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, aesthetic values, water storage, and treatment purification, aquifer recharge and biodiversity habitat, thereby supporting the life and society around them. However, they also play a key role in regulating urban micro-climates. In fact, urban wetlands can be a solution for cities struggling with urban heat island effect (UHI).

Scientific studies prove that urbanisation leads to increased temperatures of cities compared to their rural surroundings. This impacts local climate, environment and affects the health and quality of life for its residents. Urban wetlands regulate these local climates by reducing temperatures, including in their surroundings, thereby help to reduce the **urban heat island effect (UHI)**.

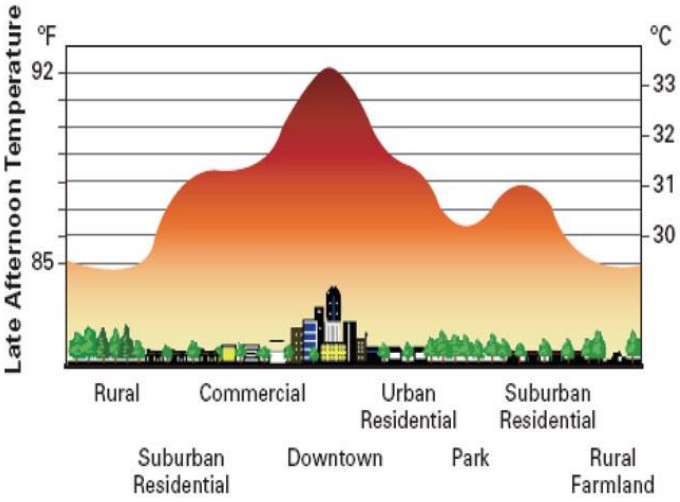


Illustration 1.Urban Heat Island (UHI. Source: Red Cross Red Crescent Climate Centre - Heat Wave Guide for Cities[1]

What are Urban Heat Islands?

When cities replace natural land cover with dense concentrations of pavements, buildings, etc.; these areas become islands of higher temperature in comparison to surrounding areas. - US Environment Protection Agency.

As urban areas develop, wet and green open spaces and permeable surfaces are covered with dry and impermeable construction materials like asphalt on roads, concrete on buildings and pavements. These absorb heat during the day time and warm the urban area, affecting the micro-climate in comparison to adjacent areas.

IMPACTS OF URBAN HEAT ISLAND (UHI) EFFECT

Frequently and widely occurring heat waves further makes cities vulnerable to risks of vector borne diseases and other health impacts, especially on vulnerable groups. During the 2003 heatwave in Europe, 70,000 excess deaths were reported[1]. In June 2019, some parts of France reported record-breaking day temperatures as high as 45.9°C killing 1,500 people. Temperatures in India and other parts of Asia have also surged up killing hundreds of people[2]. In US, people aged 65+ are more likely to die from heat-related cardiovascular disease, respiratory illness or diabetes, according to a report by the US Environment Protection Agency[3].

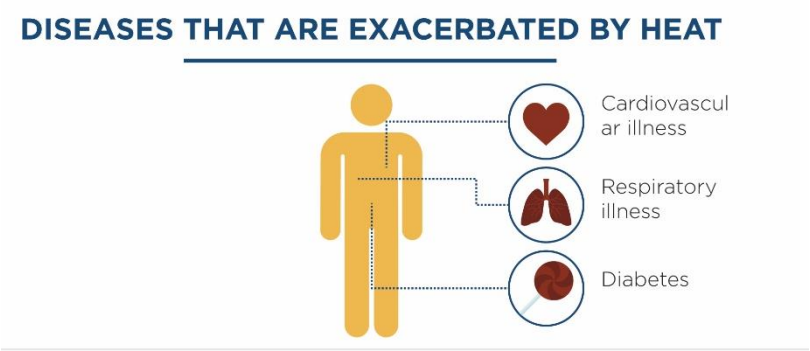
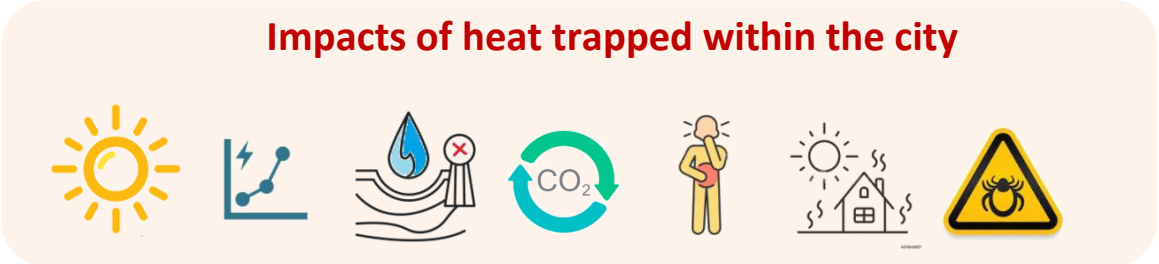


Illustration 2.Urban Heat Island (UHI) health impacts. Source: Red Cross Red Crescent Climate Centre - Heat Wave Guide for Cities[1]

Furthermore, to keep indoor spaces cool, buildings consume more energy, with air conditioning equipment emitting warm air into the streets, which further intensifies the UHI effect. The urban poor are the most vulnerable communities who suffer from lack of services, access and affordability, increasing their risk to health impacts. During 2013 heat wave in South Korea, to stave off a country wide power shortages, local government cut down air conditioning in public buildings. In 2010 Berlin (Germany), due to temperatures soaring high and air-conditioning malfunctioning in public transports, the temperatures inside the high speed trains reached over 50°C; forcing evacuation of people[4].

Summarising, the four main impacts of UHI 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 the heat into streams/rivers/lakes negatively affecting the aquatic life)



HOW DO URBAN WETLANDS REDUCE UHI?

- Urban wetlands with an open water surface can absorb a lot of heat. Water has a high specific 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 evaporates) than construction materials.

Illustration 3: Healthy wetlands reduce urban heat island (UHI) effect and also provide many other ecosystem services. Source: Wetlands International

Thus, water and wetlands can affect the humidity and thermal behaviour of local climate. High humidity also has high impact on human health. Thus, through natural processes, wetlands can modify local climates, reducing the impacts on human health. The Really Cooling Water Bodies in Cities (REALCOOL) project initiated by Wageningen University (WUR) in 2016-18 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 have shading from trees, if wind can flow unobstructed along or across the water body, and when fountains or water mists are introduced in neighbouring locations[7]. This combination is also more effective in combination with larger urban water bodies, further increasing their UHI reduction function.

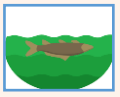
DO DEGRADED URBAN WETLANDS ALSO REDUCE UHI?

Urban wetlands face the threat of eutrophication, which is an excessive growth of plant species as a consequence of high 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 and thereby it can absorb less heat. Thus, their urban heat island (UHI) reduction service is reduced, but still delivers. Also, less light and oxygen causes a loss of its biodiversity.

Once eutrophied, these urban wetlands require restoration, but often shrink in size with growing need of land for infrastructure and housing or be used as waste dumping ground, further causing health risks to the surrounding population due to stagnant water allowing for growth in mosquito populations, and loss of ecosystem services such as water storage causing increased flood risk. Further studies need to be conducted on the comparative effect of eutrophied vs. healthy wetlands and best restoration practice for UHI reduction.

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

OTHER IMPACTS OF URBAN WETLAND DEGRADATION[8]


EUTROPHICATION


URBAN FLOODS


LOW AQUIFER LEVELS


STAGNANT WATER

CASES FROM AROUND THE WORLD

» Wetlands International and Delft IHE researcher Nupur Jain conducted a study in dry months during December 2019-January 2020 in the Mexico City's (State) Lake Chalco and the Xochimilco wetland protected area. Mexico City has maximum day temperatures ranging between 28-30°C and night temperatures of night was 6-7°C. The city is densely populated with a population of 8.85 million in 2015. The study measured temperature increases by ~ 2°C per 35 meters of distance starting from both wetlands moving going inward into the neighbourhoods.

Lake Chalco, a neglected wetland area enclosed by the city is highly eutrophied (as shown in the pictures below) with some parts converted into a waste disposal area. Average maximum day temperatures in and around Lake Chalco was found to be approx. 25°C and in the night was 3-7°C, still cooler than other parts of the City where day temperatures during the time of study was around 29-31°C.

Xochimilco wetland is a UNESCO World Heritage Site, a Ramsar Wetland of International Importance with high touristic values. Its open water channels link the wetland with the agricultural area and built-up urban area. Average maximum day temperatures were approx. 23°C and night temperature 4-6°C. The pictures below show the open water canals and river Amecameca of Xochimilco wetland. Xochimilco is located 17 kms south from Mexico city centre.

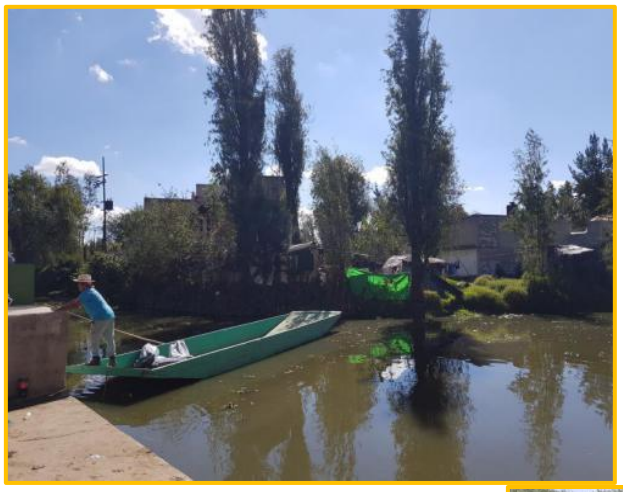
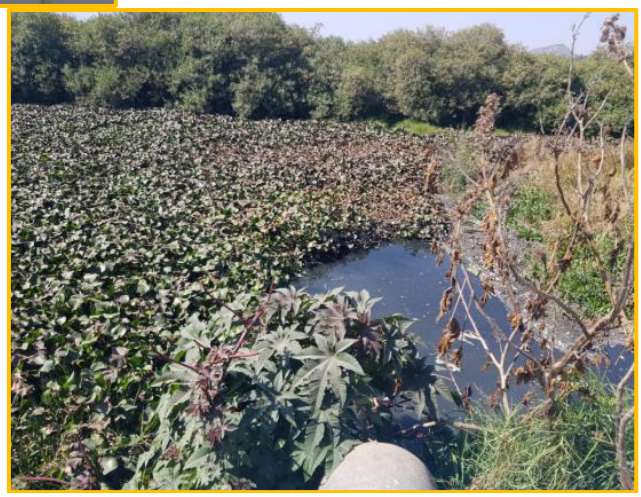


Photo left: healthy part of Xochimilco wetland (Mexico City). Photo: Nupur Jain

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



OTHER STUDIES

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

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

- A study conducted in Pearl River Delta Metropolitan Region (PRD) China, shows that natural cooling processes of the assessed blue spaces like wetlands and water bodies proved that a 10% increase in water body coverage lead to 11.33% reduction of UHI intensity.[12]

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

- A study conducted in 44 cities of India with a population of over a million despite being surrounded by green areas; concluded that cities like Kolkata, Chennai and Thiruvananthapuram have heightened UHI in day time[14]. These areas also have wetlands that are however not included in the current "cooling action plan"[15] launched by the government.

Photo above: East Kolkata Wetlands, India provide many services to the city, including reducing of urban heat island effect. By Wetlands International South Asia

HOW CAN CITIES REDUCE URBAN HEAT ISLAND EFFECT (UHI) THROUGH URBAN WETLANDS?

There is a growing evidence and recognition of urban wetlands for their UHI reduction services in addition to enhancing biodiversity, flood risk reduction, 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 the recipe to maximize their services, including for urban heat island effect reduction.

Incorporation of urban wetlands in planning and investment in restoration and construction as Nature-based Solutions can help cities reduce the impacts of heat waves and urban heat island effect (UHI), thereby contributing to local climate change adaptation.

- Restoring and constructing urban wetlands can help reduce urban heat island effect (UHI), while providing multiple benefits, such as revitalising biodiversity of a city and for the region, as they can be key habitats for endangered or endemic species.
- Local policies for 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 heat waves and urban heat island effect (UHI)
- 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 organisations 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**.

URBAN WETLANDS REDUCE URBAN HEAT ISLAND EFFECT (UHI)

- ✓ Densely built-up areas and sealed urban surfaces with impermeable construction materials like asphalt on roads, concrete and pavements absorb heat during the day and warm the urban area, creating an Urban Heat Island (UHI)
- ✓ During the day urban wetland water bodies can significantly reduce thermal load due to their high capacity to conduct and store heat; at night they allow for faster cooling than paved surfaces
- ✓ Green areas also help to reduce UHI through evapotranspiration and are best to be combined with urban wetlands.
- ✓ Degraded wetlands, such as eutrophied water bodies, reduce UHI. Restoring degraded urban wetlands can maximize their UHI reduction function!

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