Wetlands INTERNATIONAL

PARTNERS FOR RESILIENCE
Working together on disasters, climate, ecosystems

COMPENDIUM GUIDE

HEAT AND URBAN ENVIRONMENTAL ISSUES
URBAN WETLANDS

OVERVIEW

Urban wetlands are well known for their ecosystem services of flood protection, water storage, infiltration, aquifer recharge, biodiversity habitat and aesthetic values – supporting life and the societies that surround them. They also play a key role in regulating urban microclimates. In fact, urban wetlands can be a solution for cities struggling with the urban heat island (UHI) effect.

Scientific studies show that urbanization leads to increased temperatures in cities compared to their rural surroundings. This impacts the local climate and environment, affecting city-dwellers' health and quality of life. Urban wetlands regulate the local climate by reducing temperatures, helping to relieve the **UHI effect**.

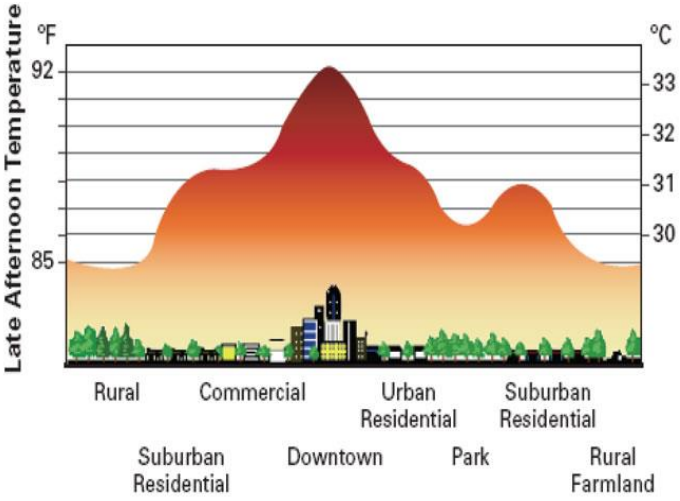


Illustration 1. Urban Heat Island. Source: Heatwave Guide for Cities, Red Cross Red Crescent Climate Centre[1]

What are Urban Heat Islands?

"When cities replace natural land cover with dense concentrations of pavements and buildings etc., these areas become islands of a higher temperature, in comparison to surrounding areas."

As urban areas develop, wet and green open spaces and permeable surfaces are replaced with dry and impermeable construction materials, like asphalt on roads and concrete in buildings and pavements. These materials absorb heat during the day and warm the urban area, affecting the microclimate in comparison to the rural surroundings.

IMPACTS OF HEAT WAVES AND URBAN HEAT ISLAND EFFECT

Frequently and widely occurring heatwaves exacerbate urban heat islands and make cities vulnerable to the risks of vector-borne diseases and other health impacts, especially on vulnerable groups. During the 2003 heatwave in Europe, for example, 70,000 excess deaths were reported[1]. In June 2019, parts of France registered record-breaking daytime temperatures as high as 45.9°C which killed 1,500 people. According to a report by the United States Environment Protection Agency, people aged 65 and over in the United States of America are more likely to die of cardiovascular disease, respiratory illness or diabetes during periods of extreme heat[3], especially severe in cities.

Illustration 2: Urban Heat Island health impacts. Source: Heatwave Guide for Cities, Red Cross Red Crescent Climate Centre [1]

During periods of extreme heat, buildings consume more energy to keep indoor spaces cool; with air-conditioning equipment emitting warm air into the streets, further intensifying the UHI effect. During the 2013 heatwave in South Korea, to stave off countrywide power shortages, local government reduced the amount of air conditioning in public buildings. In 2010, Berlin (Germany), soaring temperatures and malfunctioning air-conditioning caused the temperature inside a high-speed train to reach over 50°C, forcing the evacuation of its passengers[4]. The urban poor – who already suffer from a lack of services, access and affordability – are the most vulnerable to the impacts of extreme heat, due to a lack of thereof.

In summary, the four main impacts of UHIs are[5]:

- compromised human health and comfort
- increased energy consumption
- elevated emissions of air pollutants and greenhouse gases (formation of smog, fine particulate matter and acid rain)
- impaired water quality (high temperatures on rooftop surfaces can heat stormwater runoff, draining into sewers and in turn releasing heat into streams/rivers/lakes, negatively affecting aquatic life).

Impacts of heat trapped within the city

HOW DO URBAN WETLANDS REDUCE UHI?

- Urban wetlands, with their open-water surfaces, can absorb a lot of heat. Water has a high heat absorbing capacity, which also helps to regulate the rate at which air changes temperature. Furthermore, open-water wetlands also reflect solar radiation, especially at a low sun angle. This means that water will absorb more heat – before it begins to get warmer and subsequently evaporate – than construction materials.

Illustration 3: Healthy wetlands reduce the UHI effect and also provide many other ecosystem services. Source: Wetlands International

Water and wetlands also affect the humidity and thermal behaviour of local climates. Through natural processes, wetlands can modify local climates, reducing the impacts on human health. The Really Cooling Water Bodies in Cities (REALCOOL) project was initiated by Wageningen University in the Netherlands in 2016–18. It created optimal cooling strategies for common urban water bodies to explore effective combinations of shading, water evaporation, natural cooling and ventilation through simulation[6].

Photo above: A constructed wetland in Kuala Lumpur, Malaysia stores and purifies water, but also reduces urban temperatures together with its green surroundings. By Wetlands International Malaysia

- Smaller urban wetlands also contribute to urban heat reduction, especially if the immediate surroundings are shaded by trees; if wind can flow unobstructed along or across the water body; and when fountains or water mists are introduced in neighbouring locations[7]. The bigger the urban water body, the more effective these measures will be, further reducing the UHI effect.

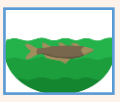
DO DEGRADED URBAN WETLANDS ALSO REDUCE UHI?

Urban wetlands face the threat of eutrophication – an excessive growth of plant species due to the richness of nutrients that drain into the wetland from urban sewage or agriculture. Dense plant growth on the water surface blocks the sunlight entering the water body causing it to absorb less heat, lowering its ability to reduce the UHI effect. At the same time, less light and oxygen can lead to a loss of the wetland's biodiversity.

Once eutrophied, these urban wetlands need restoring but, instead, often shrink in size with the growing demand for land for housing, infrastructure and waste disposal. This can lead to further health risks to the surrounding population as stagnant water allows mosquitoes to flourish and negatively affect health of surrounding population; while the loss of ecosystem services such as water storage can cause an increase in flood risk. Further studies need to be conducted to compare eutrophied and healthy wetlands to find the best restoration practice for UHI reduction.

Illustration 4: Eutrophied urban wetlands also reduce the UHI effect but significantly less than healthy open-water body wetlands. Source: Wetlands International

OTHER IMPACTS OF URBAN WETLAND DEGRADATION[8]


EUTROPHICATION


LOW AQUIFER LEVELS


URBAN FLOODS


STAGNANT WATER

CASES FROM AROUND THE WORLD

Wetlands International and Nupur Jain of the IHE Delft Institute for Water Education conducted a study in December 2019 to January 2020 in Lake Chalco and the Xochimilco wetland protected area in Mexico City, Mexico. Mexico City has a maximum daytime temperature of 28–30°C and a night-time temperature of 6–7°C. The city is densely populated with 8.85 million people calling it home in 2015. The study measured incremental temperature increases of approximately 2°C every 35 metres, starting from both water bodies and moving towards the local neighbourhoods.

Lake Chalco – a neglected wetland area enclosed by the city – is highly eutrophied (see pictures below), with some parts converted into a waste disposal site. The average maximum day temperature in and around Lake Chalco was approximately 25°C, while the average night-time temperature was 3–7°C – still cooler than other parts of the city where daytime temperatures were 29–31°C.

Xochimilco wetland is a UNESCO World Heritage Site as well as a Ramsar Wetland of International Importance. As such, it is highly valued for tourism. Its open water channels link the wetland to local agriculture and a built-up urban area. Here, the average maximum daytime temperature was approximately 23°C, while the average night-time temperature was 4–6°C. The pictures below show the open water channels and River Amecameca of Xochimilco wetland. Xochimilco is located 17 kilometres south of Mexico City centre.

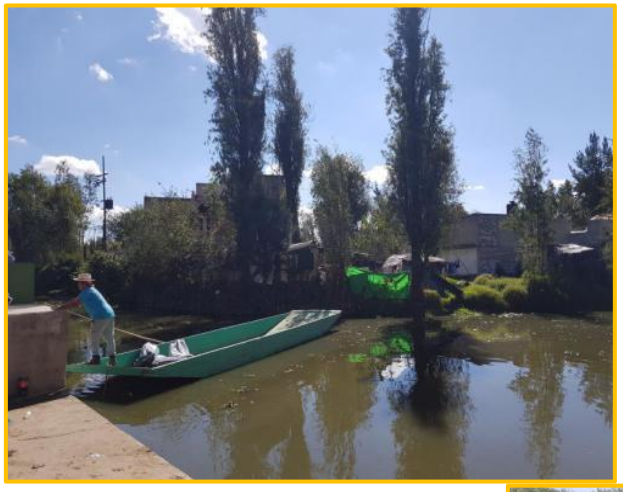
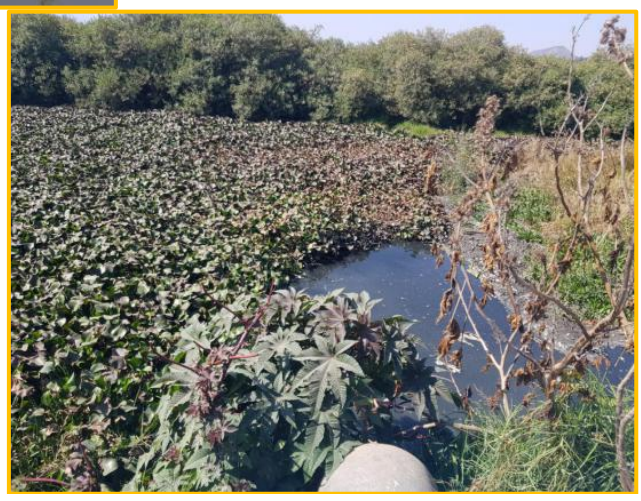


Photo left: healthy part of Xochimilco wetland (Mexico City). Photo: Nupur Jain

Photo right: A clearly eutrophied Lake Chalco (Mexico City). Photo: Nupur Jain



OTHER STUDIES

- Similar scientific case studies on megacities that support this correlation, like Bangkok (Thailand)[9], Adelaide (Australia)[10] and Bucharest (Romania)[11], also provide evidence of urban wetlands reducing the UHI effect.

  1. Study in Bangkok reveals that the UHI effect is also influenced by other meteorological variables including rain, cloud cover and relative humidity. Urbanization decreases humidity and leads to an urban–rural humidity contrast. The study concluded on specific floor area ratios, building coverage ratios, and the correlation between atmospheric temperature and urban heat islands.
  2. The study in Adelaide concludes that the magnitude of urban–rural temperature difference varies with daily and seasonal changes. An increase in urban greenery is correlated with building resilience to heat through evaporative cooling.
  3. The study in Bucharest in 2016 reveals that the change in land use – from cropland and forested areas to built-up areas – coincided with the thermal behaviour and characteristics of the land use category. The difference in surface temperatures indicates that change in land use is the key trigger for increased UHI in cities.

- A study conducted in the Pearl River Delta Metropolitan Region of China shows that for every 10 per cent increase in water body coverage – such as wetlands – there is an 11.33 per cent reduction of UHI intensity due to the water body's natural cooling processes.[12]

- In Colombo, Sri Lanka, the wetlands and surrounding areas are on average 10°C cooler than the non-pervious concretized areas of the city (e.g., parking lots) at the hottest time of the day, resulting in energy savings for artificial cooling systems such as air conditioning.[13]

- A study conducted in 44 cities of India, each with a population of over one million people, concluded that cities like Kolkata, Chennai and Thiruvananthapuram have a heightened UHI effect in the daytime. Although there are green areas in their surroundings[14], their wetlands are ignored in the current cooling action plan[15] launched by the government.

Photo above: East Kolkata Wetlands, India provide many services to the city, including a reduction of the UHI effect. By Wetlands International South Asia

HOW CAN CITIES REDUCE THE UHI EFFECT THROUGH URBAN WETLANDS?

There is a growing evidence and recognition of urban wetlands for their UHI reduction services in addition to enhancing biodiversity, reducing flood risk and boosting recreational activities and other health benefits. Making sure urban wetlands are protected, restored or in some cases constructed, is key to making cities more sustainable and climate resilient. Restoring degraded urban wetlands is essential to maximize their services, including the ability to reduce the UHI effect.

Incorporating urban wetlands in planning and investing in their restoration and construction as a Nature-based Solution can help cities to reduce the impacts of heatwaves and the UHI effect, contributing to local climate change adaptation.

- Restoring and constructing urban wetlands can help reduce the UHI effect, while providing multiple benefits such as revitalising the biodiversity of a city as they can be key habitats for endangered species.
- Local policies for the better management and protection of urban wetlands can be effective if enforced and action driven.

- Urban wetlands should be an integral component of urban planning, climate resilience, and mitigation strategies to tackle heatwaves and the UHI effect.
- Urban wetlands are best combined with other blue–green infrastructure and Nature-based Solutions, such as bioswales or blue–green corridors.

- Engage local residents, stakeholders, community-based organizations and NGOs in wetland restoration and urban planning around wetlands to rally support.
- Develop the capacity and raise awareness of local stakeholders to integrate wetlands in sectoral plans and investment.

This compendium guide was developed by researcher M.Sc. Nupur Jain and Urban Resilience Coordinator Sander Carpaij in close collaboration with the Red Cross Red Crescent Climate Centre. See **www.wetlands.org/UHI** *or contact* **sander.carpaij@wetlands.org** *for more information.*

URBAN WETLANDS REDUCE URBAN HEAT ISLAND EFFECT (UHI)

- ✓ Densely built-up areas and urban surfaces made of impermeable construction materials – like asphalt on roads and concrete in pavements – absorb heat during the daytime and warm the urban area, creating an urban heat island.
- ✓ During the daytime, urban wetland water bodies can significantly reduce thermal load due to their high capacity to conduct and store heat; at night-time they cool faster than impermeable surfaces.
- ✓ Green areas also help to reduce the UHI effect through evapotranspiration; they are best combined with urban wetlands.
- ✓ Degraded wetlands, such as eutrophied water bodies, also reduce the UHI effect. Restoring degraded urban wetlands can maximize their help in reducing the effects of heat in urban areas.

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