ERASMUS-EDU-2023-CBHE
Project number: 101129032

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(01/01/2024 – 31/12/2026)

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LAND MANAGEMENT
ENVIRONMENT &
SOLID-WASTE

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MICRO-CREDENTIAL

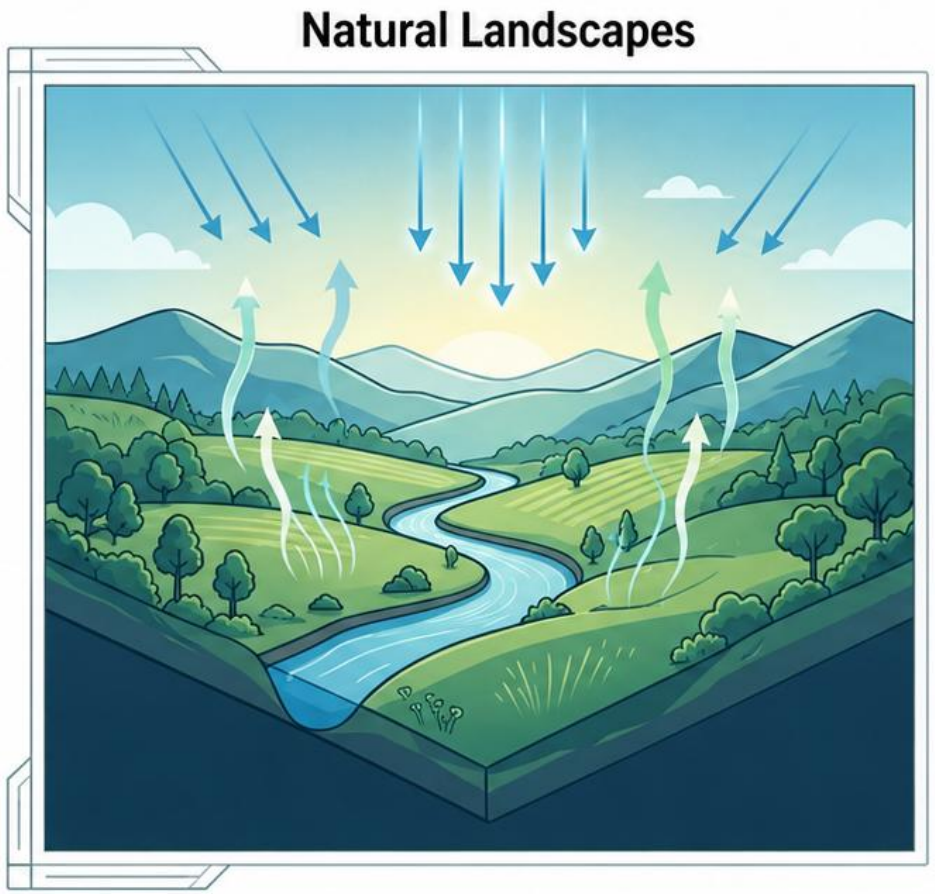
CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

7.- Cities, Air Quality and Human Health

Urban Heat Island, Built Enviroment and Energy Demand

CC-W07-V25

Why Are Cities Becoming Hotter?





Urbanization replaces natural cooling surfaces with materials that absorb, store and release more heat.

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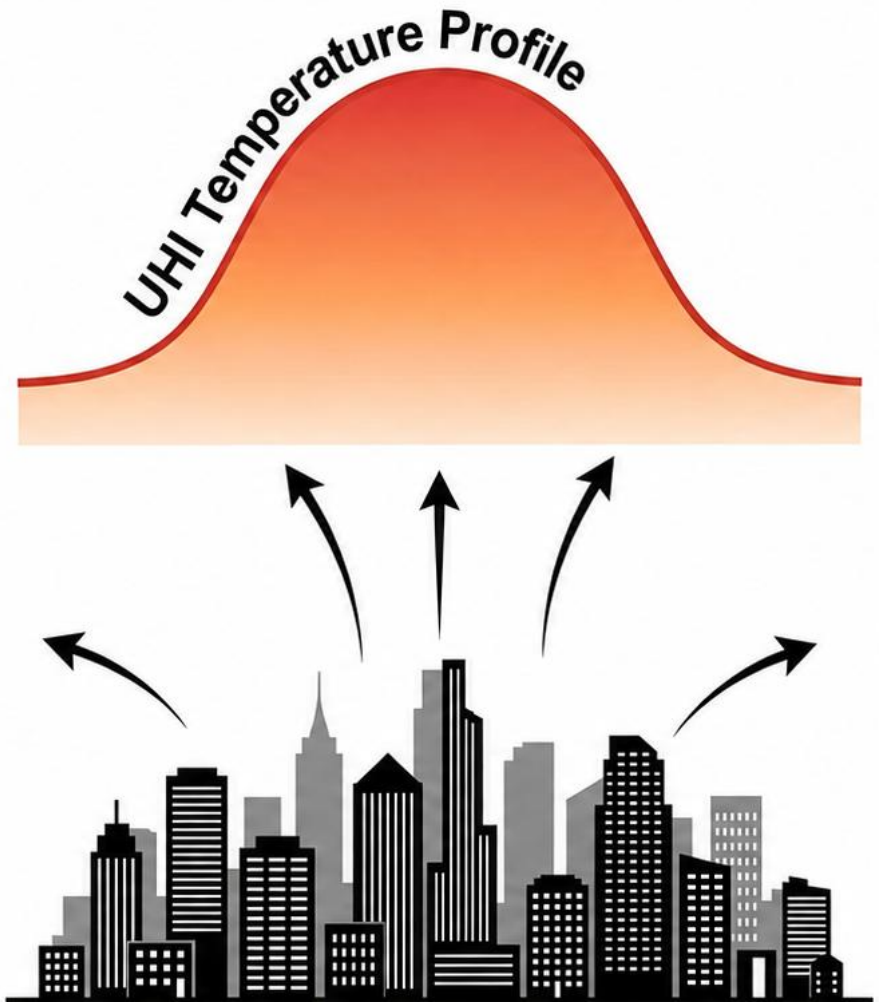
Understanding the Urban Heat Island

1. The Urban Heat Island (UHI) is the temperature difference between urban areas and their surrounding rural environments.



2. Temperatures usually peak over the urban core, where buildings and paved surfaces dominate.

3. UHI intensity increases with dense construction, limited vegetation, and heat stored during the day.

4. The effect is often strongest after sunset, when urban materials release stored heat.

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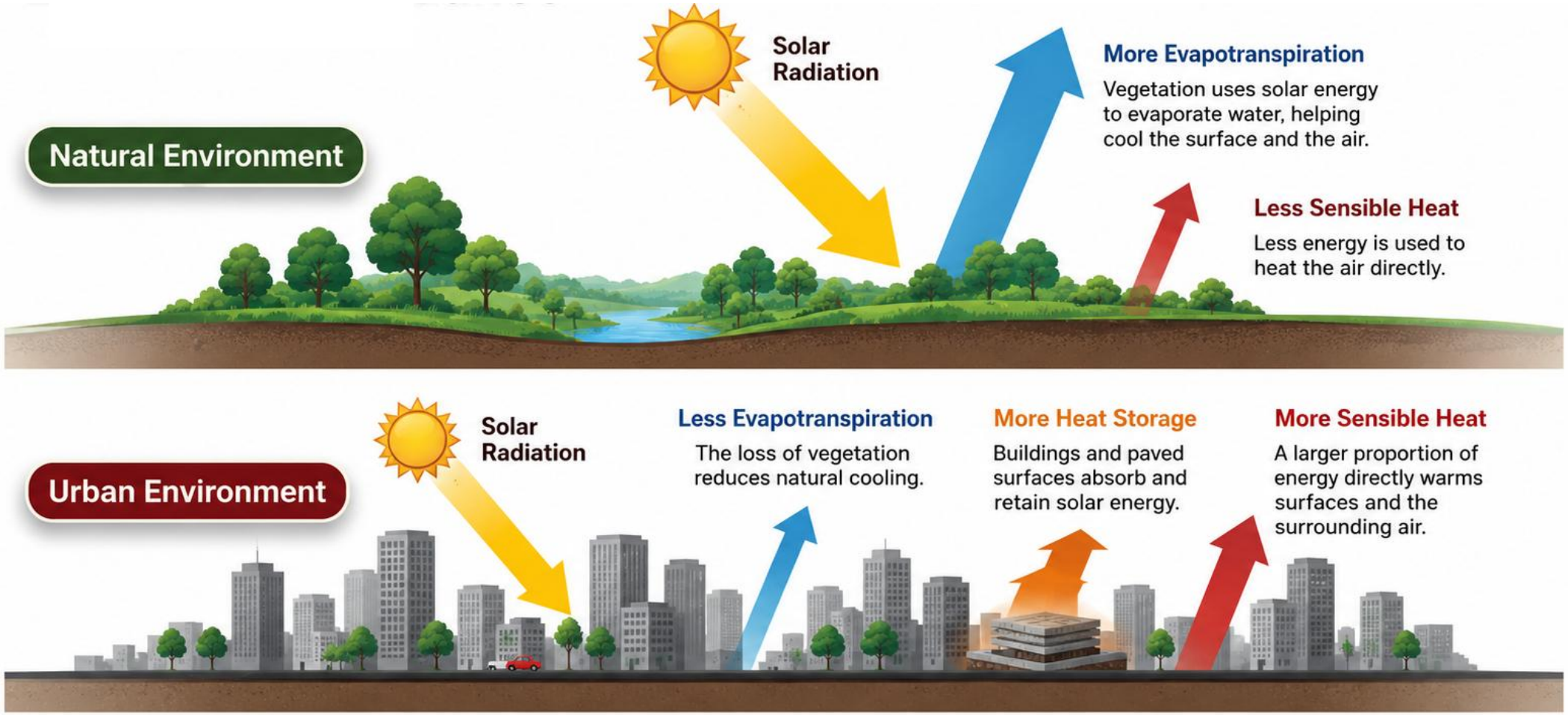
How Urbanization Changes the Local Energy Balance



Urbanization shifts energy away from evapotranspiration and toward heat storage and sensible heating.

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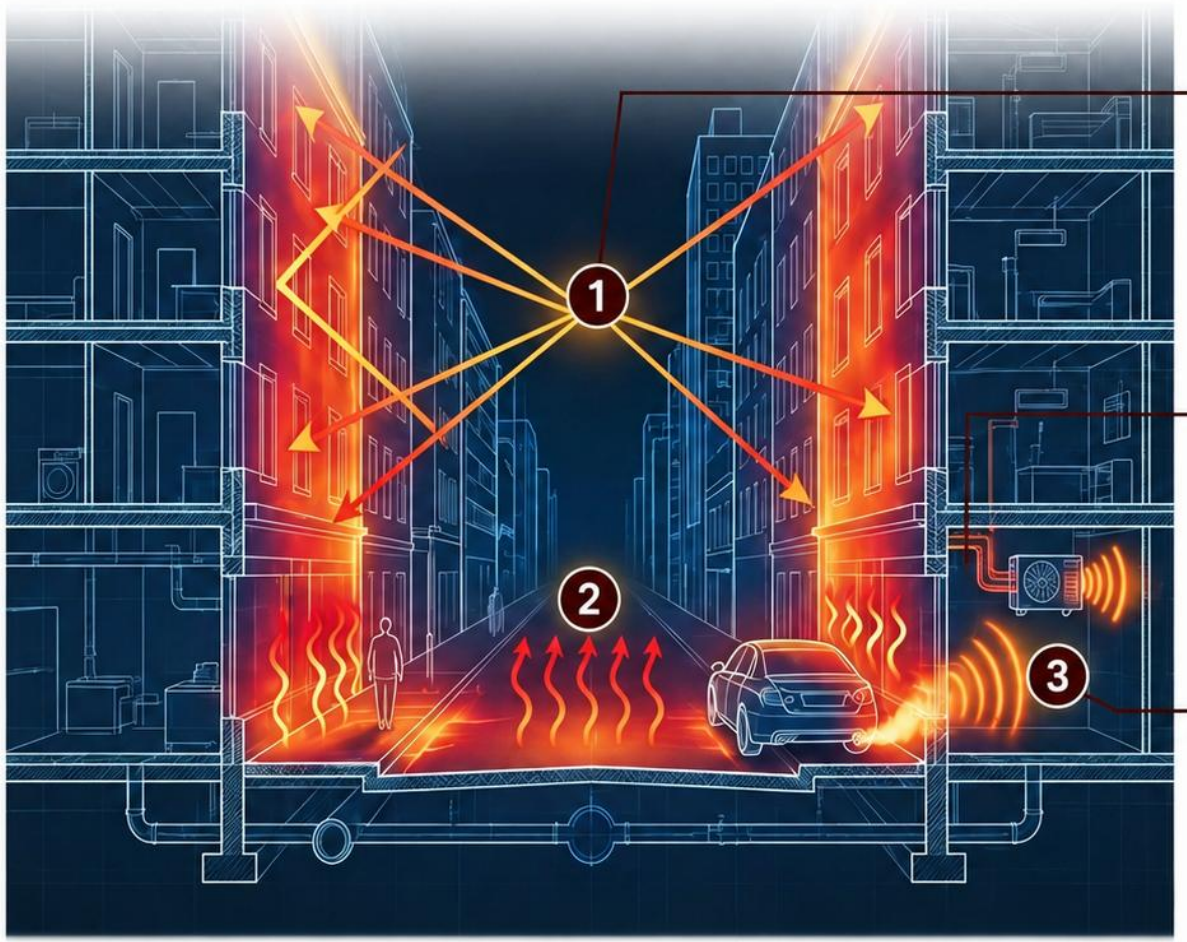
The Built Environment as a Heat Generator



1 Urban Canyon Effect:
Tall buildings reduce sky exposure, airflow, and nighttime heat loss.

2 Heat Storage:
Buildings and paved surfaces absorb solar energy and release it slowly.

3 Anthropogenic Heat:
Traffic, buildings, industry, and air conditioning release additional heat.

Urban form, heat-storing materials and human activities intensify urban warming.

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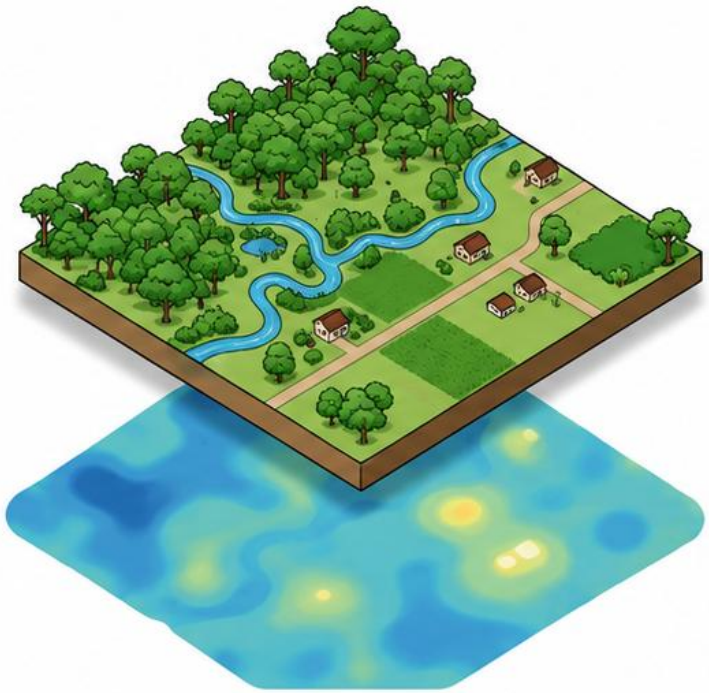
Why Some Parts of a City Are Hotter Than Others

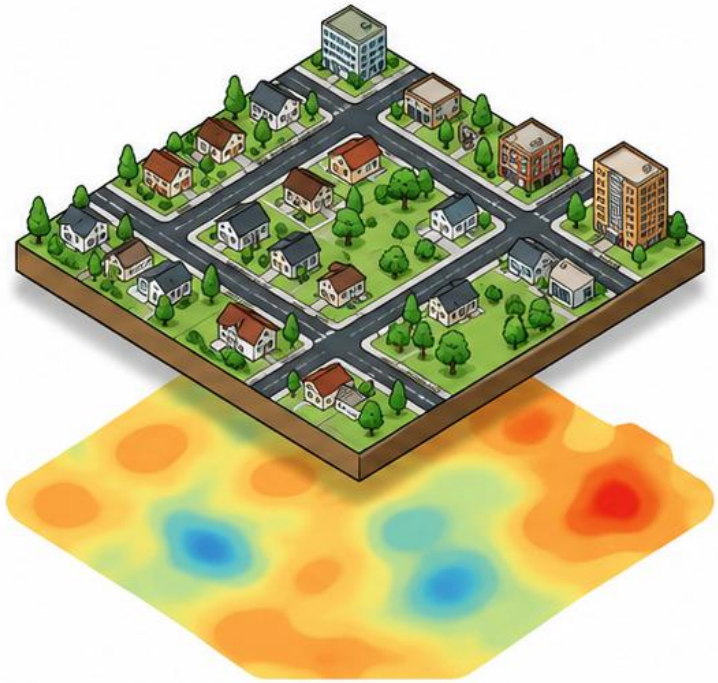
Urban temperatures vary according to vegetation, building density, surface materials, and human activity.

Green / Peri-Urban Zone



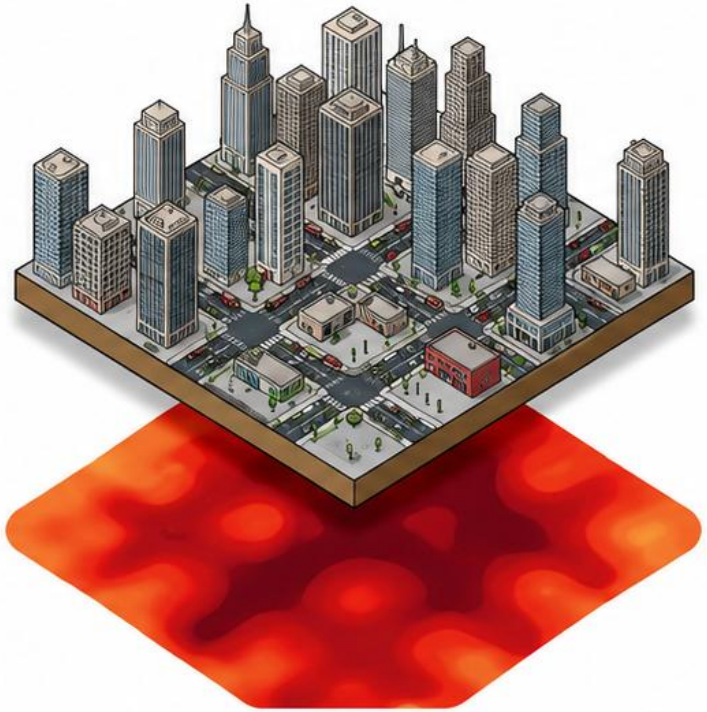
Vegetation and water provide shade and evaporative cooling.

Residential / Suburban Zone



Mixed land cover creates intermediate temperatures and local variations.

Dense Urban Center



Dense buildings, impervious surfaces, and limited vegetation produce the highest temperatures.

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Evidence of Urban Heat Islands Around the World

Observed Worldwide

Urban Heat Islands have been documented across different climates and continents.

Measured by Multiple Methods

Weather stations, mobile measurements, and satellite observations reveal urban–rural temperature differences.



Magnitude Varies

UHI intensity depends on city form, vegetation, weather conditions, and the measurement method.







Urban Heat Islands are globally observed, but their intensity and spatial pattern differ between cities.

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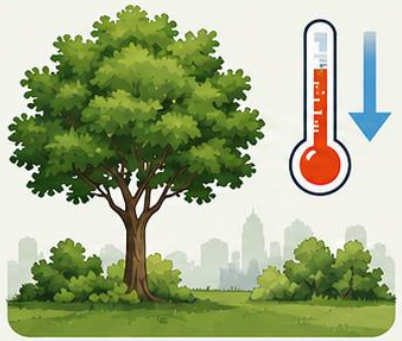
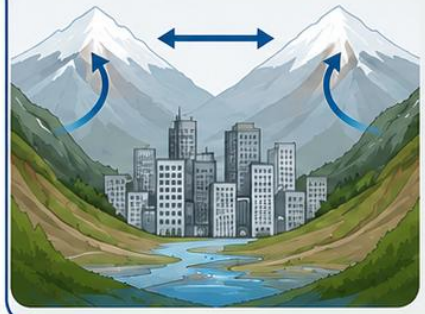
Urban Heat in Central Asian Cities

Central Asian cities combine hot, dry summers, rapid urban growth, and uneven vegetation cover, increasing exposure to urban heat.



Tashkent: Urban Growth and Vegetation

Urban expansion and declining vegetation can increase surface temperatures. Trees and green spaces provide localized cooling.



Almaty: Urban Form and Topography

Dense development and limited air circulation can intensify heat in some districts. Local topography also influences urban ventilation.



Urban heat in Central Asia is shaped by regional climate, urban form, vegetation and local topography.

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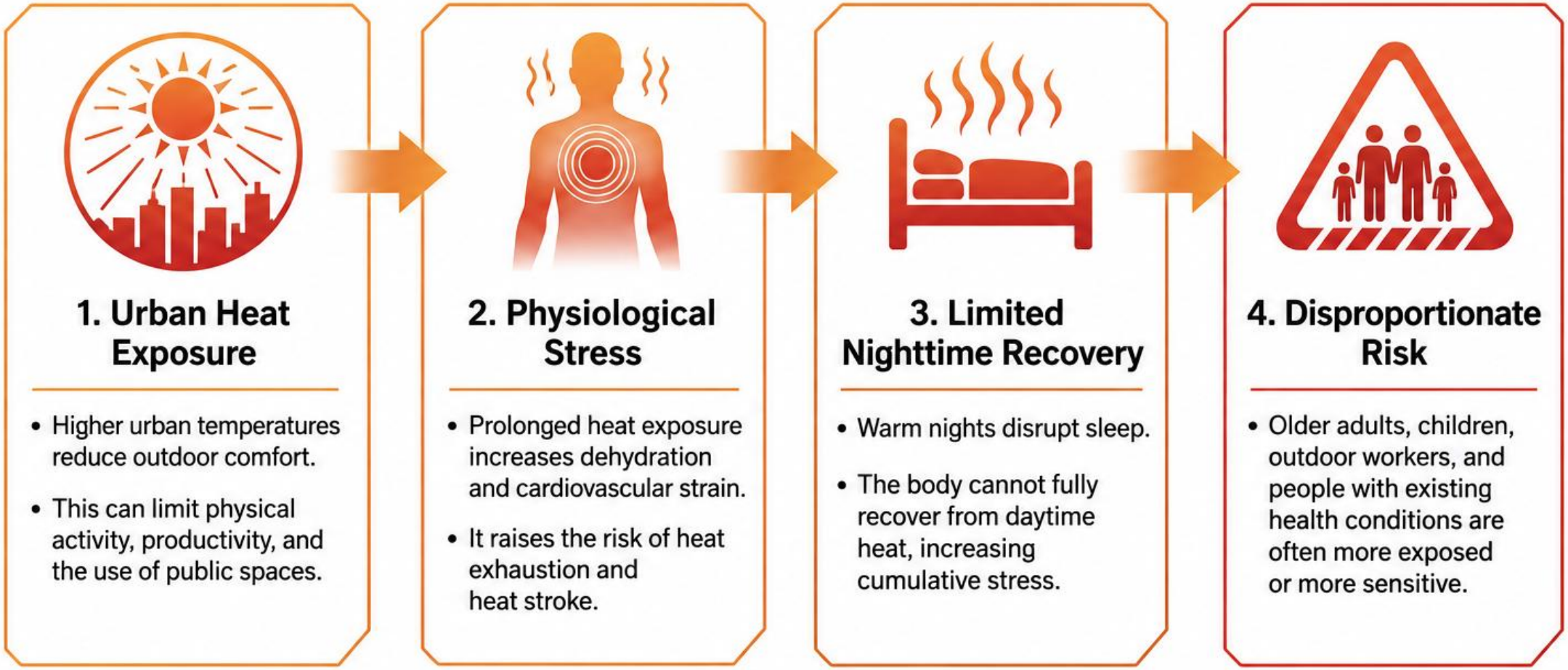
Urban Heat and Human Well-Being



1. Urban Heat Exposure

- Higher urban temperatures reduce outdoor comfort.
- This can limit physical activity, productivity, and the use of public spaces.

2. Physiological Stress

- Prolonged heat exposure increases dehydration and cardiovascular strain.
- It raises the risk of heat exhaustion and heat stroke.

3. Limited Nighttime Recovery

- Warm nights disrupt sleep.
- The body cannot fully recover from daytime heat, increasing cumulative stress.

4. Disproportionate Risk

- Older adults, children, outdoor workers, and people with existing health conditions are often more exposed or more sensitive.

Urban heat affects health, sleep, productivity and quality of life, with unequal impacts across the population.

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Why Hotter Cities Need More Energy

1. Rising Cooling Demand

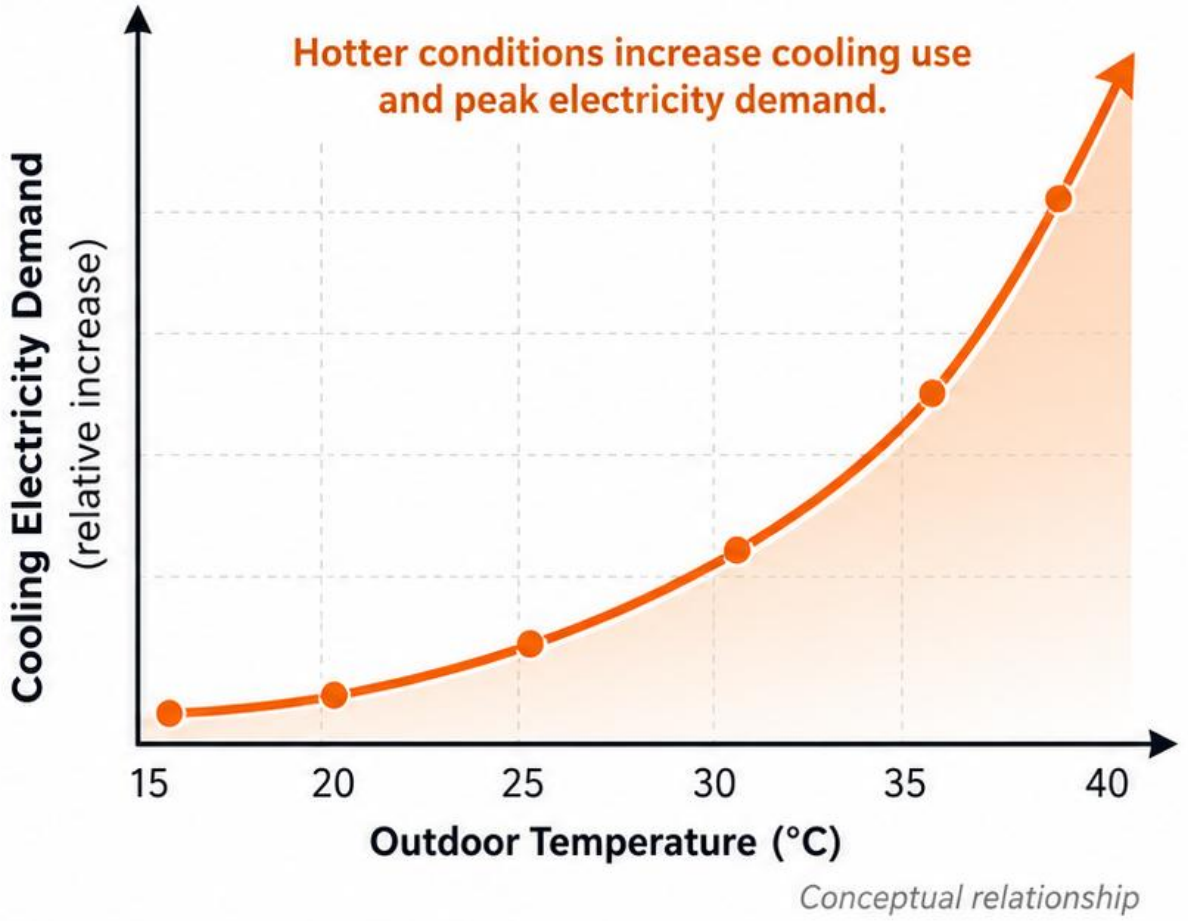
As outdoor temperatures rise, households and buildings use more fans and air conditioning.

2. Higher Peak Electricity Demand

During hot periods, simultaneous cooling use can create sharp peaks in electricity consumption.

3. Greater Costs and Emissions

Higher electricity demand increases operating costs and may raise emissions where power generation depends on fossil fuels.



Higher urban temperatures increase cooling needs, electricity consumption, and pressure on energy systems.

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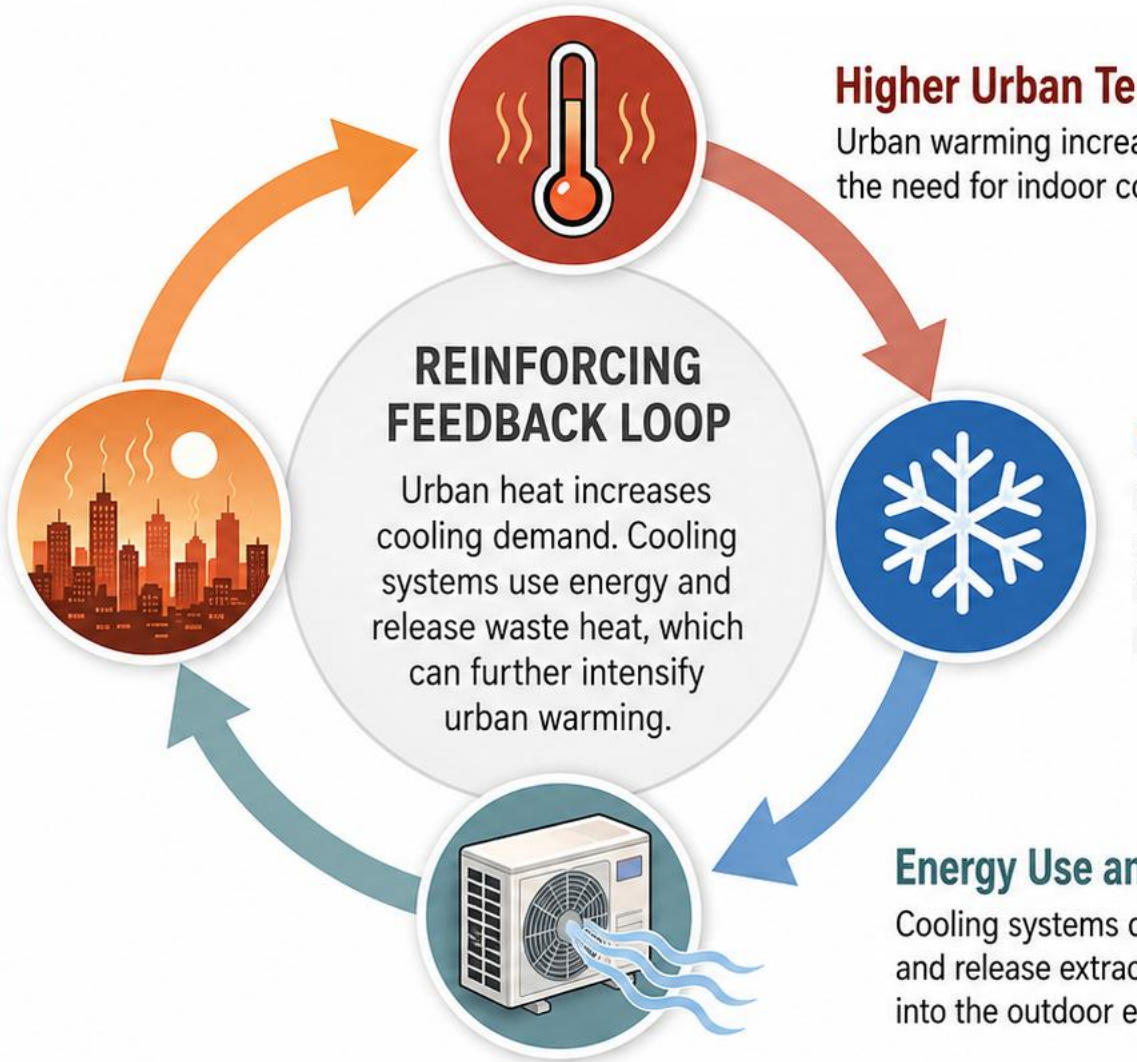
The Urban Heat–Energy Feedback Loop



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Cooling Cities with Nature

Before



Dark impervious surfaces absorb and store solar energy, increasing surface temperatures.

After



Shade

Tree canopies reduce the solar radiation reaching streets, sidewalks, and building surfaces.

Evapotranspiration

Vegetation uses water to dissipate heat, helping cool surfaces and the surrounding air.

Green Infrastructure

Parks, green roofs, and tree-lined streets provide cooling while supporting stormwater management and urban well-being.

Green infrastructure can reduce urban heat through shade and evapotranspiration while providing additional environmental and social benefits.

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Designing Climate-Smart Cities



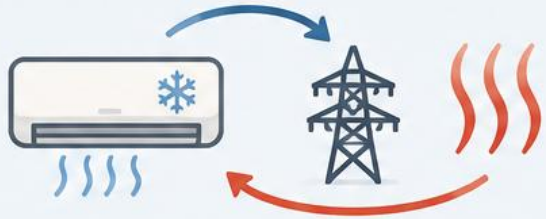
1. Urbanization Changes the Local Energy Balance

Replacing vegetation with buildings and pavement reduces evaporative cooling and increases heat storage.



2. Urban Heat Affects People and Urban Systems

Urban heat increases health risks, reduces well-being, and raises cooling and electricity demand.



3. Cooling Can Reinforce Urban Warming

Air conditioning provides indoor relief, but electricity use and outdoor waste heat can intensify urban warming.



4. Integrated Urban Design Can Reduce Heat

Green infrastructure, cool materials, and climate-sensitive urban form can reduce heat exposure and improve resilience.

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