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Commentary: Urban design initiatives to decrease the urban heat island effect

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ABSTRACT
This article provides a brief review of resources on strategies to decrease the urban heat island effect, mitigate extreme heat, and create urban infrastructure resilient to extreme heat. Key strategies are summarized along with data sources that enable local and specific site analysis. Examples of urban design projects illustrate the application of these strategies.

KEYWORDS
Cities; urban planning; environment

Introduction

As practicing architects and urban designers and architecture faculty members with secondary appointments in public health at the University of Miami, we see an increased level of public awareness and academic research on the topic of extreme heat events. Further, more specific attention is focused on the risks to human health in cities due to the urban heat island effect, the condition describing the process of buildings and pavements absorbing and re-emitting heat at a higher rate than more rural surroundings.

A colleague in Coral Gables, Florida, often shares her observations as she walks around the downtown area surrounding her apartment, with an eye on the impacts of the city's new housing and commercial development. During the hottest months of the year, she changes her path to walk along the nearby tree-lined residential streets. She often remarks on the notable temperature difference between the two locations. The primary difference between the two areas is the density of street trees that George Merrick, the early 20th-century founder of the city and his landscape architect Frank Button, planted throughout the city's 10,000 acres.

As buildings were added over successive decades, the original tree plantings continued to grow, resulting in the temperature-changing canopy for which we are grateful today. It also should be noted that the charm of the city's original Mediterranean-style buildings was partly due to their small scale, with narrow building sections designed for cross-ventilation, embellished and shaded by arcades and porches.

Merrick and Button were not alone in understanding the value of shaded streets. Mary Brickell, one of Miami's early leaders, platted Brickell Hammocks in the 1920s with roadways designed to be experienced as parks with a streetscape winding through the hardwood hammock of native trees. More recently, developer Craig Robins imported mature trees to plant throughout Miami's new Design District, introducing tree canopy along the streets, in its courtyards, and on rooftops to provide year-round, open-air comfort for the family-friendly retail destination. Yet, even with such historic and current examples throughout South Florida, acres of sunbaked pavements continue to contribute to urban heat island effects.

The risk that extreme heat poses for human health has taken a front-and-center position in media coverage of adverse climate impacts. Among the diverse and regionally differing effects that the inhabitants of a warming planet are forced to acknowledge, from increasing drought and wildfires

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to stronger storms and flooding, rising temperature and humidity levels represent the most commonly shared experience.

The topic has spurred government response, including publicly announced heat advisories that include humidity levels in heat projections and in some locations, regulations regarding water and shade provisions to minimize the risk of excessive heat exposure for outdoor workers. Beyond Miami-Dade County's policies and programs to issue heat alerts and advise the population to minimize their exposure, enhancing resilience to address the impacts of increasing temperatures also can be addressed in the built environment. The design of cities, streets, and buildings offers many opportunities in manageable increments for improvements to alleviate urban heat.

There is a longstanding and extensive body of literature on mitigating heat in cities. From Luke Howard's 1833 publication, *The Climate of London*, to 20th-century analysis of urban climate, the concept of the urban heat island has been consistently identified (Mills, 2008). More recently, this body of work has informed the development of effective strategies to mitigate this phenomenon. The 2008 Environmental Protection Agency (EPA, 2008) guide, *Reducing Urban Heat Islands: Compendium of Strategies*, is still relevant and applicable, and the current *Heat Island Newsletter* provides research updates, news items, and case studies (EPA, 2024).

Integrating research and application in his book, *The Urban Fix*, Doug Kelbaugh (2019) identified fundamentals to address urban heat, including raising solar reflectivity with lighter-colored roofs, pavements, and walls; reducing waste heat from tailpipes, chimneys, and air conditioners; providing cool microclimates with more trees and vegetation that release moisture and sequester carbon dioxide; shading streets and buildings; and aligning streets with ventilating breezes and prevailing winds. One might wonder why communities still suffer from urban heat when a plethora of resources that translate research into action-based toolkits is available literally at our fingertips. Some of these resources are listed below.

Urban design experience and academic research show that just as heat is a universally shared concern, well-established interventions for mitigating urban heat can also serve broadly—with tailoring to local conditions, of course. For instance, street trees are a worldwide adaptive strategy, although the species may vary according to latitude and regional specifics. It should be noted that in many U.S. cities, tree canopy is often less prevalent in less wealthy neighborhoods.

In this brief itemization, we offer a shortlist of strategies that urban planners, municipal governments, and property owners can implement with relative ease to reduce heat in three principal areas: streets and open spaces, parking lots, and buildings. In all cases, these strategies also may contribute to increasing comfort for walking and reducing reliance on mechanical cooling, thus decreasing energy use and emissions. These strategies are further articulated in the practices of the New Urbanism, a contemporary movement for sustainable urban design, that for the last 30 years has demonstrated that in order to increase walkability and decrease automobile use, the walk must be safe, comfortable, and interesting.

Streets

The open spaces of streets, building setbacks, and parks can be designed to reduce ambient heat, with attention to street geometry, shade, materials, and colors.

Street orientation and geometry

Street orientation and geometry determine exposure to sun and air movement and should be considered in laying out new urban development or altering existing urbanism. Some strategies include:

- Street orientation: Organizing streets to a north-south orientation ensures less direct sun and heat exposure than the exposure that occurs on east-west oriented streets (Figure 1).

Figure 1. Alys Beach. This streetscape view of Alys Beach, Florida, illustrates the benefits of street orientation along a north-south axis because the buildings on the west side of the street shade the street throughout the afternoon. This location also aligns with southerly prevailing breezes and uses pervious paving, shaded entries, and white walls. Photo credit: DPZ CoDesign.

Figure 2. Willow Oaks view. The streetscape view of Willow Oaks, a Hope VI community in Greensboro, North Carolina, illustrates the placement of a new street along a line of existing large trees, enabling shade for the street, sidewalk, and front of the houses. Source: DPZ CoDesign.

- Street placement: When an open space such as a park bounds a neighborhood, placing streets rather than buildings along the open space or park can diminish heat on the street and sidewalk (Figure 2 and Figure 3).
- Street space geometry and dimensions: Narrow streets and narrow spaces between buildings enable more shade and channel breezes (Venturi effect), especially when aligned with prevailing breezes.

Figure 3. Willow Oaks site plan. The site plan of Willow Oaks, a Hope VI community in Greensboro, North Carolina, illustrates the placement of a new street along a line of existing large trees, enabling shade for the street, sidewalk, and front of the houses. Source: DPZ CoDesign.

Shade

Shade is a natural way to provide cooling. Shading strategies can be applied in several types of places, such as:

- Street pavements: Position building elements to shade paved surfaces.
- Bus and transit stops: Provide structures with generous roofs oriented to provide shade from solar exposure from 11 a.m. to 3 p.m. Avoid dark colors and materials that absorb, retain, and radiate heat.
- Street trees: Plant climate- and site-appropriate trees to shade both vehicular and pedestrian pavements, in medians, and on sidewalks. The planting distance from building walls should be sufficient to accommodate tree growth over time.
- Street walls: Building walls, garden walls, hedges, and trellises placed close to the sidewalk on the west side of the street can shade the pavement.

Materials

Materials selected to make the built environment can have a cooling effect. Suggested strategies include:

- Pervious pavements: Pervious pavements enable percolation of rainwater and reduce heat absorption through reduction of paved area. Rather than the quick evaporation of rainwater from impervious pavement, pervious pavement provides cooling through slow evaporation and, if it integrates vegetation, through evapotranspiration, the slow release of water from plant surfaces and interiors.

- Street plantings: Sidewalk and setback plantings and ground covers of heat-tolerant native plants can have a cooling effect through evapotranspiration and their reduction of impervious pavement, which absorbs and retains heat. Species requiring irrigation can have a cooling effect but may be unsustainable depending on location.
- Urban forests: Generous and dense planting of climate- and site-appropriate trees where space allows can provide the episodic relief of temperature differentials and establish microclimates that serve as cooling zones.
- Water: Fountains, misters, and other water features can reduce temperatures in exterior public spaces in low-humidity climates. Higher humidity levels reduce mister cooling capabilities.

Color

Color of material surfaces can decrease heat absorption. Attention to color selection on exposed exterior surfaces should include:

- Pavements: Light-colored pavements reflect more sunlight and retain less heat. Light-colored roads can lower air temperatures.
- Street walls: Light colors on street walls can similarly reduce air temperature and building heat load. Avoid mirrored glass, which deflects solar heat to the surrounding pavement and buildings.

Parking lots

Parking lots, often comprising a larger area of land surface in urban development than building footprints, can reduce ambient heat through cooling pavement materials and shading the pavement with trees or roofs.

- Pavements: Light-colored and reflective pavements, pervious pavements, and pitching pavement to enable rainwater drainage can provide periodic cooling and, with appropriate filtration, irrigation for street trees.

Figure 4. Seaside parking lot. This parking lot in Seaside, Florida, uses light-colored, pervious pavement and an allée of sycamore trees planted at distances that define parking spaces and reduce the heat load of a parking lot. Source: DPZ CoDesign.

- Landscape: Trees planted with spacing such that the canopy at 7 years will shade all the pavement, or at least an entire car surface, and pedestrian paths between rows of cars will reduce the urban heat load of the paved surfaces and cars and maintain cooler automobile interiors (Figure 4).
- Shade devices: Solar collectors positioned as a roof system above parking lots can also provide energy generation while shading the entire car surface.

Buildings

Buildings can be designed to reduce ambient heat by paying attention to orientation, floor plans, materials, and colors.

An array of actions, such as those previously proposed for open urban spaces, can reduce ambient heat for building occupants. These actions include orientation, floor plans, materials, and colors. Orientation to avoid unprotected exposure to mid- to late-day sun, floor plans that promote cross-ventilation (avoid double-loaded corridor plans), shaded outdoor spaces such as porches and balconies, light-colored walls and roofs, and copious landscape to shade exterior walls with the most heat load can be part of every new building program. Renovations can, at a minimum, introduce reflective colors and shading landscape (Figure 5).

Urban design for cooling is not new. As global temperatures rise, urban design should play a role in mitigating heat and enhancing the resilience of cities to extreme heat. The previously mentioned strategies proven to be effective will help lower temperatures and improve public health, energy efficiency, and overall quality of life.

In summary, many options are available for ameliorating the experience of heat in the urban environment. For both new and existing development, attention to shade, air movement, and reflective colors can provide perceptible relief for life in a warming world. With emphasis on the easy-to-understand and the doable, one can hope that heat reduction strategies may soon be integrated routinely in new and retrofit urban developments.

Figure 5. Blue water workforce housing. Blue Water Workforce Housing, Tavernier Key, Florida, illustrates the use of cool colors, reflective roofs, courtyards, and gardens positioned to enable cross-ventilation and plantings to shade the buildings. Source: DPZ CoDesign.

Disclosure statement

No potential conflict of interest was reported by the author(s).

About the authors

Joanna Lombard is an architect and ACSA Distinguished Professor at the University of Miami (UM) School of Architecture with a secondary appointment in the Department of Public Health Sciences at the Miller School of Medicine. A founding member of the UM Built-Environment Behavior & Health Research Group with funded projects in the area of neighborhood design and health, she investigates the health impacts of greenness and greening initiatives. An author and co-author of articles, book chapters, and books, she worked on *Historic Landscapes of Florida* with Rocco Ceo and worked on the intersection of cultural landscape and resilience with colleagues in the national research and design collective, Practice Landscape founded by Rosetta S. Elkin. Lombard has collaborated with UM colleagues on "Hyper-localism: Transforming the Paradigm for Climate Adaptation," to develop community based approaches to address risk and resilience and participates in the UM Climate Resilience Institute initiatives.

Elizabeth Plater-Zyberk is Malcolm Matheson Distinguished Professor of Architecture and director of the Master of Urban Design Program with a secondary appointment in the Miller School of Medicine Department of Public Health Sciences at the University of Miami where she also served as dean of the School of Architecture. A co-founder of the Congress for the New Urbanism, her teaching, research and consulting professional practice has ranged across new community design, community rebuilding, regional plans and zoning codes, climate impacts and resilience. As a co-founder and consultant with DPZ CoDesign she focuses on walkable resilient urban design. Author of multiple articles, essays, book chapters and books, she also is the co-author of *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* and *The New Civic Art: Elements of Town Planning*. Her work, with Andres Duany and DPZ CoDesign has received global recognition and honors.

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