervention has provided for the depavimentation of a large area around the traffic circle and along the avenue. The new retention surface hosts an ecosystem of 586 native trees belonging to the local biotype, which absorb CO_2 and pollutants. The Bryggevangen has been transformed into a "green corridor:" the new zig-zag green spots, that occupy part of the packing area, contribute to slowing down cars and increasing the detention area. The plaza of 34,900 m^2 is designed for containing and delaying rainwater in green spaces. As a result of this NBS approach, biodiversity has increased as well as new vibrant places have been built that improve health and quality of life for all the residents.

Tåsinge Plads (2014). The square represents the first climate change-adapted urban space in Copenhagen designed by GHB. Once 1.000 m^2 of flat asphalt has been transformed with a new land morphology: slopes of grass allow the rain collecting is conveyed to areas with moisture-tolerant plants that filter and absorb the rainwater in the storage facility, by reducing the pressure on the urban pipe network. The paths, built on a higher level, allow fruition even when the square is completely flooded. Nowadays, the project delays and infiltrates about 8.000 m^3 of rainwater from the site, making it the flagship of climate change adaptation projects in Copenhagen (Meene et al. 2011).

In Copenhagen, the NBS approach is becoming common in most future projects, such as the Hans Tavsen Park with Korsgade Avenue (Fig. 76.2); it involves the creation of a large green–blue infrastructure, a natural basin that intercepts and drains excess rainwater (18,000 m^3), subsequently purified and conveyed toward the Peblinge Sø waterway. The project (by SLA, Rambøll, and Dreiseitl) has been developed through a co-design process with non-profit associations and residents who will be able to use this space in different climatic conditions.

Fig. 76.1 Traffic circle Skt. Kjelds Plads and Bryggevangen road (Courtesy of SLA)

76.6 Conclusion

The use of NBS for urban design is a necessity for any designer to meet climate adaptation needs, as well as to reduce greenhouse gas emissions and pollutants. The case of Copenhagen represents how the management of natural resources becomes fundamental to designing new resilient public urban spaces. Green is not conceived as a mere necessity prescribed by urban standards, but the functionality of natural elements also responds to the need to create an environment that is resilient to extreme events, as well as providing an eco-systemic service. Outcomes of this approach are a better quality of life and well-being for the communities that live there.

Fig. 76.2 Hans Tavsen Park by SLA, Rambøll, and Dreiseitl (Courtesy of SLA)

The cases show how the approach is necessarily site-specific: the natural elements (from the choice of plants to the materials used) and the solutions adopted must respond to climate, culture, and local uses. It follows that the skills involved in those projects are vast, as demonstrated by the team of designers of the studio SLA and Trejed Nature. In addition to the technical and design aspects, the social and community aspects are fundamental in the design of a project that is also responsive to the needs of neighborhood life. In the climate-resilient neighborhood project, the contribution of co-design has involved the local Østerbro Environmental Center, the municipality, stakeholders, and over 10,000 residents who have developed a greater sense of belonging and community.

These projects have enabled the municipality to save money and have a more resilient city for future climate challenges, demonstrating how NBSs should be considered as key climate devices for both urban and architectural design.

This approach, common in northern countries, can be applied also in other extreme climatic contexts, such as the Arab Emirate, where it has been tested. Some projects, such as Al Fay Park in Abu Dhabi by SLA (Fig. 76.3), have shown that it is possible to reduce the temperature to encourage the creation of public places rich in biodiversity through NBS and material contextualized to the climate zone.

Fig. 76.3 Al Fay Park in Abu Dhabi by SLA (Courtesy of SLA)

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