Forum: Environmental Commission (EC)

Topic: Mitigating the Environmental Degradation caused by the Urban Heat Island effect (UHI)

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Position: Deputy President

PERSONAL INTRODUCTION

Dear delegates,

My name is Elena and I am currently a year 11 student at St. Catherine's British School. It is a great honour and pleasure to serve as a Deputy President in the Environmental Commission at this year's SCMUN conference. I have been doing MUN for 2 years and it has really helped me meet new people and grow as a person, and as a Deputy President, I aim to ensure you all have a positive experience and participate in a fruitful debate.

This study guide will help you familiarise with the topic of "Mitigating the Environmental Degradation caused by the Urban Heat Island effect" by providing background information, past attempts to resolve this issue, and relevant countries and organizations involved. However, I encourage you to use this study guide for your research, but also conduct some of your own research to gain a deeper understanding of the topic and your delegation's stance on it.

If you have any questions, do not hesitate to reach out and email me at: elena.sobati@gmail.com [1]

Best regards,

[1] For more information regarding the conference as a whole please contact the committee's main chair Ioanna Ziakka at: ioannaziakka@gmail.com

Elena Sobati

TOPIC INTRODUCTION

In our days, climate change has been affecting humanity on all levels, everywhere around the world, in multiple ways, one of them being the Urban Heat Island effect (UHI). The UHI effect is the increase in surface temperature in urban areas compared to rural areas typically resulting in a 2-5°C higher average air temperature, which is caused by several factors including dark surfaces, human-caused warmth, and low air circulation.

This phenomenon results in a multitude of adverse effects on urban environments, as it creates a higher energy demand for cooling which leads to increased air pollution from the emission of greenhouse gases, threatening human health and urban biodiversity. The UHI effect has been shown to impact over 80% of studied cities, affecting over 1.7 billion people worldwide. Making an effort to mitigate the negative environmental effects of the UHI effect is crucial to protect vulnerable groups (elderly, children, people with chronic health conditions) from heatstroke and dehydration, reduce energy demand and consumption, and preserve biodiversity in urban areas. Biodiversity is threatened as UHI creates hotter, less hospitable conditions for many species in urban areas, reducing habitat quality and food availability.

The impacts of the Urban Heat Island effect go far beyond borders, as it creates negative externalities and exacerbates global issues such as climate change, biodiversity loss, and public health crises.

DEFINITION OF KEY TERMS

The Urban Heat Island Effect

"An increase in surface temperature in urban areas compared to rural areas."[2]

Biodiversity

"The number and types of plants and animals that exist in a particular area or in the world generally."[3]

Urbanization

"The increase in the proportion of people living in towns and cities."

Environmental Degradation

"The deterioration of the environment through depletion of resources such as air, water, and soil."[4]

Evapotranspiration

The total amount of water lost from evaporation and transpiration via plant growing media and plant surfaces.[5]

Greenhouse Gas Emissions

The release of gases into the atmosphere that trap heat and contribute to global warming.

Albedo

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[2] Taha, Haider. "Urban Heat Island Effect - an Overview | ScienceDirect Topics." *Www.sciencedirect.com*, 2004, www.sciencedirect.com/topics/engineering/urban-heat-island-effect.

[3] Cambridge Dictionary. "BIODIVERSITY | Meaning in the Cambridge English Dictionary." *Cambridge.org*, 13 Nov. 2019, dictionary.cambridge.org/dictionary/english/biodiversity.

[4] ---. "URBANIZATION | Meaning in the Cambridge English Dictionary." *Cambridge.org*, 2019, dictionary.cambridge.org/dictionary/english/urbanization.

[5] Water Science School. "Evapotranspiration and the Water Cycle." *USGS*, 8 Sept. 2019, www.usgs.gov/water-science-school/science/evapotranspiration-and-water-cycle.

The amount of light that hits a surface that is reflected back.[6]

BACKGROUND INFORMATION

Historical Background

The Industrial Revolution marked the beginning of major environmental changes in cities around the world. Rapid industrialisation led to increased temperatures, reduced air quality, and widespread damage to vegetation and local ecosystems. The burning of coal and other fossil fuels released large amounts of pollutants into the atmosphere, while the expansion of factories and urban areas replaced green spaces with concrete and metal surfaces that absorbed and retained heat.

As these changes became more noticeable, scientists began studying what would later be known as the Urban Heat Island (UHI) effect - the phenomenon where urban areas experience higher temperatures than surrounding rural regions. Early research linked this effect to rising air pollution and increased energy consumption, especially as cities required more power for cooling systems such as fans and air conditioning.

Throughout the 20th century, as cities continued to expand, meteorologists started closely monitoring the temperature differences between urban and rural environments. Their findings showed that cities consistently trapped more heat due to their dense infrastructure and limited vegetation. Over time, researchers began connecting the UHI effect not only to environmental changes but also to public health risks, such as heat-related illnesses, and greater energy demand during hot weather.

Modern research now focuses on understanding these patterns in more depth and finding sustainable ways to reduce the UHI effect — for example, by increasing urban greenery, improving building materials, and promoting energy-efficient city planning.

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[6] "Albedo." *Dictionary.cambridge.org*, dictionary.cambridge.org/dictionary/english/albedo.

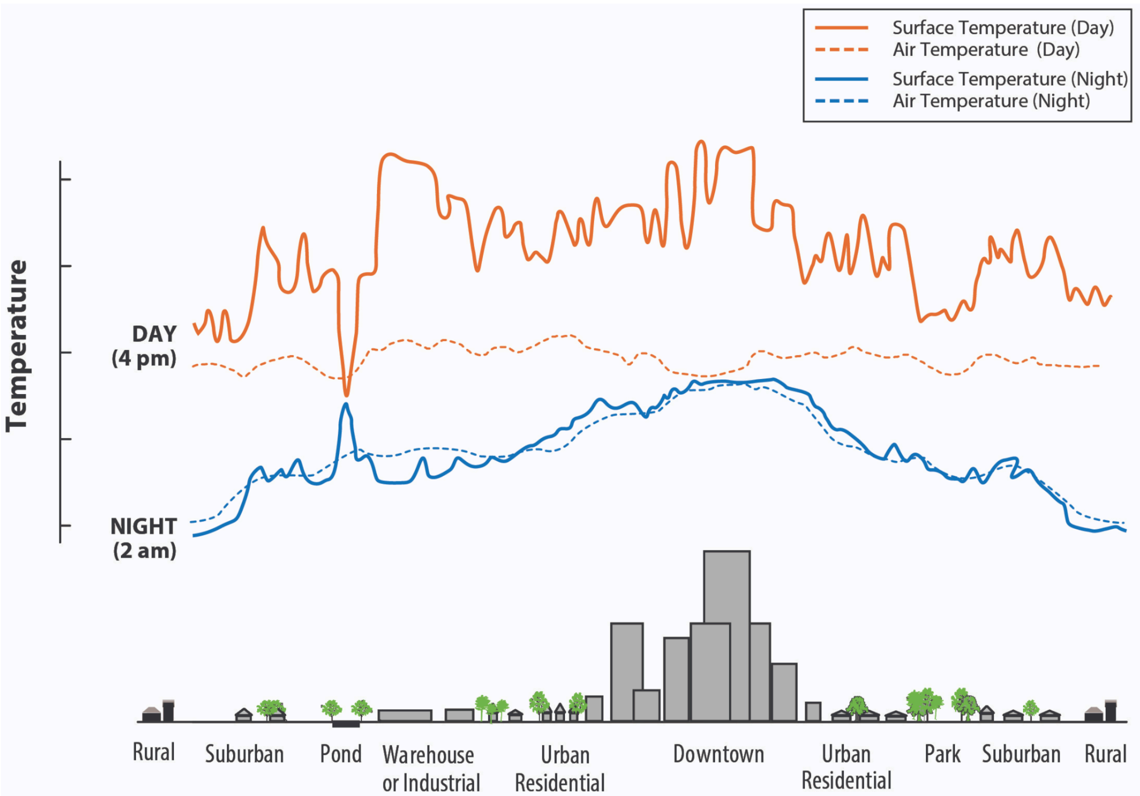

Figure 1: The temperature increase in urban areas compared to suburban and rural areas during the day and at night.[7]

Causes of the Urban Heat Island Effect

Surface Materials

One of the main causes of the Urban Heat Island (UHI) effect is the use of heat-absorbing surfaces in cities. Materials such as asphalt, concrete, and bricks absorb large amounts of solar energy during the day. Because these materials have high heat capacity and low reflectivity, they store heat and slowly release it at night. This process keeps urban areas warmer for longer periods, especially after sunset, compared to surrounding rural regions where natural surfaces like soil and vegetation cool down more quickly.

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[7]Almeida, Cátia Rodrigues de, et al. "Study of the Urban Heat Island (UHI) Using Remote Sensing Data/Techniques: A Systematic Review." *Environments*, vol. 8, no. 10, 9 Oct. 2021, p. 105, https://doi.org/10.3390/environments8100105.

Vegetation

Another key factor is the lack of vegetation in built-up areas. Trees and plants help cool the air through evapotranspiration — the process where water is released as vapour from leaves, which lowers surrounding temperatures. Vegetation also provides shade, reducing the amount of solar energy absorbed by the ground and buildings. However, as cities expand and green spaces are replaced by roads, buildings, and car parks, this natural cooling effect is greatly reduced, worsening the UHI phenomenon.

Urban Geometry

Urban geometry also plays a significant role. The tall, densely packed buildings typical of city centres trap heat and limit air circulation. This structure, sometimes referred to as the "urban canyon" effect, prevents warm air from escaping and restricts the cooling influence of wind. As a result, heat becomes concentrated within streets and between buildings, making temperatures noticeably higher in these areas.

Human Activities

Lastly, human activities contribute significantly to the UHI effect. The burning of fossil fuels by cars, factories, and power plants releases greenhouse gases and waste heat into the atmosphere. Everyday energy use — such as air conditioning, heating, and lighting — also adds more heat to the urban environment. These combined activities not only raise temperatures but also increase air pollution, which traps more heat and intensifies the overall warming effect.

The Urban Heat Island Effect and Urban Degradation

The Urban Heat Island effect is closely linked to various forms of urban degradation, as the rising temperatures in cities can worsen environmental, social, and economic problems. One of the most direct consequences is the decline in air quality. Warmer temperatures speed up chemical reactions in the atmosphere, leading to the formation of ground-level ozone, a harmful pollutant that irritates the lungs and contributes to respiratory problems such as asthma. Poor air quality also reduces overall urban livability and poses serious public health risks.

Another major issue is the increased demand for energy. As cities get hotter, more electricity is used for cooling buildings through air conditioning and ventilation systems. This higher energy demand often leads to the burning of more fossil fuels, which releases additional greenhouse gases into the atmosphere. This not only intensifies the Urban Heat Island effect but also contributes to global climate change, creating a damaging feedback loop.

The UHI effect also contributes to water stress within cities. Higher temperatures increase the rate of evaporation from rivers, lakes, and reservoirs, reducing available water supplies. At the same time, the demand for water rises as people use more for cooling and irrigation, putting additional strain on urban water systems.

In addition, biodiversity is often lost as local ecosystems struggle to adapt to higher temperatures and reduced green spaces. Many plant and animal species that once thrived in urban areas may no longer survive in the hotter, more polluted environment. Finally, the persistent heat and air pollution can cause damage to infrastructure and green areas, as roads and buildings expand and crack under extreme temperatures, and urban parks or gardens dry out or deteriorate.

Overall, the Urban Heat Island effect not only increases city temperatures but also contributes to a cycle of environmental decline that affects both people and nature in urban environments.

Case study: The UHI effect in New York City

New York City provides a clear example of the Urban Heat Island (UHI) effect in action. Studies have shown that the city's average temperatures can be around 9.7 degrees Celsius higher than those of surrounding rural areas. In some locations, particularly in the most built-up parts of Manhattan, heat increases have reached as high as 13 degrees. This makes New York one of the most affected cities in the world when it comes to urban overheating.

The main causes of this extreme temperature difference lie in the city's infrastructure and human activity. New York's dense concentration of buildings, roads, and vehicles creates an environment where heat is easily absorbed but not efficiently released. Materials such as asphalt and concrete trap heat during the day and slowly release it at night, preventing the city from cooling down. The tall buildings, arranged closely together, also limit wind flow and trap warm air within the streets. Additionally, New York's large population and heavy use of vehicles and air conditioning add more waste heat and air pollution, further intensifying the UHI effect.

To reduce these impacts, New York City has implemented several mitigation strategies. One major effort is the "Cool Roofs" programme, which encourages building owners to paint rooftops in light colours that reflect sunlight rather than absorb it. This simple change helps lower roof surface temperatures and reduce the need for air conditioning. The city has also increased efforts to plant more trees and create green spaces, as vegetation provides shade and cools the air through evapotranspiration. These initiatives not only make the city more comfortable during hot weather but also improve air quality and quality of life for residents.

TIMELINE OF EVENTS

Date of the Event	Event
1818	The urban-rural temperature difference was observed by Luke Howard.
1970-1980	Researchers in Europe and the USA begin to examine the factors contributing to the UHI effect.
1998-2002	The U.S. Environmental Protection Agency (EPA) conducts the Urban Heat Island Pilot Project in cities, testing mitigation efforts such as providing

	vegetation and cooling roofs.
May 25, 2009	The city of Toronto adopts a law requiring green roofs on new buildings larger than 2000 square meters.
2019	The 'Million Cool Roofs Challenge' is launched to promote solar reflective surfaces on roofs in developing countries.
November 21, 2024	C40 Cities collaborates with Carrier to promote sustainable cooling solutions in urban areas.

MAJOR COUNTRIES AND ORGANISATIONS INVOLVED

United States of America (USA)

The USA is one of the leading countries addressing the Urban Heat Island (UHI) effect through large-scale urban planning, environmental policies, and technological innovation. Several major cities, including New York, Los Angeles, and Chicago, have implemented urban greening and reflective infrastructure projects. These include the installation of cool roofs and reflective pavements, which reduce the amount of heat absorbed by buildings and roads. In addition, cities have expanded urban parks, planted more street trees, and introduced green roofs to increase shade and improve natural cooling through evapotranspiration.

The USA also invests heavily in research and monitoring. Temperature and heat-mapping projects are conducted across major cities to identify the most affected areas and evaluate the success of mitigation measures. Researchers study how UHI influences energy demand, air quality, and public health, helping local governments make data-driven decisions.

In evaluation, the United States has made significant progress in both understanding and addressing the Urban Heat Island effect. Substantial federal funding and long-term strategies have led to measurable improvements in some regions. However, the effectiveness of these initiatives largely depends on the level of engagement and policy enforcement at the city level. Urban areas that actively implement and maintain UHI mitigation measures tend to experience greater success in reducing temperatures and improving overall environmental quality.

China

China has made major efforts to reduce the Urban Heat Island (UHI) effect through large-scale urban greening and the use of reflective infrastructure. Cities such as Beijing, Shanghai, and Guangzhou have developed extensive urban forests and green corridors to improve air quality and lower city temperatures. The government has also required the use of reflective materials in new buildings to reduce heat absorption.

Through national and municipal policies, China has introduced guidelines for green belts and vegetation coverage, aiming to integrate greenery into urban planning. Alongside this, the country invests heavily in research and monitoring, focusing on urban microclimates to find the most effective placement for trees, parks, and water features. Continuous monitoring of air quality and heat conditions in large cities helps evaluate progress and identify problem areas.

In evaluation, China's urban greening programmes have successfully reduced heat intensity by about 1–2 degrees in pilot areas. However, the country's rapid urbanisation and industrial expansion continue to make consistent, large-scale implementation a challenge.

India

India faces severe UHI effects due to rapid urbanisation, high population density, and limited green cover. Major cities such as Delhi, Mumbai, and Ahmedabad often experience temperatures several degrees higher than nearby rural areas. To combat this, the government and local authorities have promoted urban greening, cool roof initiatives, and reflective materials in construction. Ahmedabad was the first Indian city to launch a Heat Action Plan in 2013, focusing on early warnings, public awareness, and emergency healthcare during heatwaves.

India's National Disaster Management Authority (NDMA) and Indian Meteorological Department (IMD) play key roles in monitoring heat trends and guiding policy. However, limited resources and rapid city growth make it challenging to implement these solutions everywhere, meaning progress varies widely between regions.

United States Environmental Protection Agency (EPA)

The United States Environmental Protection Agency plays a key role in helping cities manage and reduce the Urban Heat Island effect. It promotes the use of green infrastructure, including cool pavements, green roofs, and increased vegetation cover, to lower surface and air temperatures in urban areas. The EPA also encourages communities to make traditional water management practices more environmentally beneficial by planting trees and expanding green spaces, which help cool the air and absorb pollutants. In addition, the agency provides local governments with resources, research, and funding to support the implementation of heat mitigation strategies. These initiatives have had a noticeable impact in many US cities, leading to cooler neighbourhoods, improved air quality, and reduced energy consumption during summer months.

European Commission's Joint Research Centre (JRC)

The Joint Research Centre (JRC) of the European Commission supports European cities in understanding and tackling the Urban Heat Island effect through scientific research and policy guidance. The JRC studies temperature patterns, urban design, and climate impacts to help policymakers develop effective responses to rising urban temperatures. It also provides advice to local authorities on managing extreme heat, improving building design, and increasing urban greenery. The JRC's work has influenced EU climate policies and supported local governments in developing practical, data-driven solutions. As a result, several European cities have adopted more sustainable urban planning approaches, reducing heat risks and improving residents' overall quality of life.

RELEVANT UN TREATIES CONVENTIONS AND RESOLUTIONS

New Urban Agenda (A/RES/71/256)

[8]The New Urban Agenda (A/RES/71/256), adopted by the United Nations on 25 January 2017, focuses on sustainable urban development and disaster risk reduction. It encourages countries to reduce vulnerability and build resilience in urban areas through improved planning and management. Although it does not directly mention the Urban Heat Island (UHI) effect, its emphasis on sustainable city design indirectly supports UHI mitigation. The Agenda's strength lies in its explicit integration of climate resilience and sustainability into urban policy, promoting greener, more adaptable cities. However, its main limitation is that implementation depends on voluntary action from national and local governments, making enforcement inconsistent across different countries.

United Nations Framework Convention on Climate Change (UNFCCC)[9]

The United Nations Framework Convention on Climate Change (UNFCCC), adopted on 9 May 1992, serves as the foundation of international climate action. It aims to reduce greenhouse gas emissions and promote adaptation to climate impacts. The Convention indirectly includes Urban Heat Island mitigation as part of broader strategies for climate resilience and emissions reduction in cities. Its legally binding framework has driven significant global progress in addressing the root causes of UHI, such as fossil fuel emissions and poor urban planning. However, effectiveness varies by country, as not all national climate plans fully integrate UHI-specific strategies.

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[8] *A/RES/71/256* General Assembly Annex New Urban Agenda Quito Declaration on Sustainable Cities and Human Settlements for All*. 2017.

[9] "United Nations Framework Convention on Climate Change | UNFCCC." *Unfccc.int*, 2020, unfccc.int/process-and-meetings/united-nations-framework-convention-on-climate-change.

Making Cities Resilient 2030 (MCR2030)

The Making Cities Resilient 2030 (MCR2030) initiative, launched by the United Nations Office for Disaster Risk Reduction (UNDRR) in April 2025, specifically focuses on urban heat and climate risk management. It supports local governments by providing tools, data, and strategies to build resilience against extreme heat and related urban hazards. MCR2030 encourages collaboration between different sectors and integrates disaster risk reduction with climate adaptation at the local level. Its major strength is that it directly targets urban heat challenges, offering practical solutions and local-level engagement. However, like many UN initiatives, it is non-binding and relies on voluntary participation, which limits its global reach and consistency.[10]

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Vegetation and Urban Greening

One of the most effective and widely used methods to reduce the Urban Heat Island (UHI) effect is urban greening. This includes the extensive use of trees, green roofs, vertical gardens, and urban parks to cool cities through evapotranspiration—the process where plants release water vapour that lowers surrounding air temperatures. Urban greening also enhances biodiversity, improves air quality, and offers additional benefits such as carbon storage and water infiltration. For example, Singapore's "City in a Garden" initiative has successfully integrated greenery across rooftops, walkways, and high-rise buildings, significantly reducing surface temperatures. Similarly, New York City's MillionTrees NYC program has planted over a million trees to provide shade and improve thermal comfort. The main strength of this approach is that it reduces heat-related health risks and improves living conditions, especially in vulnerable

[10] "[File] Urban Heat Risk Management - Resource Package (103947)." *Undrr.org*, 2025, mcr2030.undrr.org/media/103947. Accessed 29 Dec. 2025.

neighbourhoods. However, its effectiveness can vary depending on the local climate, plant species, and maintenance levels.

Material and Surface Modifications

Another important strategy involves modifying urban materials and surfaces to make them more reflective and heat-resistant. This includes the use of *cool roofs* and *cool pavements* that have a high Solar Reflective Index (SRI), meaning they reflect more sunlight and absorb less heat. These materials help lower surface and air temperatures by dissipating heat more efficiently. In Los Angeles, for example, the city has tested reflective "cool pavements" on roads, showing surface temperature reductions of up to 10°C. Chicago and Tokyo have also adopted reflective roofing materials on public buildings. The strength of this approach is that it is highly effective in dense city centres where greenery is limited. However, reflective materials can sometimes cause unwanted glare or redirect heat to nearby areas, which needs to be managed carefully.

Urban Design and Planning

Urban design improvements aim to make cities more heat-resilient through smarter planning and construction. This includes designing streets and buildings to maximise shading, improve airflow, and reduce heat absorption. Strategies include orienting buildings to enhance wind flow, widening streets to prevent heat entrapment, and using lighter-coloured materials on pavements and facades. Cities such as Copenhagen and Melbourne have incorporated these principles into their masterplans by increasing shaded pedestrian routes, integrating green corridors, and using permeable pavements to allow water infiltration and surface cooling. These measures have proven effective in reducing both air and surface temperatures while improving urban comfort. However, large-scale implementation requires significant investment, long-term planning, and coordination between architects, city planners, and policymakers.

POSSIBLE SOLUTIONS

Research and Technological Advancements

Advances in technology and research can significantly improve how cities monitor and manage the Urban Heat Island (UHI) effect. Tools such as remote sensing, climate modelling, and dense sensor networks can provide detailed data on temperature variations across different areas, helping governments develop more targeted and efficient mitigation plans. Innovative technologies—like cool pavements that reflect sunlight and vertical greening systems that cover building walls with plants—are already being tested in cities such as Singapore and Los Angeles. These solutions are likely to be highly successful in data-driven cities with the resources to implement them, as they enable long-term planning based on accurate monitoring. However, their main limitation is cost, as installing and maintaining such systems can be expensive and require technical expertise not always available in developing regions.

Nature-Based Solutions

Nature-based strategies are among the most sustainable and visually appealing approaches to reducing the UHI effect. Expanding urban greening through the planting of trees, green roofs, walls, and parks can cool the air through evapotranspiration while also improving biodiversity and urban aesthetics. Innovative ideas such as linear forest networks, moss-covered facades, and bioreceptive concrete—designed to support plant growth on building surfaces—further extend natural cooling benefits. These methods are already being introduced in European cities like Milan and Singapore with measurable success. Nature-based solutions are generally very effective and socially beneficial, but their success depends on consistent maintenance, available space, and local climate conditions. In very dry or densely built areas, their cooling potential may be limited unless supported by irrigation systems and integrated design.

Material Innovations

Developing new building and surface materials can also play a major role in reducing urban heat. High-albedo reflective coatings on roofs and pavements help reflect sunlight instead of absorbing it, while reflective asphalt and permeable pavements can reduce heat build-up and allow water infiltration for added cooling. Emerging technologies such as membrane-assisted panels, which release stored heat at night, show promise in experimental trials. These innovations have been tested successfully in cities like Tokyo and Phoenix, where they have lowered surface temperatures by several degrees. Material innovations are effective and easy to implement in dense urban areas, but they may face limitations such as higher upfront costs, glare issues, and reduced efficiency in heavily shaded or polluted environments.

Sustainable Water Management

Integrating water management with green infrastructure can help cities cool naturally while improving water quality. Systems such as rain gardens, bioswales, and constructed wetlands absorb and filter rainwater, reducing urban flooding and enhancing soil moisture. These features also support vegetation, which complements natural cooling through evapotranspiration. Cities like Copenhagen and Rotterdam have effectively used water-based infrastructure to create cooler, more climate-resilient environments. This approach is likely to be very successful in temperate or wet climates, but its effectiveness can decline in arid regions where water availability is limited. Maintenance and proper design are also crucial to prevent issues such as mosquito breeding or water stagnation.

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