

THE GROWING CHALLENGE OF URBAN HEAT

Impacts, risks and the role of Nature-Based Solutions

Eleni (Lenio) Myrivili
Global Chief Heat Officer, UNEP

Urban Forests for Climate Change Adaptation

Cities are heating up

2×

Cities are heating at roughly twice the global average rate.

1.6B

Urban residents could face extreme heat by 2050.

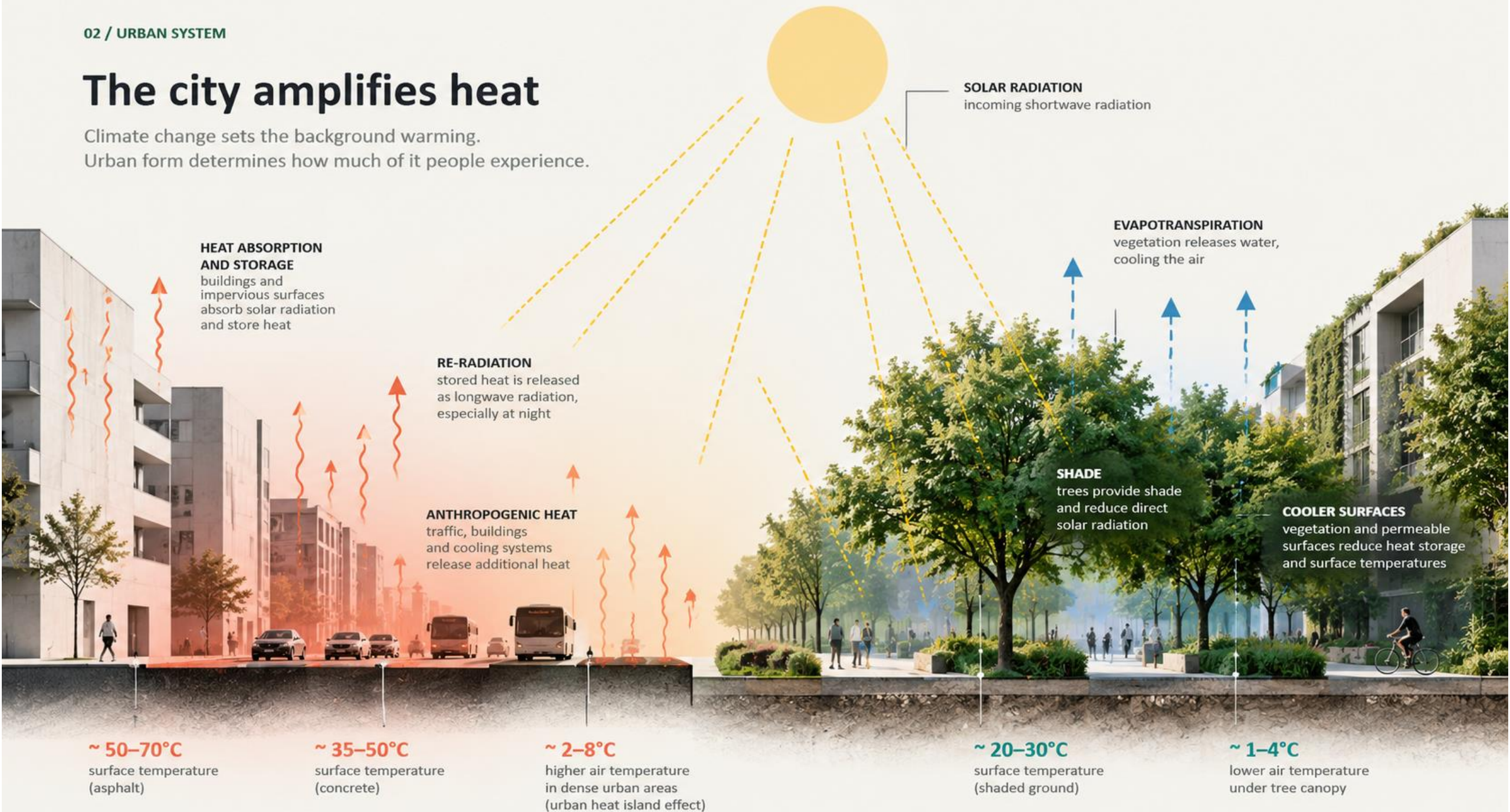
489K

Estimated heat-related deaths annually, 2000–2019.

Extreme heat is no longer an exceptional event. It is becoming a structural urban condition.

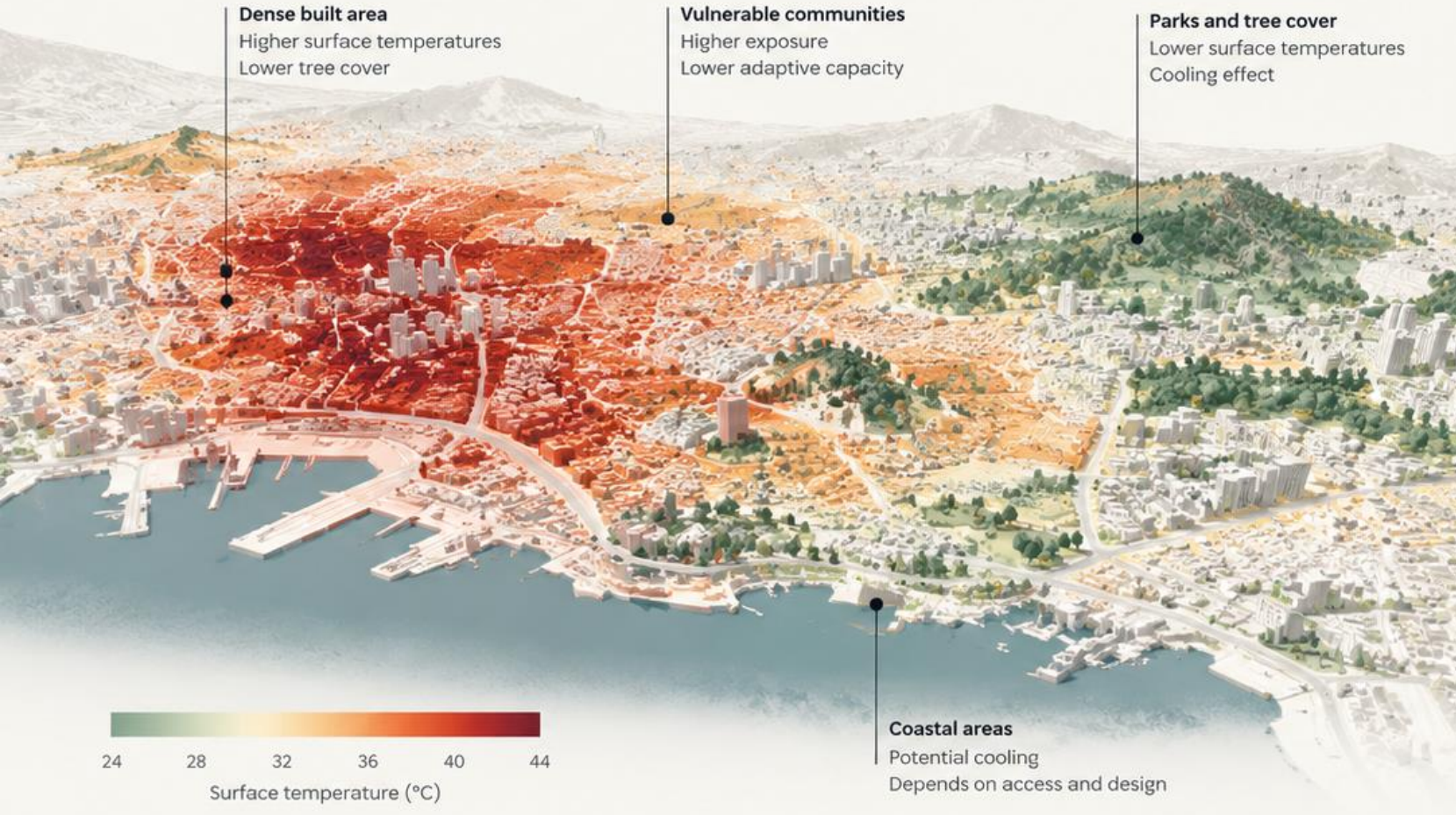
The city amplifies heat

Climate change sets the background warming.
Urban form determines how much of it people experience.

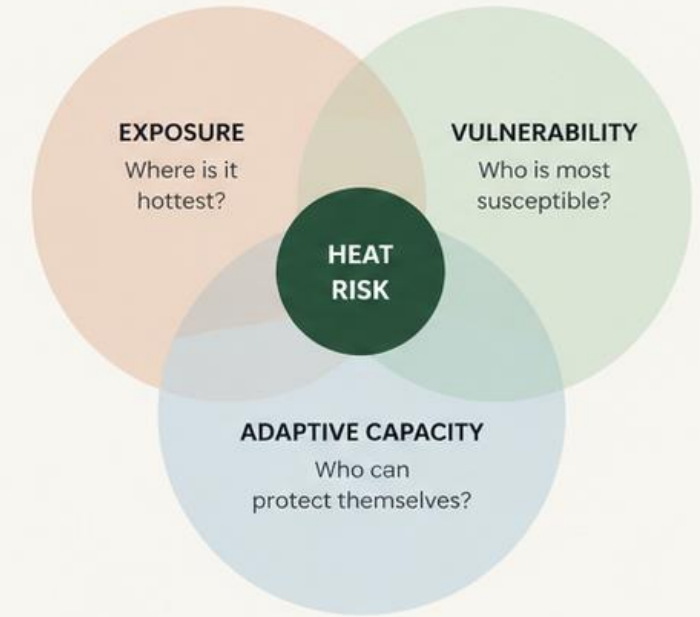


Same city. Different heat risk.

The same temperature does not create the same risk for everyone.



Heat is an environmental issue.
But it is also an equity issue.



HIGHER RISK FOR



The same city. A different climate.

In the same city, neighbourhood temperatures can differ by **more than 15°C.**



1 in 5

city residents live in neighbourhoods with high or very high heat exposure.

Surface temperature (°C)



Barcelona, Spain

Land surface temperature (Sentinel-2)
28 July 2023, 11:00 a.m.



46°C

NOU BARRIS

Low tree cover
Dense buildings
High heat exposure
More vulnerable populations



42°C

EIXAMPLE

Dense urban fabric
Limited green space
High daytime temperatures



28°C

DIAGONAL MAR

More tree cover
Shaded streets
Closer to the coast
Up to 15°C cooler than the hottest areas

Cooling must begin with people

Prioritise the people and places where heat risk is greatest.

COOLING SHOULD GO FIRST
WHERE RISK IS GREATEST.



HOME

Older people
Young children
People with chronic conditions



WORK

Outdoor workers
Delivery workers
Construction workers



MOVEMENT

Pedestrians
Cyclists
Public transport users



PUBLIC SPACE

Children
Older people
People without access to private cooling



CRITICAL SETTINGS

Schools
Hospitals
Care facilities
Mass gatherings



WE CANNOT AIR-CONDITION OUR WAY OUT.

Mechanical cooling can be lifesaving —
but it cannot be the only urban
adaptation strategy.

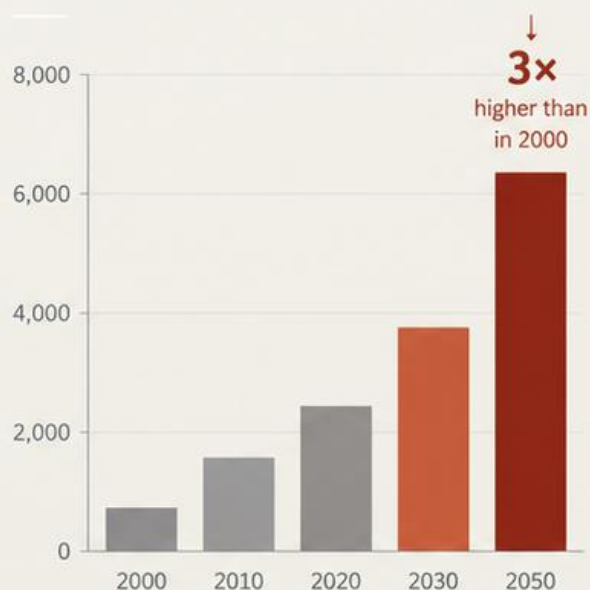


We cannot air-condition our way out.

Rising demand for air-conditioning in cities will increase energy use, costs and emissions — and can further intensify urban heat.

GLOBAL COOLING DEMAND

Electricity demand for space cooling (TWh)



3x

increase in global electricity demand for cooling by 2050.

Source: IEA (2022)



If met with conventional air-conditioning, cooling could account for

up to 40%

of global electricity emissions by 2050.

Source: UNEP (2022)

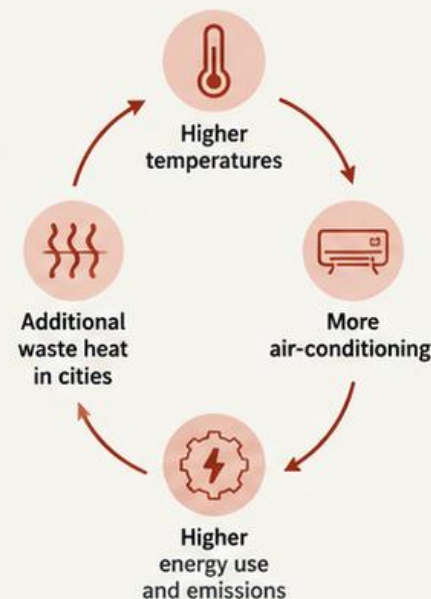


Increasing cooling demand will put additional pressure on households, cities and energy systems.

Source: IEA (2022)

A VISCIOUS CYCLE

More air-conditioning can make cities hotter.



CITIES FACE A GROWING COOLING GAP

Share of households with air-conditioning (%)



Source: IEA (2022)



We need cooler cities — not just more cooling.

Nature-based solutions, cool surfaces and urban design can reduce heat at the source.

A hierarchy for cooler, healthier and lower-emission cities.

Cooling is essential. The most effective and resilient solutions start by avoiding heat, using low-energy systems, maximising efficiency and using clean refrigerants.



The first unit of cooling should be the one we never need to produce.

Avoid heat first. Cool efficiently second. Decarbonise the cooling that remains.

Source: UNEP Global Cooling Watch 2025.

01



PASSIVE COOLING

Minimise loads

Climate-responsive urban and building design, insulation, shading, natural ventilation, cool roofs and nature-based solutions (e.g. urban green spaces and trees) to avoid heat gains in the first place.

**Less heat in.
Lower cooling demand.
Healthier and more liveable places.**

02



LOW-ENERGY COOLING

Avoid refrigeration

Use low-energy mechanical or hybrid systems before energy-intensive compressors, such as ceiling or box fans, evaporative cooling and ventilative cooling strategies.

**Effective cooling
with much lower
energy use.**

03



BEST ENERGY EFFICIENCY

Optimise active cooling

Ensure that any active cooling equipment (air conditioners and commercial refrigerators) operates at peak performance. Enforce strict Minimum Energy Performance Standards (MEPS).

**Same or better
cooling with
significantly less
energy and emissions.**

04



RAPID HFC PHASE-DOWN

Clean refrigerants

Select refrigerants with the lowest practical global warming potential (GWP) without sacrificing efficiency, and accelerate the transition away from HFCs under the Kigali Amendment.

**Dramatically lower
climate impact
from the cooling
that remains.**



**A SUSTAINABLE COOLING PATHWAY CAN REDUCE EMISSIONS
BY 64% BY 2050, AND UP TO 97% WITH A DECARBONISED POWER SECTOR.**

Compared to business as usual.

64%

lower cooling-related
emissions by 2050
(Sustainable Cooling Pathway).

97%

lower emissions by 2050
with rapid power-sector
decarbonisation.

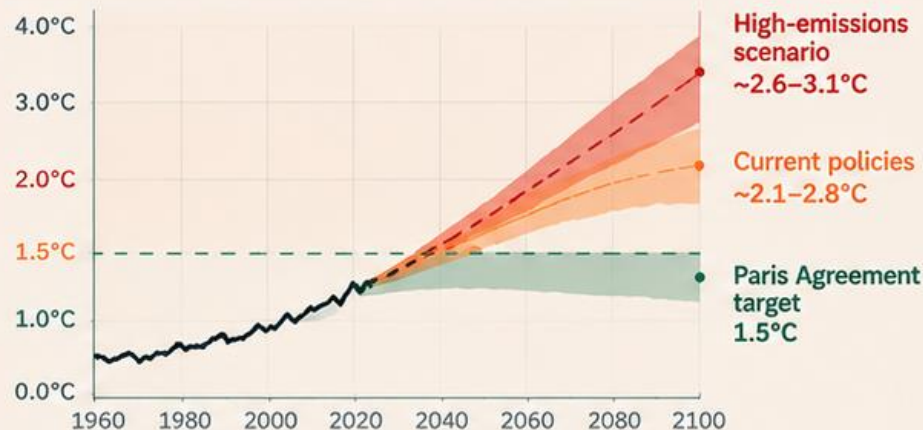
We cannot air-condition our way out of this.

Adaptation is essential, but it has limits.

As the world keeps warming, extreme heat becomes more frequent, intense and widespread, and the capacity of cities, people and ecosystems to adapt is increasingly exceeded.

GLOBAL TEMPERATURE PATHWAYS

Global surface temperature relative to pre-industrial levels



Source: UNEP (2025). Limiting Overshoot: Navigating Exceedance.

MORE HEAT, MORE EXTREMES

With every additional fraction of a degree, risks increase sharply.

+1.5°C



Already more frequent and intense heatwaves in many regions.

+2°C



High risk of unprecedented heat events in many cities. Adaptation becomes more difficult and costly.

+3°C



Extremely hot days become the norm in many regions. Significant limits to human, ecosystem and infrastructure resilience.

+4°C



Conditions in many cities and regions approach or exceed the limits of human and ecological tolerance.

Source: UNEP (2025). Limiting Overshoot: Navigating Exceedance.

WHY MITIGATION REMAINS ESSENTIAL



LIMITS TO ADAPTATION

As temperatures rise, there are physical and biological limits to how much cities, ecosystems and species can tolerate.



GROWING RISKS AND COSTS

Every additional fraction of a degree increases the frequency and intensity of extreme heat, and the damages to people, infrastructure and economies.



PRESERVE ADAPTATION SPACE

Lower temperatures keep more options open for effective, cost-efficient and equitable adaptation.



A SAFER, MORE LIVABLE FUTURE

Deep and rapid mitigation is essential to maintain a safe and adaptable future for people, cities and ecosystems.



Mitigation and adaptation must go together.

Keeping warming as close as possible to 1.5°C reduces risks, preserves adaptation space and enables cooler, livable and more resilient cities.

There are biological and hydrological limits to how much we can adapt.

Beyond certain temperature and water stress thresholds, people, trees and ecosystems cannot cool, function or survive — no matter how well we design.

PEOPLE

Limits of human heat tolerance



~35°C

Limits of effective self-cooling at high humidity.

35–40°C

Increasing risk of heat exhaustion and heat stroke.

>40°C

High risk of serious illness and death, even for healthy people.

Source: Sherwood & Huber (2010); Lancet Countdown (2023).

TREES AND SPECIES

Limits to cooling and survival



< 35°C

Most urban tree species can photosynthesise, transpire and cool effectively.

35–40°C

Decreasing photosynthesis, higher stress, reduced growth and cooling capacity.

> 40–45°C

Many species experience severe stress, loss of function and increased mortality.

Source: Urban Tree Physiology studies (e.g. Rodríguez-Catón et al., 2022); IPBES (2019).

WATER CYCLE

Increasing disruption and uncertainty



MORE INTENSE RAINFALL

Higher risk of flash floods and urban flooding.



A MORE VARIABLE WATER CYCLE

Longer dry periods and greater uncertainty in water availability.



LONGER AND DEEPER DRY PERIODS

Reduced soil moisture, stress on vegetation and lower cooling capacity.

Source: UNEP (2025). Limiting Overshoot: Navigating Exceedance.

KEY MESSAGES



THERE ARE PHYSICAL LIMITS

As temperatures rise, there are thresholds beyond which people, ecosystems and cities cannot adapt.



NATURE IS ALSO VULNERABLE

Trees and other species have temperature and water stress limits that reduce or eliminate their cooling function and survival.



THE WATER CYCLE IS DISRUPTING

More intense rainfall and longer dry periods increase risks and reduce the ability of landscapes to cool.



Mitigation and adaptation must go together.

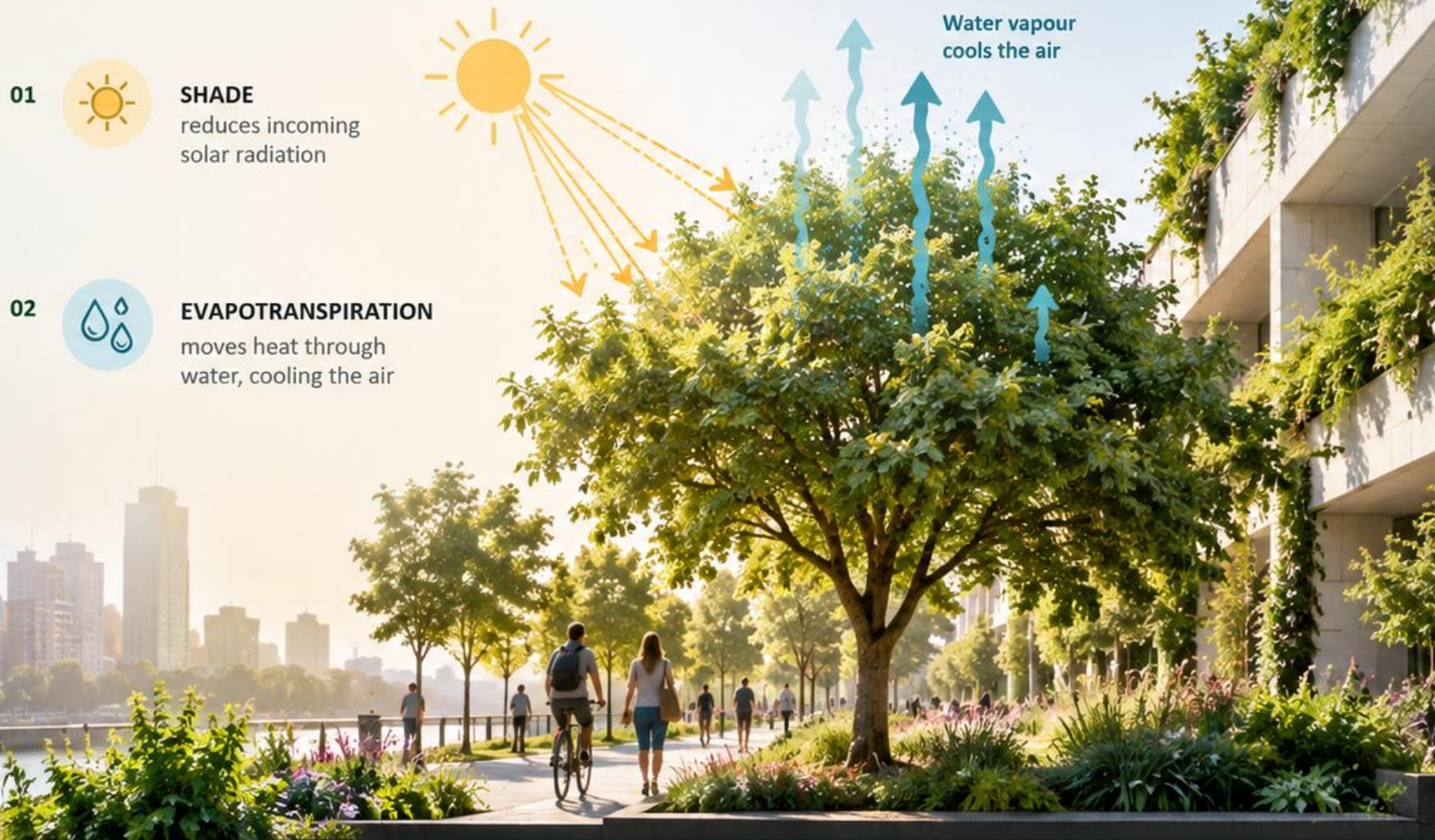
Keeping warming as close as possible to 1.5°C preserves the conditions under which our cities, trees, water systems and ecosystems can still adapt and provide cooling, liveable and resilient places.



The more we overshoot, the fewer options remain for effective and equitable adaptation.

Source: UNEP (2025). Limiting Overshoot: Navigating Exceedance.

Nature is cooling infrastructure



01



SHADE

reduces incoming solar radiation

02



EVAPOTRANSPIRATION

moves heat through water, cooling the air

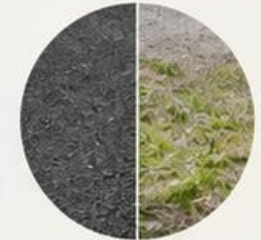
Water vapour
cools the air

03



COOLER SURFACES

less heat storage
+ re-radiation



~50–70°C
(asphalt)

~20–30°C
(shaded/
vegetated)

04



BUILDING SHADE

can reduce
cooling demand



**URBAN FORESTS ARE NOT DECORATION.
THEY ARE CLIMATE INFRASTRUCTURE.**

Planting trees ≠ a cooling strategy

Cooling performance is the product of tree, site and location — not tree count alone.



TREE

The right tree,
for the right function



Canopy

size, shape, density



Species + traits

heat and drought
tolerance



Maturity

cooling increases
with age

Shading
reduces surface
temperatures

Evapotranspiration
cools the air

Healthy soil
stores water and
supports long-term
tree cooling



SITE

Healthy conditions
enable tree cooling



Soil

volume, quality,
compaction



Water availability

rainfall, irrigation,
groundwater



Urban morphology

space for roots and canopy
to grow



LOCATION

Where trees are placed
determines who benefits



Exposure

sunlight, prevailing winds



People

high-use and vulnerable
areas



Vulnerability

social and health risk

Not simply: “How many trees?” → **Where? What? For whom? And can they thrive?”**

We don't plant trees. We plant soil.

What we want above ground depends on what we provide below ground.



COOLER AIR

Shade reduces surface and air temperatures



CLEANER AIR

Filters pollutants and dust



EVAPOTRANSPIRATION

Moves heat through water, cooling the air



HEALTHIER PLACES

Greener, more liveable cities



SOIL VOLUME

Room for roots to grow deep and wide



AIR

Uncompacted soil for healthy roots



WATER

Available when needed and retained in soil



BIOLOGY

A living soil system supports tree health

NO HEALTHY SOIL → NO HEALTHY CANOPY → NO LONG-TERM COOLING

Start with risk. Not with the solution.



Cooling is only the beginning.

Urban forests deliver multiple co-benefits for healthier, more liveable and resilient cities.



From amenity to infrastructure

OLD MODEL

URBAN GREENING

Trees as amenity



Beautification
nicer places



Tree counts
more trees



Opportunistic planting
where space allows



Project-by-project
isolated efforts



Short-term establishment
early survival



NEW MODEL

CLIMATE INFRASTRUCTURE

Trees as a city system



Heat-risk reduction
cooler, safer cities



Canopy performance
the right trees, in the right places



Priority locations
people and places most at risk



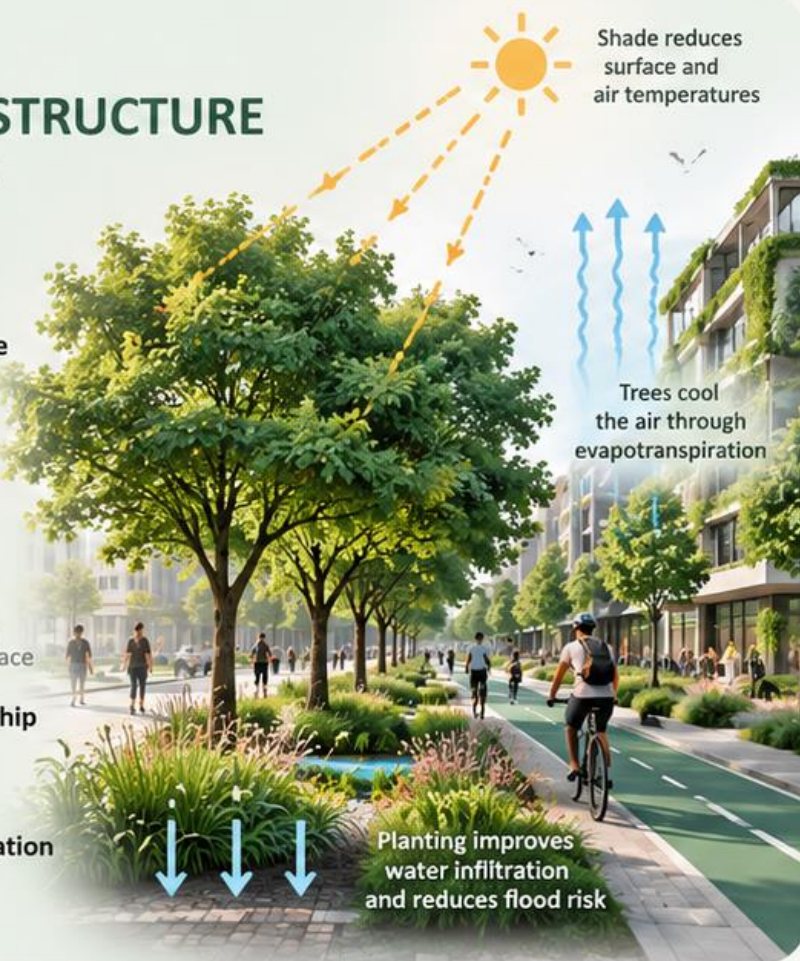
City-wide systems
integrated with water, mobility and public space



Long-term stewardship
care, funding and governance



Monitoring + adaptation
track outcomes and improve over time



PLAN IT.



FUND IT.



MAINTAIN IT.



MEASURE IT.

Shade is public health infrastructure.

During heatwaves, people naturally seek out shade. Trees and green public spaces reduce heat stress and protect health, especially for the most vulnerable.

Plaça de la Universitat,
Barcelona, Spain



Up to 50%

lower risk of heat-related illness in shaded areas.

Source: WHO (2021)



Older adults, children and vulnerable groups

are at highest risk during extreme heat.

Source: UNEP (2021)



Trees can make it feel up to 14°C cooler

under their canopy.

Source: WRI (2023)



People spend more time in green, shaded public spaces during heatwaves.

Source: EEA (2023)

"Access to shade and green spaces is not a luxury. It is a public health necessity in a warming world."

WHO, 2021

A tree can change the **climate** of a street.



Up to **14°C**
cooler under tree canopy
compared to nearby
unshaded areas.

Source: WRI (2023)



Lower surface temperatures
by shading and evapotranspiration.



Higher thermal comfort
for pedestrians.

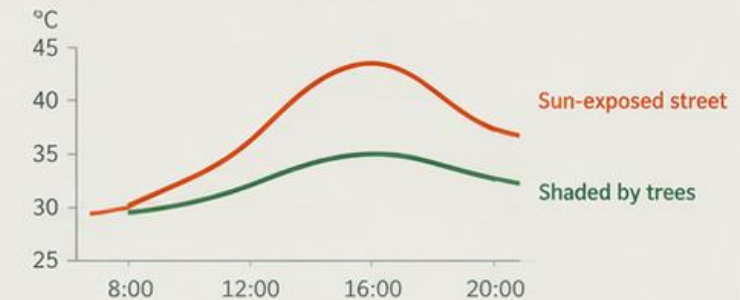


Reduced heat stress risk,
especially for vulnerable groups.



More liveable and attractive
public spaces.

AIR TEMPERATURE THROUGH THE DAY



Urban trees create cooler, healthier
and more resilient cities.

Designing streets that stay cool.

A combination of trees, shade, water, permeable surfaces and climate-responsive design can significantly reduce temperatures and make streets more liveable.



TREE CANOPY

Provides shade, lowers surface and air temperatures.



WATER ELEMENTS

Evaporation cools the air and improves microclimate.



PERMEABLE SURFACES

Reduce heat storage and support water infiltration.



COOL AIR FLOW

Trees and open corridors support natural ventilation.



PLANTING BEDS

Cool through shading and evapotranspiration.



BUILDING DESIGN

Height, orientation and materials influence shading and heat exposure.

SOLAR RADIATION

Reduced by tree canopy and building shade.

KEY DESIGN GUIDELINES



Maximise tree canopy cover

Target 30–50% shade coverage in key pedestrian areas.



Integrate water and blue elements

Use water features, rain gardens and blue infrastructure.



Use permeable and light-coloured materials

Reduce heat storage and support water infiltration.



Ensure ventilation and cool corridors

Align streets and open spaces to prevailing winds.



Design climate-responsive buildings

Consider height, orientation, shading elements and reflective materials.



Create multifunctional green spaces

Combine cooling, biodiversity, water management and social use.

RESULT: COOLER, HEALTHIER STREETS



-2 to -8°C

lower air temperatures in shaded streets

Source: Bowler et al. (2010)



Lower heat stress risk

especially for vulnerable groups



More liveable public spaces

for daily use, social interaction and active mobility



Greater resilience

to heatwaves, extreme rainfall and future climate conditions

THREE THINGS TO TAKE WITH US

01

HEAT IS UNEQUAL.

Prioritise people and places at greatest risk.



People

older adults, children, and vulnerable groups



Places

schools, hospitals, high-heat neighbourhoods



Risk

map heat exposure and vulnerability



02

NATURE IS INFRASTRUCTURE.

Urban forests are essential to sustainable cooling.



Cools cities

shade and evapotranspiration lower temperatures



Cleaner air

filters pollutants and dust



Healthier places

greener, more liveable and equitable cities



03

PERFORMANCE MATTERS.

Success is the protection and resilience delivered over time.



Plan

set targets and standards



Implement

quality design, funding and maintenance



Measure

track outcomes and adapt



FROM HEAT → TO RISK → TO NATURE → TO MEASURABLE RESILIENCE

URBAN FORESTS FOR A HOTTER WORLD

Nature-based solutions for cooler, healthier and more resilient cities.

Eleni Myrivili

Chief Heat Officer, UNEP



European Forum
on Urban Forestry